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RECORDS OF THE ANTARCTIC TREATY MEETING OF EXPERTS ON LOGISTICS

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FOREWORD

The present volume is a collection of the final report and its annexes of the Antarctic Treaty Meeting of Experts on Logistics, the papers presented thereto and other relevant papers. The Meeting was held under the Recommendations of the Fourth Antarctic Treaty Consultative Meeting. The Government of Japan acted as host to the Meeting which took place in Tokyo from June 3rd to 8th 1968.

The Headquarters of Japanese Antarctic Research Expediton was set up in the Ministry of Education in 1955, whose aim it is to promote under a well coordinated programme the preparation for and the conduct of the research expedition of geophysical phenomena in the Antarctic.

The Headquarters have been under the direction of the successive Ministers of Education and are now planning to send to the Antarctic the Tenth Research Expedition Party at the end of this month.

For a successful research expedition, the logistics are indispensable. A greater attention is always paid to the logistics in Japan. It is, therefore, quite meaningful for us all that the Meeting was a success and brought forth fruitful results in this country.

It is sincerely hoped that this volume be of service to the organizations and individuals interested in the Antarctic research expedition.

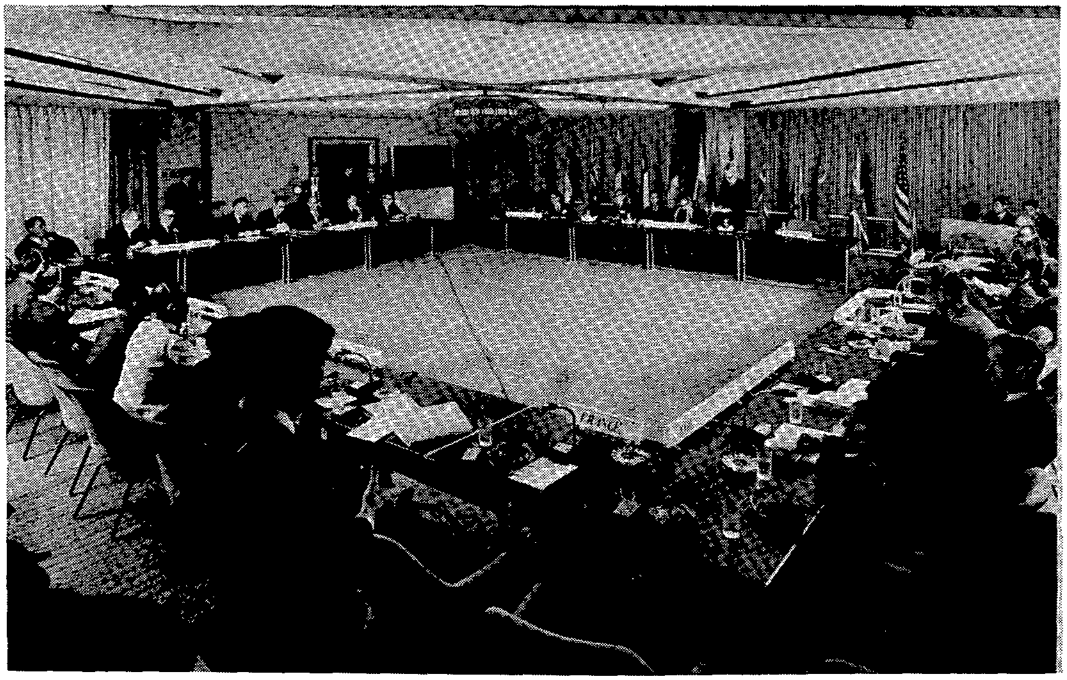
This volume has been prepared by the International Science Cooperation Section, Higher Education and Science Bureau, Ministry of Education, under the command of Mr. Keizo Shibuya, Councillor of the Bureau, then Secretary-general of the Meeting, with the cooperation of Department of Polar Research of National Science Museum, an organ under jurisdiction of the Ministry.

The final report and other documents contained in this volume are the products of a concerted effort of all the participants in the Meeting and grateful acknowledgement is made to all the participants who provided great assistance and cooperation in preparation of this volume.

November 1968

Sei Saito

Sei Saito
Vice-Minister of Education



Greeting by Mr. Hirokichi Nadao, Minister of Education at the Opening Ceremony

RECORDS OF THE
ANTARCTIC TREATY MEETING OF EXPERTS ON LOGISTICS
(Tokyo, 3 - 8 June 1968)

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PART I

FINAL REPORT

The Antarctic Treaty Meeting of Experts on Logistics was held in Tokyo, from 3rd to 8th June, 1968, in accordance with Recommendations IV-24 and IV-25 of the Fourth Antarctic Treaty Consultative Meeting held in Santiago in November, 1966.

Representatives of all the Consultative Parties attended. (see Annex A)

The Agenda included a wide range of topics (see Annex B) and 59 papers were presented (listed in Annex C). These papers will be transmitted to the participating governments.

The Minutes of the Meeting are attached (Annex D). The Japanese Government is considering the possibility of publishing a full report.

Proceedings covered descriptions of the experiences of expeditions and of plans being made for future expeditions to improve their logistic support. The principles governing logistic support were also discussed.

The Meeting noted that a very useful and productive exchange of logistic information had taken place. The representatives feel that some means should be found to continue this exchange. It was agreed that Representatives should draw the attention of their Governments to the advantages of such continuity. They feel that it would be appropriate to include discussion of this topics at the Fifth Antarctic Treaty Consultative Meeting in Paris in November, 1968. It is expected that the existing S.C.A.R. Working Group on Logistics will continue its activities within the framework of S.C.A.R.

RAPPORT FINAL

La Réunion d'Experts sur Logistique du Traité sur l'Antarctique s'est tenue à Tokyo du 3 au 8 juin 1968, comme suite aux Recommandations IV.24 et IV.25 de la 4me Assemblée consultative du Traité sur l'Antarctique tenue à Santiago en November 1966.

Des Représentants de toutes les Parties consultatives étaient présents (voir Annexe A).

Les questions à l'order du jour portaient sur un large éventail de sujets (voir Annex B); 59 rapports furent présentés (voir Annex C). Ces rapports seront transmis aux gouvernements participants.

Les compte-rendus des séances sont joints (Annex D). Le Gouvernement japonais envisage la possibilité de publier un rapport in extenso.

Les débats portèrent sur l'experience acquise sur les expéditions, ainsi que les projets d'améliorations de la logistique dans le future. Les principes généraux de la logistique furent également discutés.

L'Assemblée signale qu'au cours de cette réunion un fructueux échange d'informations logistiques a eu lieu. Les Représentants estiment que de tels échanges devraient se poursuivre. Il est demandé aux Représentants d'attirer l'attention de leur Gouvernment sur l'intérêt d'une telle continuité. Ils estiment qu'il serait opportun de faire figurer cette dernière question au nombre des thèmes qui seront débattus, à la 5me Assemblée Consultative du Traité sur l'Antarctique qui se tiendra à Paris au mois de novembre 1968. Par ailleurs le Groupe de Travail de logistique du S.C.A.R., pursuivra ses activités dans le cadre du S.C.A.R.

РЕШЕНИЕ

В соответствии с рекомендацией 4-24 и 4-25 Четвертого Консультативного совещания участников Антарктического договора, проведенного в Сантяго в ноябре 1966 года, с 3-го по 8-е июня 1968 года в Токио было проведено совещание экспертов по логистике стран-участниц Антарктического договора.

Присутствовали представители всех стран-участниц Антарктического договора. (Приложение А)

Повестка включала широкий круг вопросов (Приложение Б) и делегатами было представлено 59 сообщений (перечислены в приложении В).

Эти сообщения будут переданы правительствам стран-участниц.

Протоколы совещания прилагаются (Приложение Д). Японское правительство изучает сейчас возможность опубликования полного отчета.

В сообщениях был отражен опыт экспедиций и планы улучшения обеспечения будущих экспедиций. Обсуждались также принципы, лежащие в основе организации обеспечения.

Совещание отметило, что имел место очень полезный и продуктивный обмен информацией относительно обеспечения экспедиций. Представители высказали пожелание о том, что необходимо найти путь для продолжения такого обмена. Было решено обратить внимание своих правительств на пользу продолжения такого обмена.

Все пришли к заключению, что будет правильным включить обсуждение этого вопроса в повестку Пятого Консультативного совещания стран-участниц Антарктического договора, которое состоится в Париже в ноябре 1968 года. Ожидается, что существующая рабочая группа НКАИ по логистике продолжит свою работу в рамках НКАИ.

INFORME FINAL

Entre los días 3 y 8 de junio de 1968 se celebró en Tokio la Reunión de Expertos en Logística del Tratado Antártico, de acuerdo con las Recomendaciones IV-24 y IV-25 de la IV Reunión Consultiva de las Partes Contratantes del Tratado Antártico que se celebró en Santiago de Chile en noviembre de 1966.

A la Reunión de Tokio asistieron Representantes de todas las Partes Contratantes. (ver Anexo A)

La Agenda incluyó una amplia variedad de temas (ver Anexo B), y además las diversas Delegaciones presentaron 59 informes (ver Anexo C). Estos informes serán enviados a los Gobiernos participantes.

Se agregan las minutas de la Reunión (ver Anexo D). El Gobierno del Japón está considerando la posibilidad de publicar un informe completo.

En el curso de las conversaciones se presentaron descripciones de las experiencias obtenidas por las diversas expediciones, y los planes en proyecto para mejorar su apoyo logístico. Se discutieron también los principios que gobiernan el apoyo logístico.

La Reunión reconoció que durante su desarrollo tuvo lugar un intercambio de informaciones logísticas muy util y productivo. Los Representantes estiman que debieran hallarse medios para continuar este intercambio. Se acordó que los Representantes deberían poner en conocimiento de sus Gobiernos las ventajas de tal continuidad.

Los Representantes creen que sería apropiado incluir la discusión de este tópico en la V Reunión Consultiva de las Partes Contratantes del Tratado Antártico que tendrá lugar en París, en noviembre de 1968.

Es de esperar que el Grupo de Trabajo sobre Logística del S.C.A.R. continuará sus actividades dentro del marco general del S.C.A.R.

Annex A

LIST OF PARTICIPANTS

ARGENTINA

Representative:	Capt. Julio Alberto Aureggi, Naval Military and Air Attaché, Embassy of the Argentine Republic, Tokyo
Alternate Representative:	Lt. Commander Jorge Felix Roberto Búsico
Advisers:	Mr. Javier J. Rinaldini Consul
	Capt. Carlos Perticarari

AUSTRALIA

Representative:	Mr. D. F. Styles Acting Director, Antarctic Division, Department of Supply
Alternate Representatives:	Mr. M. I. Homewood Assistant Secretary, Department of Supply
	Mr. J. L. Lavett Department of External Affairs
	Mr. A. M. Brown Senior Engineer, Antarctic Division, Department of Supply

BELGIUM

Representative:	Baron Gaston de Gerlache de Gomery Président du Comité antarctique belge-néerlandais et du Comité antartique belge

CHILE

Representative:	Mr. Lucio Parada Chargé d'affairs a.i., Embassy of Chile, Tokyo

FRANCE

Representative:	M. C. de Bartillat Directeur-adjoint d'Amérique
Alternate Representative:	M. Paul-Emile Victor Directeur des Expéditions Polaires françaises

JAPAN

Representative:	Dr. Takesi Nagata Professor, Geophysical Institute, University of Tokyo
Alternate Representatives:	Dr. Eizaburo Nishibori Board of Directors, Japan Nuclear Ship Development Agency
	Dr. Koreo Kinosita Professor, Department of Physics, Gakushuin University
	Dr. Tetsuya Torii Professor, Chiba Institute of Technology
	Rear Admiral Toshiharu Honda Maritime Staff Office, Japan Maritime Self Defense Force
Advisers:	Dr. Seiiti Awano Professor, Department of Mechanical Engineering, Nihon University
	Dr. Matao Sanuki Professor, Department of Mechanical Engineering, Nihon University
	Dr. Fumio Tamaki Professor, Institute of Space and Aeronautical Science, University of Tokyo
	Mr. Takeo Kawahara Technical Adviser, Nihon Short Wave Broadcasting Company
	Mr. Akira Murauchi Assistant Professor, Department of Architecture, Nihon University

JAPAN (Cont'd)

Mr. Toshio Sato
Assistant Professor, Department of Architecture, Nihon University

Dr. Yoshimichi Harada
Head of Geodetic Division, Geographical Survey Institute

NEW ZEALAND

Representative: Mr. R. B. Thomson
Superintendent, Antarctic Division, Department of Scientific and Industrial Research

NORWAY

Representative: Dr. Tore Gjelsvik
Director of Norsk Polarinstitutt

SOUTH AFRICA

Representative: Mr. D. Joubert
Secretary of Transport

Alternate Representative: Mr. M. Coetsee
Administrative Control Officer, Antarctic Affairs

SOVIET UNION

Representative: Dr. E. S. Korotkevich
Arctic and Antarctic Research Institute

Alternate Representatives: Dr. M. G. Ravich
Arctic Geological Research Institute, Academy of Science of the USSR

Dr. V. A. Troitskaya
Geological Institute, Academy of Science of the USSR

UNITED KINGDOM

Representative: | Dr. Brian Roberts
Head of Polar Regions Section,
Americal Department, Foreign Office
Alternate Representatives: | Sir Vivian Fuchs
Director of British Antarctic Survey

Representative:	Dr. Brian Roberts Head of Polar Regions Section, Americal Department, Foreign Office
Alternate Representatives:	Sir Vivian Fuchs Director of British Antarctic Survey
	Dr. Gordon Robin Director of Scott Polar Research Institute, Cambridge

UNITED STATES OF AMERICA

Representative:	Rear Admiral James L. Abbot, Jr. USN, Commander, U.S. Naval Support Force, Antarctica
Alternate Representatives:	Mr. Philip M. Smith National Science Foundation
	Capt. Fred J. Bernstein USN, Assistant Chief of Staff for Operations, Naval Support Force, Antarctica
Advisers:	Mr. William Littlewood Deputy Scientific Attaché, American Embassy, Tokyo
	Dr. Louis Quam Chief Scientist, Office of Antarctic Programs, National Science Foundation
	Cdr. James Keith Assistant to Commander, U.S. Naval Support Force, Antarctica

OBSERVER

Rear Admiral Rodolfo N. Panzarini

Annex B

AGENDA

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2. Oversnow transport; new vehicles including air cushion types.
3. Air transport, including airfields.
4. Sea transport.
5. Safety measures.
6. Personal equipment.
7. Special and future support projects.
8. New and urgent problems which Governments agree require discussion.

ORDRE DU JOUR

1. Dessins et plans des bâtiments, services des bâtiments en y incluant l'élimination des déchets et l'approvisionnement en eau.
2. Transports sur neige(véhicules nouveaux, y compris les types de coussin à air).
3. Transports aériens et aérodromes.
4. Transports maritimes.
5. Mesures de sécurité.
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ROYAUME-UNI		
La logistique par rapport aux futures recherches scientifiques antarctiques	G. de Q. Robin	59
ETATS-UNIS D'AMERIQUE		
Emploi de données obtenues des satellites météorologiques, comme aide à la prévision des programmes de travaux dans l'Antarctique	C. F. Bird	60
Praticabilité d'observatoires géophysiques automatisés, dégarnis de personnel	Philip M. Smith et Jon A. Jenny	61

Annex D

MINUTES

MONDAY, JUNE 3

Opening Session
(10:10~10:55)

Delegations present: Argentina, Australia, Belgium, Chile, Japan, Norway, New Zealand, South Africa, the United Kingdom and the United States of America.

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Officers

Chairman:	Dr. T. Nagata (Japan)
Secretary General:	Mr. K. Shibuya (Japan)
Secretaries:	Dr. K. Kusunoki (Japan)
	Mr. T. Misumi (Japan)
Rapporteurs:	Mr. J. Lavett (Australia)
	Baron de Gerlache de Gomery (Belgium)

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Chairman Nagata (Japan) called the meeting to order at 10:10 hours and introduced Mr. Nadao, Minister of Education and concurrently General Director of the Headquarters of the Japanese Antarctic Research Expedition.

Mr. Nadao delivered a welcoming address on behalf of his government, in which he stressed the basic importance of logistics in Antarctic research expeditions.

Chairman Nagata (Japan) read two goodwill message telegrams to the Meeting: one from Mr. Hamm of the Mawson Station and the other from Mr. Murayama of the Syowa Station.

He then called a brief recess at 10:16. The session was resumed at 10:40.

Chairman Nagata (Japan) introducted a draft Rules of Procedure(of which the text had been distributed to all delegations), and, in accordance with suggestions his government had received from signatory countries, he proposed an amendment to Rule 2, deleting the phrase which read: " . . . prior to the opening of the meeting." Having ascertained that there were no objections, he declared the Rules of Procedure approved, as amended.

On the motion of the Delegations from the United Kingdom and the United States, Chairman Nagata nominated, and the Meeting appointed, Mr. J. Lavett of the Australian Delegation and Baron de Gerlache de Gomery of the Belgian Delegation respectively as Rapporteurs, the latter on the understanding that his charge would be taken over by the French Delegation as soon as it arrived in Tokyo.

In accordance with Rule 8 of the Rules of Procedure, Chairman Nagata (Japan) advised the meeting of the appointment of Mr. Shibuya as Secretary General, Dr. Kusunoki and Mr. Misumi as Secretaries.

On the proposal of the Australian Delegation, the Representative of the Japanese Government was nominated, and approved by the Meeting as chairman for the opening and closing sessions.

Chairman Nagata (Japan), referring to the proposed agenda which had been previously circulated among all participating governments, reported that the agenda had been accepted by all of them, and noting no objections, he declared the Agenda adopted.

Dr. Roberts (U.K.) proposed, under Recommendation IV-24, that Rear Adm. R.N. Panzarini of Argentina should be asked to attend the Meeting as a guest expert.

The proposal was supported by Argentine Delegation and approved by all countries except Belgium whose Government thinks that this proposal does not conform with to the interpretation which should be given to Recommendation IV-24. The Belgian Delegation abstained, pending instructions from his Government, but he hoped that it would allow him to give a favourable conclusion to the British proposal.

Having finished the procedural matters, Chairman Nagata declared the Opening Session closed at 10:55 hours.

Morning Session

(11:15~12:00)

Subject	Agenda 1	
Delegations present		(as for the Opening Session)
Officers	Chairman:	Capt. J.A. Aureggi (Argentina)
	Secretary General:	Mr. K. Shibuya (Japan)
	Secretaries:	Dr. K. Kusunoki (Japan)
		Mr. T. Misumi (Japan)
	Repporteurs:	Mr. J. Lavett (Australia)
		Baron de Gerlache de Gomery (Belgium)

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Chairman Aureggi (Argentina) expressed his government's keen interest in the exchange of technical information concerning Antarctic logistics, and invited the Australian Delegation to present its paper.

Mr. Styles (Australia) presented a short summary of the 1st paper of his Delegation on the outline design of an Antarctic station to minimize drift accumulation (Document 7). By way of an explanation of the background to his summary, he described the station at Wilkes as being based on rock in an area where there was fairly high drift accumulation and stated that the temperatures varied from -37°C in winter to +8°C in summer with a mean of approximately -10°C, an environment that could not be called very severe in Antarctic terms. The logical thing, he observed, seemed to be to try to use the forces which create the problem to remove the problem, and, on the basis of wind tunnel tests with a scale model and the actual experiences his team had had, he suggested that (1) buildings should be built on ridges, instead of in a depression, with a minimum ground clearance of 5 ft. beneath the buildings in order to ensure that the wind would keep the slots open beneath them; (2) the buildings should form a single line having the direction across the wind; (3) the station should be designed storongly enough to withstand winds of 120 knots.

Sir Vivian Fuchs (U.K.) asked whether the laboratory test, to which Mr. Styles had referred, had been conducted on a simulated rock surface or on ice, and commented that the acceleration of the wind under the elevated building might erode that surface and form a hollow and thus distort the calculations.

Mr. Styles (Australia) replied that the test had been conducted with a hard surface and that he expected the hollow to be filled with a low velocity wind. On these grounds, he thought that it would not cause any closure of the open area beneath the building.

Sir Vivian Fuchs (U.K.) cited one of his experiences with elevated stores, four feet above the surface, to show an increase of the drift on the downwind side, and Mr. Styles replied that in the recent experiment conducted on the plateau near Wilkes where deposition exceeded erosion, the area beneath the building showed no sign of closing, although the test could not be regarded as definitive.

Dr. Kinosita (Japan) invited attention to the fact that Reynold's law of similitude, on which the design of ordinary wind-tunnel experiments is based, is hardly applicable to wind-tunnel experiments on snow drift (such as has been carried out by Mr. Styles). Anyone planning such experiments should refer to E. Inoue: Oyo Rikigaku (Applied Mechanics) 7 - 7 (1948) 15,4 - 22 (1951) 27.

Baron Gaston de Gerlache de Gomery (Belgium) wondered whether it was possible to construct an entire elevated station on ice shelves, and Mr. Styles observed taht an elevated structure might have some advantages if footings were provided for the buildings with a jacking system which would maintain a constant elevation above the surface.

Mr. Sato (Japan) gave a report on the recent building at the Syowa Station (Document 18) with the visual aid of slides, emphasizing the material used and engineering techniques applied to the construction of each building of the Station.

Chairman Aureggi (Argentina) called a recess at 12:00 hours.

Afternoon Session

(14:00~16:40)

Subject	Agenda 1
Delegations present	Argentina, Australia, Belgium, Chile, Japan, New Zealand, Norway, South Africa, the United Kingdom and the United States of America.
Officers	Chairman: (i) Capt. J.A. Aureggi (Argentina)
	(ii) Mr. D.F. Styles (Australia)
	Secretaries: Dr. K. Kusunoki (Japan)
	Mr. T. Misumi (Japan)
	Rapporteurs: Mr. J. Lavett (Australia)
	Baron de Gerlache de Gomery (Belgium)

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Chairman Aureggi (Argentina) opened the session at 14:00 hours.

Mr. Thomson (New Zealand) outlined his Delegation's paper concerned with man-made interference and site contamination (Document 20). He dealt with the problems of rubbish disposal and radio noise, and the necessity to signpost sites and restrict transportation on them.

Mr. Smith (United States) summarized his country's paper on construction concepts for camps on permanent ice caps (Document 23),citing the examples of various stations built at the snow surface or in tunnels. Referring to the impending replacement of the South Pole station, he stated that an elevated station was out of the question due to the expense involved.

Capt. Bernstein (United States) described the paper entitled "Fuel systems employed at the Antarctic Stations of the United States." (Documnet 24), covering three systems; welded tanks, fuel bladders, and collapsible fuel drums.

Lt. Cdr. Búsico (Argentina) then read extracts from Documents 3,4,5 and 6, dealing respectively with the construction at Almirante Brown Station, the new dwelling house constructed at Destacament Naval (Naval Station) Orcadas, over a reinforced concrete box, the dismountable Antarctic refuge transportable by air, and the plant installation with air-cooled engines, and use of the heat.

Mr. Styles (Australia) summarized Documents 9, 12 and 47 of his Delegation, concerned with the accommodation for a temporary station on the Amery Ice Shelf, concreting problems and the modern requirements of Antarctic surgery.

Mr. Brown (Australia) presented Document 8, "Structural design of an elevated station", and then proceeded to cover Document 10 "Project planning, programming and site construction of an Antarctic station." He said that the station was scheduled to be completed four years from the time of approval. He gave an account of the progress of the work, and mentioned the problems encountered in using explosives, stating that a solution was found by using AN 60 gelignite. He then went on to present Document 11, "Integration of power, heating and water supplies applied at Australian Antarctic stations." In this, he dealt with the importance and the various methods of recovering waste heat and the advantages of a central heating system, and described the water cooled engine and central heating system used in the station.

In answer to a question by Baron de Gerlached de Gomery (Belgium), Mr. Brown (Australia) specified the buildings heated by this system.

Mr. Thomson (New Zealand) asked whether any way had been found of overcoming condensation, fouling, corrosion and excess back pressure, and, in reply, Mr. Brown (Australia) suggested an exhaust heat exchanger or silencer, and pointed out that the heat requirement in the station system had not yet necessitated these.

Sir Vivian Fuchs (U.K.) mentioned the humidity problems caused by the drying effect of electric heating, and Mr. Brown (Australia) replied that Australian expeditions had had no humidity problems, due to the presence of water, in ablution areas within the sleeping block, and in cooking areas. Humidifiers have only been necessary in the operating theatres for security against electro-static explosions.

Mr. Smith (U.S.A.) remarked on the highly successful waste energy system at Plateau Station giving the relevant figures on fuel savings resulting from the system, and offered to make the engineering and supporting documents available when the Delegation returned to the United States.

Chairman Aureggi called a recess at 15:10 hours.

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The session was resumed at 15:40 hours under the chairmanship of Mr. Styles (Australia).

Chairman Styles invited the Australian Alternate Representative to present his paper "Tests on building panels for structural strength and fire resistance." (Document 13)

Mr. Brown (Australia) reported the various strength tests and fire tests, and drew attention to the difference between penetration by fire and the spread of fire index.

Chairman Styles (Australia) reviewed the papers already presented and invited discussion.

Sir Vivian Fuchs (U.K.) raised the question of building stations on ice, and described his country's system of building the foundation on a raft, with resultant lack of subsidence, mentioning the innovation of using extended main foundation bearers at Halley Bay to avoid subsidence into any cavities which might form beneath the buildings. In reply to a question from Mr.Brown (Australia), he stated that the annual normal accumulation over the area was one metre of snow.

Mr. Smith (U.S.A.) asked for comment on the problem of exit and entry into an undersnow station.

Sir Vivian Fushs (I.K.) replied that at the new Halley Bay Station the access shaft was built at the end of each building. The buildings were also interconnected by a tunnel. He then went on, with reference to deformation of buried buildings, to say that, experiences showed that heated buildings deformed more than unheated ones.

Mr. Brown (Australia) asked the United States Delegation to give more information about the deformations at Byrd Station.

Mr. Smith (U.S.A.)answered that the extreme deformation shown in the pictures of the U.S. paper (Document 23) was located at the places of greatest heat concentration, and that it was being combatted

1) by an increase in the temperature discipline by the occupants;

2) by a cold air plenum in the snow to draw cool air into the tunnel and recounted the problems of keeping the access tunnels to heavy equipment free of snow.

Sir Vivian Fuchs (U.K.) stated that U.K. practice had been to cover vehicle access tunnel entrances with a horizontal lying door. In answer to a question from Chairman Styles, Sir Vivian Fuchs stated that the tunnel doors had to be relocated each year since the tunnel had to be extended from time to time.

Dr. Nagata (Japan) asked the United States Delegation for information on the design of rocket launching buildings.

Mr. Smith (U.S.A) proposed deferment of the question until the arrival of the French Delegation, due to their unique Antarctic experience with large rocket firings.

Mr. Brown (Australia), referring to flexible fuel bladders, indicated that they could stand temperatures of minus 36°F without cracking but with loss of fuel, and that when exposed to wind the ensuing waves worked it free from the American-type tie-downs. This was remedied by a different method of tying and a small surrounding fence. He concluded by saying that steel tanks were more permanent and economical.

Mr. Joubert (South Africa) invited suggestions to cope with the smell from the toilets occurring at the Sanae Station.

Sir Vivian Fuchs (U.K.) suggested continual partial filling with snow, and described an easy method of burning new pits with petrol.

Referring to the problems of building deformation by lateral snow pressure, he mentioned the problem of the wedge formed between the wall and the surrounding ice by the freezing of melt water from the roofs of buried buildings.

Mr. Smith (U.S.A.), on the request of Chairman Styles, described the wall-shaving operations, and stressed the expense involved, suggesting the alternative of building an arch over the roof of a station built on the snow surface and allowing natural accumulation.

Chairman Styles (Australia) summarized, and said the United States suggestion might be a future alternative.

Sir Vivian Fuchs (U.K.) commented that the extra cost involved in erecting arches was not justified, in terms of the life of a building which would in any case be deeply buried in the course of a few years.

Mr. Smith (U.S.A.) concurred that the arch may not be necessary on floating ice shelves where the temperature is warmer, and mentioned other factors considered in favouring an arch for the South Pole Station, such as the low temperature.

Baron de Gerlache de Gomery (Belgium), speaking on the subsidence of buildings indicated the advantages and disadvantages of using solid materials.

Chairman Styles (Australia) reminded the Meeting that this was an interim summary and hoped for the contribution of the French and Soviet Delegations on this item. He then asked the Secretary to arrange the presentation of the two films: 1) Project Ice Shelf; 2) Vostok 900.

The films were shown at 16:40 hours.

TUESDAY, JUNE 4

Morning Session
(09:05~12:05)

Subjects	Agenda 1 (Cont'd), 2		
Delegations present	Argentina, Australia, Belgium, Chile, Japan New Zealand, Norway, South Africa, the United Kingdom and the United States of America.		
Officers	Chairmen:	(i)	Mr. L. Parada (Chile)
		(ii)	Mr. R.B. Thomson (New Zealand)
	Secretaries:		Dr. K. Kusunoki (Japan)
			Mr. T. Misumi (Japan)
	Rapporteurs:		Mr. J. Lavett (Australia)
			Baron de Gerlache de Gomery (Belgium)

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Chairman Parada (Chile) called the meeting to order at 09:05 hours.

Secretary Kusunoki (Japan) introduced Commander James Keith of the U.S. Naval Support Force, Antractica, who was an addition to the United States Delegation in the capacity of an adviser.

Baron de Gerlache de Gomery (Belgium), referring to the proposal of the United Kingdom Delegetion that Rear Admiral Panzarini of Argentina be invited to this Meeting as an observer, reported that he had been authorized to accept said proposal since it is agreeable to the Argentine Delegation, but as an exception and on the understanding that this would not be a further interpretation of Recommendation IV-24.

Chairman Parada (Chile), having ascertained that the delegations had no further reports or comments to make on Agenda 1, declared Agenda 1 finished, and suggested that the Meeting move on to Agenda 2.

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AGENDA 2: Oversnow transport; new vehicles, including air-cushion types.

Mr. Brown (Australia), referring to his paper "Experience with Nodwell RN110B tracked carrier "(Document 25), described some of this experiences with the Nodwell RN110B at Wilkes Station, which enabled his team to overcome most of the difficulties it encountered with the earlier model, such as cold failure, and the uneven lengthening of the rubber tracks. He concluded by saying that with the exception of the limited low temperature capability, the carrier was a very useful vehicle for traverse work.

In the absence of comments or question, Chairman Parada (Chile) invited the Australian Delegation to deliver another paper.

Mr. Brown (Australia) described "A small caravan for Antarctic traverses "(Document 26) a moulded, monolithic, glass fibre plastic and foam sandwith shell, mounted on sledge runners with leaf springs, designed to accommodate 3 men, with a maximum payload of 1.5 tons.

Sir Vivian Fuchs (U.K.) commented that for long distance journeys, it could well be necessary to suffer the inconvenience of using tents since a caravan weighing 1½ tons represents about 250 days of food and fuel for four men. Tents for four men would weigh only about 110 lbs (50 kilos).

Dr. Nishibori (Japan), representative of the Antarctic Snow Vehicle Design Engineering Committee of Japan, explained the problems related to the development of snow vehicles and their design. (Document 28). He also mentioned the successful completion of KD 604, 605 and 606. He then reported on the 2,500-KM, three-month traverse from Syowa Station to Plateau Station undertaken by the Japanese Observation Party in 1967-68 headed by Dr. Torii.

Dr. Torii (Japan) explained, with colour slides, the various vehicles used at Syowa Station.

Mr. Styles (Australia) asked how long it had taken the Japanese Party to go from the coast to Plateau Station and what type of heater the party had used on the trip. Dr. Torii (Japan) replied that it had taken his party 40 days, from November 5 to December 14, 1967, and on the second question, he referred Mr. Styles to Fig. C of Document 28. In response to Sir Vivian Fuch's (U.K.) question, Dr. Nishibori (Japan) explained that the Japanese vehicles were constructed with special high tensile steel track pads with rubber cleats to prevent the tracks from slipping.

* * Recess at 10:20 hours * *

The session was resumed at 10:40 hours under the chairmanship of Mr. R.B. Thomson (New Zealand).

Dr. Nagata (Japan) requested those delegates with specific questions with regard to the Japanese snow vehicles to submit their questions to Dr. Nishibori, so that Mr. Yamashita could prepare adequate answers to them.

Secretary Kusunoki (Japan) announced the arrival of Rear Adm. Panzarini (Argentina).

Sir Vivian Fuchs (U.K.) presented a paper on "The use of hovercraft in polar regions" (Document 33). He described the various tests made with hovercraft SR.N5 and its extended version, SR. N6, carried out in Canada and Sweden, and discussed their advantages and disadvantages as seen from the viewpoint of their use in the Antarctic. He reported that much information had been obtained during these trials and that the problems associated with ancillary equipment could be solved easilly. He stated that their present range (145 nautical miles) was too limited for long-range polar work. For this reason and because of the difficulty of traversing steep slopes and sastrugi fields, they should at present be regarded as practical only for ship-to-shore work. He illustrated his paper by presenting a film.

Mr. Styles (Australia) wanted to know (1) if Sir Vivian Fuchs had any curves showing payload versus range, taking into account the fuel consumption for the SR. N6, (2) if he had come across the problem arising from the difficulty of maneuverability and the question of how to detect a crevasse ahead of the vehicle in time to stop it, and (3) whether he had considered the possibility of handling such a relatively large vehicle on small ships like those employed by some nations in Antarctic explorations.

Sir Vivian Fuchs (U.K.), referring to question (1), invited Mr. Styles (Australia) to look, afterwards, at some technical details he had. With regard to question (2), he observed that it depended on the skill and experience of the operator, and in reply to question (3), he stated that the dimensions and weight could be reduced by removing the skirt and the lateral chamber sections, enabling it to be carried aboard ship.

Rear Adm. Abbot, Jr. (U.S.A.) asked what advantages a hovercraft would afford over a helicopter as a vehicle in antarctic explorations.

Sir Vivian Fuchs (U.K.) observed that a hovercraft would be definitely superior to a helicopter in conditions of bad visibility.

In reply to a question of Dr. Kinosita (Japan), Sir Vivian Fuchs mentioned that the maximum slope that a hovercraft was expected to climb was 1 in 6. There followed a discussion on the technical aspects of hovercraft.

Capt. Bernstein (U.S.A.) presented a summary of Document 34, entitled, "Vehicle road systems on snow and ice", prepared by members of the U.S. Civil Engineering Laboratory at Port Hueneme, California, which described the equipment and techniques used to build high quality snow roads for wheeled vehicles up to 75,000 lbs. Thirteen slides were shown illustrating the snow roads, construction procedures, and the snow processing equipment.

The session adjourned at 12:05 hours.

Afternoon Session

(14:10--16:50)

Subjects :	Agenda 2 (Cont'd), 3
Delegations present	Argentina, Australia, Belgium, Chile, Japan New Zealand, the Soviet Union (second part of session only), the United Kingdom and the United States of America.

Officers	Chairmen:	(i)	Dr. B. Roberts (U.K.)
		(ii)	Mr. P. Smith (U.S.A.)
	Secretaries:		Dr. K. Kusunoki (Japan)
			Mr. T. Misumi (Japan)
	Rapporteurs:		Mr. J. Lavett (Australia)
			Baron de Gerlache de Gomery (Belgium)

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Dr. Roberts (U.K.) took the chair and opened the session at 14:10 hours.

Mr. Thomson (New Zealand) proceeded to summarise his papers under Agenda 2. The first--"Human and mechanical failures in temperatures below minus 60°F" (Document 29)--described the problems of fuel and lubricants, metal fatigue, weld failure, the hardening of rubber tracks, the cracking of cables, the failure of stoves, batteries and electrical equipment, and glass contruction. To Capt. Bernstein's (U.S.A.) question regarding whether the welds had been x-rayed, magna-fluxed or oil dye penetrated, previously, he replied in the negative.

Sir Vivian Fuchs (U.K.) advised silicone rubber insulation for electric cables to avoid cracking, and mentioned the system of passing A.C. power through the battery to heat it. He warned that silicone rubber is destroyed if it comes into contact with hydrocarbons.

Mr. Brown (Australia) reported his country's use of the cold room for checking rubbers and plastics. Answering Mr. Styles' enquiry concerning American cold-room experimentation, Mr. Smith (U.S.A.) said that most recent work in this field had been concerned with aircraft problems, a field where much remained to be done. He said that much use was made of empirical field observations in oversnow vehicle design. Sir Vivian Fuchs (U.K.) agreed with this.

Chairman Roberts (U.K.) then welcomed Admiral Panzarini from Argentina, in the capacity of Observer.

Mr. Thomson (New Zealand) proceeded with his next paper, entitled "Effective methods of navigation under varying conditions on the Antarctic Plateau." (Document 30), listing the equipment used, and stressing the effectiveness of the mirror system, a point which Mr. Brown (Australia) endorsed. Mr. Thomson then presented the next paper, concerned with the field use of motor toboggans (Document 31), covering the strengthening modifications made to the Polaris 95 model, stressing that the speed should not exceed 5 or 6 miles per hour. He then described the advantages of the Polaris model 2500. He concluded by describing the convenience of using toboggans for short distances of about 4 miles, as opposed to dog teams.

On the invitation of the Chairman, Sir Vivian Fuchs (U.K.) recounted his disappointing experiences with motor toboggans, adding that strengthened Skidoos were being used, and he expressed the need for a small reliable motor toboggan.

Mr. Brown (Australia) spoke of his country's experiences over the past few years with the Polaris K95, 016, and K75, the Skidoo, and more recently, the Snow Cruiser, and asked about the Yamaha; Baron de Gerlache de Gomery (Belgium) said that he had no trouble with Polaris Toboggans.

Mr. Smith (U.S.A.) reported his country's use of motor toboggans for short sorties away from the laboratories at stations such as McMurdo, for oversnow or geological traverses and for local transport for remote field parties. The Eliason was first introduced in 1961 for glaciological research on the Ross Ice Shelf. The Polaris K95 has been used extensively but is now not manufactured. Recently motor toboggans made by Fox Co. of Wisconsin have been purchased. They are largely untried to date but have been satisfactory so far, in 700 miles of operation on Anvers Island.

Chairman Roberts (U.K.) hoped that further information on the Fox motor toboggan could be included in the record, and then asked whether anyone present had had practical experience with the recently developed Swedish types. Mr. Thomson (New Zealand) said that one of the Swedish machines was being evaluated by them.

Mr. Thomson (New Zealand) presented the paper on Land-rovers used at Scott Base (Document 32), describing modifications, and noting the effectiveness of using treadless sand tyres, concluded that the vehicle was versatile and required little maintenance.

Mr Brown (Australia) asked for information as to whether any progress had been made in developing wheels to travel on snow successfully.

Mr. Thomson (New Zealand) said that, in his experience, the land-rover was preferable to modified Volkswagen, especially on soft snow.

Rear Adm. Abbot.Jr. (U.S.A.) called attention to the relatively small amount of maintenance required for wheeled vehicles as contrasted with track vehicles and indicated therefore that continued experimentation with wheeled vehicles was to be encouraged. He recounted a project with a Dodge Power Wagon operated between Byrd Station and the Byrd VLF Station, 11 miles apart. This project had limited success. A second project being undertaken by Fabco Co. is a wheeled oversnow vehicle using 2 articulating axles with 8 large tyres each. He listed the important factors in the development of a wheeled vehicle as 1) power; 2) footprint pressure; 3) clearance; 4) wheel diameter.

Mr. Styles (Australia) reported that his country's experiences with various wheeled vehicles had indicated that in their present stage of development they could be used only on a very limited path between crevasses and melt water streams in the ablation zone near Mawson. Even a few inches of fresh drift would stop a wheeled vehicle.

Chairman Roberts (U.K.) commented that the development of low pressure balloon-type tyres was required and asked the U.S.A. about snow trains conceived in U.S.A. and Canada for Arctic work.

Rear Adm. Abbot, Jr. (U.S.A) affirmed that an overland tractor train had been successfully tested but abandoned as a project by the U.S. Army.

Sir Vivian Fuchs (U.K.) suggested trying a Swamp Buggy, developed for oil prospecting in swamp.

Baron de Gerlache de Gomery (Belgium) then described a successfully-employed AS 24, made in Belgium, characterised by small balloon tyre wheels.

In answer to the chairman's inquiry, concerning the maximum practical size of wheeled vehicles as regards crevasse hazard, Mr. Smith (U.S.A.) said that the tyre width as well as the diameter was important in that when crevasses were approached at an acute angle, narrow-width tyres would sink into the snow bridges. A compromise must be reached in the design, Mr. Smith said, for large diameter wheels tended to move the cargo bed or cab of the vehicle to a greater distance above the snow surface thereby making access to the vehicle difficult.

Mr. Styles (Australia) stressed the necessity of a balance between lowground pressure and traction, saying that the lack of traction would be a disadvantage of the Swamp Buggy in soft snow. He suggested as a solution that provision should be made to vary tyre pressures with varying snow conditions encountered.

Rear Adm. Abbot, Jr. (U.S.A.) asked about the time limit for obtaining information for the record, and Chaiman Roberts (U.K.) said this would be reported by the Secretariat later.

* * Recess at 15:35 hours * *

Session resumed at 16:00 hours under the chairmanship of Mr. Smith (U.S.A.). Chairman Smith welcomed the Soviet Delegation, and reported that they would present papers scheduled in Agenda 1 the following day. The Soviet Delegation promised to distribute its papers at that time.

Agenda 3: "Air transport including airfields"

Lt. Cdr. Búsico (Argentina) summarised Document 35 "Special preparation of the C-47 airplane for Antarctic flights," and Document 36, "Portable equipment for fuel load to airplanes."

Dr. Sanuki (Japan) asked about the flying hours of the C-47 and the position of the Marbore gas turbine on it.

Lt. Cdr. Búsico (Argentina) replied that the plane had flown 1500 hours since conversion. The turbine had been installed in the after end of the fuselage.

Mr. Styles (Australia) presented a paper on the marking of airstrips in Antarctica (Document 37), saying that the use of markers should approach the ICAO's standards as closely as possible, and described the provisions, which he outlined, as conforming to these.

Capt. Bernstein (U.S.A.), referring to the cone markers recommended in the paper, feared that they might become covered with ice and snow if left unattended and that they possibly lacked the reflecting capability of a barrel for an aircrafts radar approach to the runway.

Mr. Styles (Australia) replied that the airstrips in mind would not be unattended.

Baron de Gerlache de Gomery (Belgium) noted the convenience of using uniform markers, and, while agreeing with him, Sir Vivian Fuchs (U.K.) objected that owing to the impermanent nature of many of the airfields the availablity of barrel markers made them satisfactory.

Chairman Smith (U.S.A.) concluded that complete standardisation was still distant because of the wide variety of aircraft operations.

Rear Adm. Abbot, Jr. (U.S.A.) referred to Document 39, "Aviation support for the U.S. Antarctic Research Program," and invited questions concerning air operations.

Mr. Styles (Australia) aked about the method of compacting snow for heavy aircraft landing.

Rear Adm. Abbot, Jr. (U.S.A.) replied that they used a ski-equipped Hercules and thus did not compact snow, but only levelled it.

Mr. Styles (Australia) then described the problems encountered with landing aircraft on the plateau near Wilkes where there was a lenticular formation which tended to fail on impact.

Dr. Korotkevich (Soviet Union) asked about the past and future use of Starlifter. Rear Adm. Abbot, Jr. (U.S.A.) detailed the past success and the future planned flights of this airplane. In 1966-67, C-141 Starlifter landed on the Annual Ice Runway establishing the feasibility of using the aircraft to carry passengers and cargo. C-141 Starlifters will be utilized in the 1968-69 austral summer season to carry both cargo and passengers. It is expected that five or six flights would be scheduled.

Sir Vivian Fuchs (U.K.) then described a rescue mission flown by the United States from McMurdo Station to Halley Bay Station where a temporary emergency air strip had to be made at very short notice. He expressed his gratitude for the skill with which this operation had been conducted.

Chairman Smith (U.S.A.) closed the discussion of Agenda 3.

Secretary Kusunoki (Japan) asked that additional information on motor toboggans and other subjects as called for in the record to be sent to the Ministry of Education before the end of the month.

* * The meeting was recessed at 16:50 * *

A film on the 1965 Belgian-Netherlands Expedition (campagne d'ete 1965) was shown at 17:00.

WEDNESDAY, JUNE 5

Morning Session

(09:00~12:00)

Subject	Agenda 4		
Delegations present	Argentina, Australia, Belgium, Chile, Japan, New Zealand, South Africa, the Soviet Union, The United Kingdom and the United States of America.		
Officers	Chairmen:	(i)	Mr. D. Joubert (South Africa)
		(ii)	Dr. E.S. Korotkevich (the Soviet Union)
	Secretaries:		Dr. K. Kusunoki (Japan)
			Mr. T. Misumi (Japan)
	Rapporteurs:		Mr. J. Lavett (Australia)
			Baron de Gerlache de Gomery (Belgium)

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Chairman Joubert (South Africa) called the meeting to order at 09:00 hours.

On the invitation of the Chairman, Dr. Torii (Japan) reported on the use of a portable gyroscopic compass which had satisfactorily helped his team determine its position during an Antarctic traverse. In response to Mr. Styles' question as to how effective the gyroscopic compass had been in rough conditions, he reported that it had proved quite useful.

Lt. Cdr. Búsico (Argentina) summarized the paper of his Delegation entitled "Employment of small plastic craft in ice areas" (Document 40), describing the various advantages of the plastic surface boat (superior resistance, lightness, high maneuverability, ease of cleaning and repair and small maintenance requirement) used at the station on Laurie Island and its disadvantages (the tendency of its screw to be damaged by submerged ice, and the slipperiness of the interior surface when wet).

Sir Vivian Fuchs (U.K.) observed that plastic boats, especially when operating with divers, were liable to be unstable, and in reply, Lt. Cdr. Búsico (Argentina) reported that the experiences on the boat proved that the boat was suitable and that divers had preferred to work with plastic boats.

Mr. Styles (Australia) presented a paper entitled "Mooring bollards for ships in 100 knot winds" (Document 41), which described the design and techniques employed to hold 2000-ton vessels at winds of 100 knots at the Australian Antarctic stations.

In the absence of any question or comment, Chairman Joubert (South Africa) asked the Australian Delegation to present its next paper.

Mr. Styles (Australia) presented his next paper, entitled "Icebreaker operations in Antarctic waters," (Document 42) which discussed the limitations of operating icebreakers as escorts to other ships. He suggested, as a project for a future design study, the possibility of combining the functions of an icebreaker and an expedition ship in a single vessel and discussed two examples, "Ob" of the U.S.S.R. and "Fuji" of Japan.

Sir Vivian Fuchs (U.K.) observed that the shape of hull designed to carry 2,000 tons or more of cargo, did not lend itself to the traditional forms of an icebreaker. He concluded that the length of a ship, meant to have reasonable maneuverability, should not exceed 300 feet unless it became an icebreaker proper. He asked about the relative enphasis given to icebreaker and cargo carrier features in the specific case of "Fuji".

Mr. Styles (Australia) commented that the absolute size presented no unsurmountable problem, except financial, so long as the shape, friction at the water line, and draught of the ship were kept proportional to its power.

Dr. Nagata (Japan) commented, in reply to Sir Vivian Fuchs' question that "Fuji" is an icebreaker rather than a cargo carrier.

Adm. Honda (Japan) presented his paper on sea and air transportation to the Syowa Station (Document 43). He described the air transport methods employed by the Japanese Antarctic Research Expedition -- inside the helicopter and sling transportation. The latter method proved by far the most efficient method in terms of time saved. He then reported on the performance records, and concluded by saying that the sling system was very effective for the movement of small amounts of cargo between ship and shore.

Mr. Styles (Australia) commented that air transport of bulk fuel to the shore was not very satisfactory unless there was a possibility of using a large helicopter or a hovercraft. He then asked Adm. Honda whether the Japanese air transport operations had been handicapped by the cloud conditions and how the helicopter had unloaded cargoes of awkward shape such as building materials, particularly when there was wind.

Adm. Honda (Japan) answered that toward the end of January -- when the "Fuji" arrived at Syowa -- the Japanese team had been fovoured with good weather conditions, which had enabled it to operate for most of the month. The visibility had to be 5 miles or greater for most operations. On the question of the transport of bulky cargo, he referred Mr. Styles to page 6 of his report (Document 43) in which the limitations are indicated.

Dr. Nagata (Japan) reported that the maximum size of cargo transported by sling was 6 by 2 metres, weighing up to 2 tons.

Rear Adm. Panzarini (Observer) classified polar vessels in terms of their functions into those performing (1) supply operations, (2) scientific work in general at sea and (3) hydrographic surveying. Polar ships operated in two different types of areas: (a) those with heavy sea ice conditions and (b) those with favourable ice conditions or open waters. He observed that, in the long run, different designs of ships for different tasks and for different physical conditions would give the best results, expensive though they might be.

Dr. Korotkevich (Soviet Union)presented his paper, entitled "New research expedition ships for the Soviet Antarctic Expedition".(Document 44).

* * * Recess at 10:50 hours * * *

The session was resumed at 11:20 hours under the chairmanship of Dr. E.S. Korotkevich (Soviet Union).

Sir Vivian Fuchs (U.K.) presented a paper entitled "The use of United States satellite photographs for ship navigation in Antarctic sea ice." (Document 45) He reported that his government in 1967 had accepted a United States offer to provide photographs of the Antarctic region taken from the ESSA 3 satellite in polar orbit. These pictures had proved to be of great help in determining exactly where expedition ships should enter the ice to the best advantage. He then showed 6 slides of the region.

Mr. Styles (Australia) reported that satellite photographs had also been used to assist Australian expeditions to pass through the ice.

Mr. Smith (U.S.A.) summarized the paper of his Delegation, entitled "Ship offloading and docking facilities at McMurdo and Palmer Stations" (Document 46), discussing the problems encountered in constructing piers at these stations.

The meeting adjourned at noon.

Afternoon Session

(14:05 ~ 17:15)

Subjects	Agenda 4 (Cont'd) 1,5,6		
Delegations present	Argentina, Australia, Belgium, Chile, Japan New Zealand, South Africa, the Soviet Union, the United Kingdom and the United States of America.		
Officers	Chairmen:	(i)	Mr. J.A. Aureggi (Argentina)
		(ii)	Mr. D.F. Styles (Australia)
	Secretaries:		Dr. K. Kusunoki (Japan)
			Mr. T. Misumi (Japan)
	Rapporteurs:		Mr. J. Lavett (Australia)
			Mr. Paul-Emile Victor (France)

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Chairman Aureggi (Argentina) opened the session at 14:05 and aked for questions on the United States paper on "Ship offloading and docking facilities at McMurdo and Palmer Stations" (Document 46).

Mr. Styles (Australia), referring to the summary presented by Mr. Smith (U.S.A.), requested clarification on the placement of vertical members for the dock facing at McMurdo.

In reply, Mr. Smith (U.S.A.) described the area, and the placing of footings in drilled underwater holes followed by the placing of the vertical members, the protective barrier for the dock facing and the back-filling of the area between the facing and ice foot of the dock itself.

Chairman Aureggi (Argentina) then returned to Agenda 1, and invited the Soviet Delegation to present its paper.

Dr. Korotkevich (Soviet Union) read Document 21, entitled "Construction of dwelling and official buildings at Molodezhnaya Station," giving details of structure and materials used.

Mr. Smith (U.S.A.) said that he was impressed by the experimental engineering techniques, and asked for the dimensions of the underground storage frozen food space, which had been constructed in the solid rock at the station.

Dr. Korotkevich (Soviet Union) replied that it was about 50 square metres and the height about 3 metres.

Mr. Styles (Australia) inquired whether the clearance beneath the building mentioned in the paper sufficed to avoid drift accumulation.

Dr. Korotkevich (Soviet Union), in replay, showed photographs of the station and mentioned, the low annual accumulation of snow, attributing it largely to the fact that it was not an area of accumulation. Replying to a question by Mr. Styles (Australia) concerning the duration of the experience with these buildings, he stated that the station was established in 1962, but the first big building was erected in 1964.

Mr. Styles (Australia) then asked about the material silicalcite, and Dr. Korotkevich (Soviet Union) replied that for reasons of weight, aluminium panels were preferred to arbolite, and that silicalcite was foamed calcium silicate. Replying to a final question from Mr. Styles, Dr. Korotkevich said waste was dumped at sea.

In the absence of further questions, Dr. Korotkevish read Document 22, entitled "Construction of fuel oil tanks in Mirny Observatory and Molodezhnaya Station, Antarctica."

Sir Vivian Fuchs (U.K.) asked the meeting about the use of horizontal cylindrical-type tanks, as opposed to vertical ones, and Rear Adm. Panzarini (Observer) and Mr. Thomson (New Zealand) described their use of smaller tanks of this sort. Mr. Brown (Australia) described the offloading of 8,500 gallon tanks, and the methods of moving them to the site.

Dr. Torii (Japan) said that horizontal tanks were being used at Syowa, and, in response to a question from Sir Vivian Fuchs, he reported that the prices of horizontal tanks and vertical tanks were about the same.

Chairman Aureggi (Argentina) then proposed to move on to the Agenda 5 and invited the Australian Delegation to present its paper.

Mr. Brown (Australia) outlined the paper of his Delegation, entitled, "An Antarctic surgery: some design factors, "(Document 47), saying that, despite the rarity of occurrence, provision must be made for any emergency. He stressed the importance of reducing the possibility of electrical sparks because of the use of oxygen and inflammable anaesthetic gases in the operating theatre.

Secretary Kusunoki (Japan) then made some announcements concerning press conferences.

* * Recess at 15:20 hours * * *

The session was resumed at 15:45 hours under the chairmanship of Mr. Styles (Australia)

Chairman Styles (Australia), after dealing with some details of the press conferences asked the Australian Delegation to present their next paper.

Mr. Brown (Australia) outlined "Field training in Australia for Antarctic expeditions, " (Document 48) emphasising the use of mountaineering techniques as a means of training men in methods.

Dr. Nagata (Japan) asked Mr. Brown about 1) the duration of the training, 2) the lack of snow training in the Australian programme. Dr Nagata said emphasis was placed on snow training in Japan.

Mr. Brown (Australia) replied that the training was for three days and two nights. Snow training in Australia was not practicable.

Mr. Joubert (South Africa) said that his country had the same problem as Australia, namely lack of snow, and described the training given by South Africa.

Baron de Gerlache de Gomery (Belgium) recounted the training given to his country's expedition team, and pointed out that some pilots had had training with ski planes in Switzerland.

Mr. Thomson (New Zealand) said that field people were trained on crevasses in his country, and that great attention was paid to Antarctic fire-fighting methods.

Sir Vivian Fuchs (U.K.) stated that his county used an overlap system of posting and that in this way the more experienced could teach the others. He related that they had a class of "General Assistant," experienced in snow and ice and climbing, and that these served as safety men in the field. After mentioning that pilots were trained in Switzerland or Canada, he introduced the problem of selecting leaders, concluding that character was more important than experience.

In the absence of further questions, Chairman Styles (Australia) proposed to move on to the next paper from the Soviet Delegation.

Dr. Korotkevish (Soviet Union) read his paper "Safety measures in the Soviet Antarctic Expedition." (Document 49)

Chairman Styles (Australia), referring to the paper just read, noted the Soviet Delegation's suggestion of using the symbol "T" as a safe landing indication, as opposed to the symbol of a triangle, agreed at Boulder Symposium.

Rear Adm. Panzarini (Observer) suggested that the letter "T" might indicate the landing direction for the plane.

In answer to the Chairman's inquiry about the possiblity of obtaining the booklet "Rules of Safety for the Expedition Personnel," Dr. Korotkevich

(Soviet Union) said that this had not yet been published but that it might be within a few months.

Sir Vivian Fuchs (U.K.) suggested postponement of any decision about the use of the letter "T" and the triangle, due to the absence of aviation experts from the meeting.

Chairman Styles (Australia) then proposed moving on to the Agenda 6: "Personal Equipment."

Lt. Cdr. Búsico (Argentina) summerized his paper "Antarctic wearing apparel equipment." (Document 50)

In the absence of any questions, Chairman Styles (Australia) asked the Argentine Delegation to present an abstract of its next paper.

Lt. Cdr. Búsico (Argentina) summarized "Preservation of meats in Antarctica" (Document 51)dealing with a successful test with meat placed for a year in a tunnel in a glacier.

Sir Vivian Fuchs (U.K.) stated that his similar tests had been unsuccessful and asked the temperature, and to this, Lt. Cdr. Búsico (Argentina) answered that it was about - 4°C at the upper level in the storage area. It had been necessary to pump in cold air to reduce the temperature at a lower storage area where the meat was kept.

Mr. Brown (Australia) proceeded to outline "Australian experience with clothing in Antarctica, "(Document 52). The importance of colour and style and their subordination to physical design were noted, and the importance of resistance to accumulation of static electricity was stressed.

Sir Vivian Fuchs (U.K.) suggested the use of terylene filled sleeping bags both for their comfort and the ease of cleaning. Answering Mr. Brown's query about the compactness of these bags, he replied that they weighed about 1½ kilos more than down bags but were far warmer.

* * Recess at 17:00 hours * *

The session was resumed at 17:05 hours.

Chairman Styles (Australia) welcomed the arrival of the French Delegation, and asked for the nomination of a French Rapporteur to cover the remaining period.

Dr. Nagata (Japan) recommended Mr. Victor (France), and the Chairman accepted the nomination. Chairman Styles then thanked the representative of Belgium for his cooperation.

Mr. Victor (Fance) apologised for the delay of the French Delegation, and proposed to postpone the distribution of the documents of his Delegation until the following morning.

Mr. Thomson (New Zealand) then gave a brief introduction to the film, entitled "140 days under the world."

-- Film Presentation at 17:15 hours --

THURSDAY, JUNE 6

Morning Session
(09:10～12:25)

Subjects	Agenda 1,3,6 (Cont'd), 7		
Delegations present	Argentina, Australia, Belgium, Chile, France Japan, New Zealand, South Africa, the Soviet Union, the United Kingdom and the United States of America.		
Officers	Chairmen:	(i)	Baron de Gerlache de Gomery (Belgium)
		(ii)	Mr. C. de Bartillat (France)
	Secretaries:		Dr. K. Kusunoki (Japan)
			Mr. T. Misumi (Japan)
	Rapporteurs:		Mr. J. Lavett (Australia)
			Mr. P.-E. Victor (France)

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Chairman de Gerlache de Gomery (Belgium) called the meeting to order at 09:10 hours, and proposed that, after the Japanese Delegation had finished its report on Personal Equipment, the French Delegation should be given the floor to present its papers on Agenda 1 and 3. All Representatives agreed.

Dr. Torii (Japan) described the various tests conducted in the search for an adequate synthetic fibre and insulating materials which are inexpensive, easy to wash and serviceable at low temperatures. He reported that polyvinylchloride felt boots which absorbed practically no water and permitted perspiration vapour to diffuse from the boots to some extent, while retaining their insulation properties, proved to be the warmest at temperatures below -60°C. (Samples of the boots were circulated among the delegates.)

In response to Mr. Victor's (France) query, Dr. Torii reported that a pair of the boots cost $25.

Mr. Thomson (New Zealand) highly recommended the boots for Antarctic use, adding that the only drawback he had found in them was a tendency to roll, which could be remedied, if only partially, by adding a large strap.

Mr. Victor (France) related his experience with boots of Danish design which were heavier than the Japanese and which had the similar disadvantage of rolling.

Chairman de Gerlache de Gomery (Belgium) announced that the discussion would return to Agenda 1 and asked the French Delegation to present its paper.

Mr. Victor (France) summarized the paper of his Delegation, entitled "The Dumont d'Urville Base drinking water supply "(Document 14) and reported a solution his team had found which possessed two main features: (1) the use of three stages of heat recovery from electrically-run diesel motors, (2) the automatic safety system designed to prevent the pipes from freezing in case of breakdown.

In the absence of any question or comment, Mr. Victor (France) presented the paper, entitled "Use of bituminous cement at the Dumont d'Urville Base," (Document 15) describing the techniques of building a quay using bituminous cement.

Mr. Victor (France) went on to present his third paper, entitled "Helicopter wind break wall," (Document 38) describing the experience of his team in Adélie Land, where the 250 km/hr wind was lowered to about 50 km/hr by means of a windbreak wall of 3 metres in height.

In reply to Dr. Nagata's (Japan) question as to whether the wind in Adélie changed its direction with the season, Mr. Victor (France) reported that the violent winds always came from the southeasterly direction.

Mr. Victor (France) then outlined the four papers his Delegation to submit when they were received from Paris (1) "Reconstruction and development of the Dumont d'Urvile Base," (2) "The new buildings at the Dumont d'Urville Base," (3) "Mobile launching unit for rocket-probes" and (4) "New French polar vehicle HB40".

Reminded by Dr. Nagata (Japan) of the postponement, agreed to at a previous meeting, of the discussion on the question relating to the rocket firing installation, Chairman de Gerlache de Gomery (Belgium) asked Mr. Victor to report on the question.

Mr. Victor (France) stated that all the details related to the subject would be given at the next week's meeting of the SCAR Working Group on Logistics. He then related the experiences his team had had with the new HB 40 vehicle, called "Beaver," which could easily tow four to five tons, as compared with Weasel's two tons.

Mr. Smith (U.S.A.) requested Mr. Victor to give a more complete description of the track and suspension system of the vehicle.

Mr. Victor (France) reported that the track was about 40 to 50 cm in width, made either of synthetic rubber and cotton, or synthetic rubber and nylon, and that the one made of synthetic rubber and cotton had proved superior.

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Chairman de Gerlache de Gomery (Belgium) proposed to move on to Agenda 7 : Special and future support projects.

Mr. Thomson (New Zealand) summarized his paper, entitled "New Zealand's future research and logistic requirements" (Document 58), mentioning the following main points: (1) de-centralization of laboratory work, particularly of the geophysical sciences to small huts remote from Scott Base, (2) further development of the present remote bases, (3) construction of additional huts in areas of special (geological and marine biological) interest, and (4) continued use of helicopters and air transport, with the further reduction of dog teams.

In response to Sir Vivian Fuchs' (U.K.) question, Mr. Thomson explained that, apart from helicopters, his team utilized the United States C-130

Hercules, for transporting men and supplies usually 450 to 500 miles from Scott Base.

Mr. Victor (France) reported that his team used Allouette 2's, capable of flying 1,000 km at an altitude of about 3,000 metres.

* * Recess at 10:35 hours * *

The session was resumed at 11:05 hours under the Chairmanship of Mr. de Bartillat (France). Moving to Agenda Item 7, "Special and future support projects" he invited the United Kingdom Representative to speak.

Dr. Robin (U.K.) presented Document 59, stressing that logistics and research were interdependent, and placed importance on remote sensing techniques from aircraft and satellites, on the improved equipment of major stations and the increased use of geophysical station networks for future development. Using slides, he then described some remote sensing operations and results, saying that this valuable information as easily obtainable with good logistic support. The basis of effective logistic support was communications, especially in regard to meteorological information. He recommended closer co-operation between the three organizations interested in Antarctic communications. There also appeared to be a risk that Antarctic logistic co-operation might be receiving recommendations from two bodies acting independently -- the Antarctic Treaty Consultative Meetings and SCAR. He hoped that any conflicts of interest would be avoided.

Baron de Gerlache de Gomery (Belgium) inquired 1) whether the nature of the surface influenced the quality of echo sounding results and 2) whether the instrument could be used on an Otter aircraft.

Dr. Robin (U.K.) said, in reply to 1), that the surface made very little difference, and in reply to 2), that the instrument has been used on an Otter, as well as with other small aircraft, adding that a minimum of two men were needed for operation, although, for longer flights, 3 or 4 men afforded some rest period, and he mentioned that some work had been published on work over Ellesmere Island.

Mr. Styles (Australia), referring to the recommendation of Dr. Robin (U.K.) that 50 or 100 tons of fuel be moved to suitable landing strips to assist logistic support by long range aircraft, asked the United States whether they could spare time for such an operation.

Rear Adm. Abbot, Jr. (U.S.A.) replied that it depended on the operational feasibility and safety of the proposed project and its effects on the programme of the National Science Foundation. Any specific proposal would have to be studied with these three factors in mind.

Mr. Victor (France) then said that, since the only justification for logistics was scientific research, permanent co-ordination between the two was essential. He regretted the absence of any members of the SCAR Working Group on Logistics, and concluded by saying that logistic experts should understand the scientific aim of operations for the sake of efficiency.

Dr. Nagata (Japan) advised closer co-operation between scientists and government people concerned with Antarctica, and asked Dr. Robin for recommendations to improve liaison between SCAR and Antarctic Treaty powers and WMO.

Dr. Robin (U.K.) replied that, with regard to logistics, the two bodies might meet and compare notes. In the case of the present meetings, this was made practicable by calling the meetings in succeeding weeks. With regard to communications, the three bodies concerned might set up a single co-ordinated group with representatives from all three, or perhaps arrange simultaneous meetings of those concerned, which could work together towards common conclusions.

The meeting adjouned at 12:25 hours.

Afternoon Session
(14:05~16:45)

Subject	Agenda 7 (Cont'd)
Delegations present	Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, the Soviet Union, the United Kingdom, and the United States of America.
	Observer: Rear Adm. R.N. Panzarini
Officers	Chairmen: (i) Mr. L. Parāda (Chile)
	(ii) Mr. R.B. Thomson (New Zealand)

Secretaries:	Dr. K. Kusunoki (Japan)
	Mr. T. Misumi (Japan)
Rapporteurs:	Mr. J. Lavett (Australia)
	Mr. P.-E. Victor (France)

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Chairman Parade (Chile) opened the session at 14:05 hours, and invited the United States Delegation to present its paper.

Capt. Bernstein (U.S.A.) summarized Document 60, entitled, "The use of weather satellite data as an aid to operational forecasting in Antarctica," which discusses the usefulness of the weather satellite in determining the formation of weather systems in Antarctica and over the ocean areas. Though a technique of great promise, the weather satellite, in its present stage of development, is supplementary to other observation techniques, which must also contribute to flight forecasting procedures.

In reply to Mr. Styles' question concerning the design of the satellite system, Capt. Bernstein (U.S.A.) said there were two types of antenna, the helix and the omni-directional, the former being superior but more expensive. In response to a further question, Adm. Abbot (U.S.A.) said that an infrared read-out had been planned for U.S. operations but experience had been obtained with infra-red data. Answering Dr. Nagata's question, Adm. Abbot said that the time-schedule for the orbits and other information could be obtained from the centre in Suitland, Maryland.

In the absence of any other questions, Chairman Parada (Chile) invited the United States to present its next paper.

Mr. Smith (U.S.A.) presented Document 61 by Mr. Jenny and himself concerning the feasibility of establishing unmanned, automated geophysical observatories for communicating data directly to U.S.A. Slides illustrated the discussion, which summarizes a more detailed paper by the Radio Science Laboratories, Stanford University. The system which is being considered by the United States will utilize radio isotope thermal-electric or wind-driven generators to supply about 65 watts of power to the automatic station. The station, recording a full complement of upper atmosphere geophysical phenomena, will transmit the data to the United States by way of synchronous communication satellite.

Mr. Styles (Australia) described the difficulties in unmanned stations due to failure of components, and the possible solutions to this problem by designing the stations in a series of duplicate units so arranged that should one unit fail its duplicate would automatically assume its function.

Dr. Nagata (Japan) mentioned that he was planning an unmanned atmospheric observing station, and asked about the power cost and the weight of the radio isotope system, Mr. Smith (U.S.A.) referred him to the document and offered a fuller report at a later data. Mr. Thomson (New Zealand) mentioned an English manufactured power supply that may be used by New Zealand at its Vanda Station.

Dr. Robin (U.K.) asked to what extent the concept of an unmanned, automated geophysical observatory could be broken down, and whether a study had been made of the advantages of intermediate steps towards full automation such as automation of communication systems alone or other component systems.

Mr. Smith (U.S.A.), in answer, indicated that some phases of the study, such as the communication system, were applicable to manned Antarctic station, and that automatic stations recording fewer measurements would be smaller and less complex. The purpose of the Stanford study was to expose all of the problems so that further design study could ensue.

Mr. Homewood (Australia) inquired whether the polar orbiting satellite had been considered. Mr. Smith (U.S.A.) answered that it had, but that a synchronous satellite was the most practical, since the polar orbiting satellite did not have the capacity for the large amount of data generated by the complex geophysical station.

On the invitation of the Chairman, Dr. Nagata read Document 57 entitled "Plan of the Japanese sounding rocket range in the Antarctic." The paper describes in some detail the Japanese plans for facilities at Syowa and presents the schedule of yearly construction.

Mr. Victor (France) described the small mobile launching unit used at Dumont d'Urville promising to distribute the relevant documents when they were available. He said further information would be obtainable form the National Committee on Space Studies in Paris. In answer to Dr. Nagata's question he continued by giving a description of the system of preparing the rockets for launching, Dr. Nagata (Japan) then asked what the elapsed time was between the decision to launch a rocket and the actual launching. Replying, Mr. Victor said that after waiting a month for weather conditions, the rocket was launched an hour after the decision, and later 3 rockets were launched in 2½ hours. Mr. Smith (U.S.A.) proposed that those interested in the rocket programme meet again when the French papers were available.

Chairman Parada (Chile) then returned to the earlier discussion of the relationships of the Antarctic Treaty parties and SCAR in logistic problems.

Baron de Gerlache de Gomery (Belgium) referred to Recommandation IV-24 and said his government's interpretation of "Others experts may be invited to attend" was that experts from countries other than "Consulative Parties" may be asked to attend as observer to meetings of Treaty Logistic Experts. Commenting on the SCAR and Treaty meetings, he said that they should be separate so that SCAR remains free of governmental pressure. He recognised that scientific research could depend on logistics and therefore considered that coordination was necessary between the activities of bodies dealing with logistic and scientific matters. He thought that a welcome step in that direction was already achieved in the participation for certain countries of the same delegates to both meetings of Scarlog and of Treaty Logistic Experts. He regretted that the agendas of this meeting of Treaty Experts and of the forthcoming meeting of Scarlog were similar. Many logistic problems - and in some countries all of them - were a governmental responsibility. One should avoid that problem of pure logistic be dealt with concurrently or successively be the two groups. Similar matters should only be discussed in both groups when scientific considerations are involved in logistics, because in that case it is not only useful but necessary.

Baron de Gerlache de Gomery suggested that SCARLOG meetings should in future be held several months before Treaty experts meetings and that their purposes be to advise the group of Treaty Logistic Experts. He also thought desirable that a permanent rapporteur be appointed for each country with a view to obtaining closer coordination on the national level between Treaty experts and scientific and logistic bodies or departments. Finally he suggested that more frequent meetings be held of Treaty Logistic Experts. In conclusion, he undertook to report fully to his government the different views expressed by others delegations on these matters.

Sir Vivian Fuchs (U.K.) stressed the need for continual exchange of information and discussion. He considered that this had been and would continue to be possible within the framework of SCAR. On the other hand, it seemed that there was no mechanism within the Treaty organization whereby this could be done. He added that it did not seem desirable to have two organizations handling the same matters especially as a majority of the representatives attending either type of meeting were likely to be the same persons.

Dr. Roberts (U.K.) commented on three points that had been raised:
(i) There had been complaints that information exhanged by governments did not reach those who are primarily concerned. The distribution to those who need it of information exchanged between governments under Article VII(5) of the Antarctic Treaty must be an internal matter for each country.
(ii) Commenting on the suggestion by Baron de Gerlache de Gomery (Belgium) that only governments could appropriately deal with logistic questions, he recalled that all Treaty recommendations must be unanimous before any action can be taken, and that they do not become binding until approved by all twelve governments. This can result in a two-year delay, which is quite unrealistic for recommendations on subjects like telecommunications. Less formal discussions which do not bind governments to act would be much more effective.
(iii) There are risks in any attempt to bring the Treaty governments and SCAR too closely together. SCAR's freedom to act so successfully stems from the fact that it operates under the protection of the Treaty and has been sheltered from political difficulties. It is most important to preserve this freedom from political interference with the scientific work. But this should not obscure the need to bring scientists and logisticians together.

Mr. Joubert (South Africa) stated that in his opinion SCAR should act independently, and mentioned the liaison solution of a co-ordinating committee used in his country. Regarding closer cooperation between countries, he thought this should be left to the countries themselves.

Mr. Victor (France) thought that Baron de Gerlache de Gomory's suggestion was constructive. The SCAR logistics group could be used in an advisory capacity for Antarctic Treaty meetings concerned with problems of logistics. Members of the SCAR group, who, as scientists, used logistics, seemed able to reach decisions without referring them to Governments, although there were clearly some dicisions which could be made only at governmental level. It seemed desirable to have SCAR keep the question under study and make recommendations at an Antarctic Treaty meeting. This would need to be covered at a Treaty Meeting.

Rear Adm. Abbot, Jr. (U.S.A.) stated that commitment of resources was a governmental problem, not an advisory one.

Dr. Nagata (Japan) stated that it would be better to make Minutes to be conveyed to the following Antarctic Treaty Consultative Meeting in November, rather than vote for any proposal.

Baron de Gerlache de Gomery (Belgium) said that he had hoped for discussion on the problem of the duplication of the agenda of this and the SCARLCG. meeting, as well as on the frequency of Meeting of Treaty Experts.

Mr. Victor (France) expressed his agreement with Dr. Nagata's view calling for exchange of opinions without submitting recommendations.

Dr. Nagata, in his capacity as chairman of the opening and closing sessions, suggested that the conclusions of the meeting should be included in the report and that the matter should be referred to the Drafting Committe. This was agreed, and Mr.Parada (Chile) closed the afternoon session.

Chairman Parada (Chile) closed the discussion of Agenda Item 7.

Chairman Thomson (New Zealand) asked the Secretary to arrange the presentation of French film: Terre Adélie Annee Spatiale No. 1.

--- Film presentation at 16:45 hours ---

SATURDAY, JUNE 8

Closing Session

Delegations present — Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norways, South Africa, the Soviet Union, the United Kingdom and the United States of America.

Officers

Officers	Chairman:	Dr. T. Nagata (Japan)
	Secretary-General:	Mr. K. Shibuya (Japan)
	Secretaries:	Dr. K. Kusunoki (Japan)
		Mr. T. Misumi (Japan)
	Rapporteurs:	Mr. J. Lavett(Australia)
		Mr. P.-E. Victor (France)

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Chairman Nagata (Japan) called the session to order at 09:50 hours and reported that the Drafting Committee had met twice, on Thursday evening and Saturday morning, and that as a result of its discussions, amendments to the original draft had been made. He then asked Secretary Kusunoki to read the the amended draft report. (See the text attached.)

Referring to the second draft which had previously been circulated, Chairman Nagata (Japan) reported (1) that paragraphs one and two had been adopted at the second Drafting Committee meeting without amedments, (2) that a figure "59" had been inserted between the words "and" at the end of the first line of paragraph three and "papers" at the beginning of its second line, (3) that then a new sentence "These papers will be transmitted to participating governments" had been added after the first sentence of paragraph three, (4) that paragraph four had been adopted with no corrections nor amendments, (5) that the words following the word "support" of the third line of paragraph five--namely, "arrangements, and discussions of the principles underlying current and proposed arrangements"--had been deleted and that a new sentence "The principles governing logistic support were also discussed" had been added after the first sentence of paragraph five, and (6) that paragraph six had been adopted without amendments.

On the suggestion of Baron de Gerlache de Gomery (Belgium), Mr. de Bartillat (France) read the text of the report in French.

Mr. Parada (Chile), referring to Rule 22 and 23 of the Rules of Procedure wanted to know who will translate the report into Spanish and Russian and when. He then added that under these rules, the Meeting also had to approve the Spanish and the Russian versions of the report.

Mr. Styles (Australia) observed that the Meeting was asked to approve the report, not its translation.

Mr. de Bartillat (France), referring to the French version of the draft report, suggested that the phrase at the beginning of the fourth sentence of paragraph six "They expressed the feeling . . . "be amended to read: "They feel . . ." Baron de Gerlache de Gomery (Belgium) agreed to the proposed amendment to the French Version.

Mr. Parada (Chile) asked again who would translate the report into Spanish and Russian, and Secretary Kusunoki (Japan) reported that the Secretariat had translated the report into Spanish and Russian and invited the Spanish-speaking delegates to comment on it.

Mr. Aureggi (Argentina) indicated that he would be happy to help the Secretariat in the translation.

On the suggestion of Baron de Gerlache de Gomery (Belgium), Chairman Nagata (Japan) announced that the title of this document had been amended to "Final Report."

In response to Mr. de Bartillat's (France) question, Secretary Misumi reported that the full report, referred to in the Final Report, would be ready by the beginning of October.

In the absence of further comments, Chairman Nagata (Japan) declared the Final Report adopted.

He then asked Secretary Kusunoki (Japan) to read the draft press communique to be released to the press, local as well as foreign, and added that lists of participants and of papers would be attached to the communique. Secretary Kusunoki (Japan) read the text of the communique.

In the absence of any comments on the communique, Chaiaman Nagata (Japan) declared the communique approved, and he then asked if any one wishes to speak on other business.

Mr. Smith (U.S.A.) expressed, on behalf of the participating delegations, their joint gratitude to the Chairman, the Secretary General, the Secretaries and to the members of the Secretariat for the most admirable and efficient arrangements they had made for the Meeting.

On the proposal of Mr. Styles (Australia), the Meeting decided to send the following message to all Antarctic stations:

"The Antarctic Treaty Meeting of Experts on Logistics which has met in Tokyo, from 3rd to 8th June, sends its greetings to personnel of all Antarctic stations. It hopes that the fruitful exchanges of views which have taken place will serve to improve logistic arrangements on which scientific achievements in Antarctic depends".

Chairman Nagata (Japan) then took the occasion to express, on behalf of his Government, his sincere thanks to all of the participating delegations for their very friendly and kind cooperation.

The Meeting was closed at 10:20 hours.

M I N U T E S

LUNDI, 3 JUIN

Séance d'Ouverture
(10:10~10:55)

Délégations Présentes	Argentine, Australie, Belgique, Chili, Japon, Norvège, Nouvelle-Zélande, Afrique du Sud, Royaume-Uni, Etats-Unis d'Amérique		
Officiels	Président	:	Dr T. Nagata (Japon)
	Secrétaire général	:	M.K. Shibuya (Japon)
	Secrétaires	:	Dr K. Kusunoki (Japon)
			M. T. Misumi (Japon)
	Rapporteurs	:	M. J. Lavett (Australie)
			Baron de Gerlache de Gomery (Belgique)

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Le Président Nagata (Japon) déclara ouverte la séance, à 10:10 heures, et présenta M. Nadao, Ministre de l'Education et Directeur Général du Quartier général de l'Expédition de recherche antarctique japonaise.

M. Nadao (Japon) lut son allocution de bienvenue aux participants, au nom du Gouvernement japonais, dans laquelle il souligna, entre autres choses, l'importance fondamentale de la logistique pour les expéditions d'études dans l'Antarctique.

Le Président Nagata (Japon) lut deux télégrammes de salutations envoyés à ce Congrès: l'un de M. Hamm, depuis la Station Mawson, et l'autre de M. Murayama, depuis la Station Syowa.

Puis, il annonça une brève intersession à 10:16. La séance fut reprise à 10:40.

Le Président Nagata (Japon) présenta un projet de Règlement intérieur, dont le texte avait été mis à la disposition de toutes les délégations, et, conformément aux suggestions que son gouvernement avait reçues des Pays signataires, il proposa un amendement à apporter à l'Article 2, consistant en la suppression de la phrase: "... avant l'ouverture de la Réunion". N'ayant constaté aucune objection, il déclara approuvé le Règlement intérieur amendé.

Sur la motion des Délégations du Royaume-Uni, et des Etats-Unis, le Président Nagata, à l'approbation de l'Assemblée, nomma Rapporteurs, respectivement, MM. J. Lavett, de la Délégation australienne et le Baron de Gerlache de Gomery, de la Délégation belge, sous réserve que ce dèrnier céderait sa fonction à la Délégation française dès son arrivée à Tokyo.

Conformént à l'article 8 du Règlement intérieur, le Président Nagata (Japon) recommanda à l'Assemblée la nomination de M. Shibuya (Japon) au Secrétariat général, et MM. Kusunoki et Misumi au Secrétariat.

A la proposition de la Délégation australienne, le représentant du Gouvernement japonais fut, à l'approbation de l'Assemblée, nommé Président pour les séance inaugurale et de clôture.

Le Président Nagata (Japon), en se référant à l'Ordre du Jour proposé, et dont les Gouvernements des pays participants avaient été informés au préalable, porta à la connaissance des délégués présents, que l'Ordre du Jour avait été accepté par tous les Gouvernements intéressés, et, n'ayant noté aucune objection, il déclara adopté l'Ordre du Jour.

Le Dr Robert (Royaume-Uni) proposa, en se basant sur la Recommandation IV24, qu'il soit demandé à l'Adm. R. N. Panzarini d'Argentine, d'assister à la Réunion en qualité d'expert invité.

La proposition fut appuyée par la Délégation argentine et approuvée par tous les pays, à l'exclusion de la Belgique, dont le Gouvernement estimait qu'elle n'était pas conformé à l'interprétation que devrait être donnée à la Recommandation IV24. La Délégation belge s'abstint en attendant que lui parviennent des instructions de son Gouvernement, mais espérait que ce dernier lui permettrait de donner une suite favorable à la proposition britannique.

Ayant terminé avec les questions de procédures, le Président Nagata déclara clôturée, à 10:55 heures, la Séance d'Ouverture.

Séance du matin
(11:05~12:00)

Sujet	Point No.1 à l'Ordre du Jour
Délégations Présentes	(Comme pour la Séance d'Ouverture.)
	(Comme pour la Séance d'Ouverture.)

Officiels

Président	:	Capitaine J.A. Aureggi (Argentine)
Secrétaires	:	Dr K. Kusunoki (Japon)
		M. T. Misumi (Japon)
Rapporteurs	:	M. J. Lavett (Australie)
		Baron de Gerlache de Gomery (Belgique)

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Le Président Aureggi (Argentine) fit part du très vif intérêt que prenait son Gouvernement à l'échange d'informations techniques se rapportant à la logistique antarctique, et invita le Délégué australien à présenter son rapport.

M. Styles (Australie) présenta un résumé succinct du premier rapport de sa Délégation portant sur le plan d'une station antarctique où seraient minimisées les accumulations d'amas neigeux (Documents 7). A titre d'exemple pour étayer son exposé, il se lança dans la description de la Station de Wilkes; celle-ci est en effet assise sur la roche, dans une région où l'amoncellement est assez important, et où les températures, poursuivit-il, varient de -37° en hiver à +8° en été, avec une moyenne d'environ -10°C., situation climatique qui ne saurait donc être qualifiée, en termes antarctiques, de très rigoureuse. Il fit observer qu'il serait en somme logique, pour résoudre le problème, d'utiliser les forces mêmes qui l'ont fait naître, aussi suggéra-t-il, sur la base des essais effectués sur maquette dans les souffleries, et sur les expériences acquises sur le terrain par sa propre équipe, que (1) les bâtiments fussent élevés sur des crêtes plutôt que dans des dépressions, avec un minimum d'espace libre de 5 pieds au moins, afin d'assurer au vent le libre passage sous lesdits bâtiments; (2) les bâtiments fussent alignés sur une seule rangée faisant face au vent; (3) la station fût conçue de manière assez robuste pour résister à des vents de 120 noeuds.

Sir Vivian Fuchs (Royaume-Uni) demanda si les essais de laboratoire auxquels M. Styles faisait allusion avaient été conduits sur une surface rocheuse simulée ou sur la glace, car, commenta-t-il, l'accélération du vent sous les bâtiments surélevés risquait d'éroder la surface, formant ainsi une dépression que vient fausser les calculs.

M. Styles (Australie) répondit qu'il avait été procédé à ces essais sur une surface dure et qu'il escomptait que les dépressions se trouveraient comblées par les vents de faible vitesse. En conséquence, il estimait qu'il ne devait en résulter aucun Comblement de l'espace libre, sous le bâtiment.

Sir Vivian Fuchs (Royaume-Uni) cita, à l'appui de l'entassement du côté non exposé au vent, une expérience personnelle qu'il avait faite avec des entrepôts surélevés, à quoi M. Styles répliqua que lors des récentes expériences faites sur le Plateau près de Wilkes où l'alluvion l'emportait sur l'érosion, l'espace libre sous le bâtiment n'avait montré signe d'obstruction; les résultats des essais ne pouvaient toutefois pas être considérés comme définitifs.

Le Dr Kinosita (Japon) attira l'attention sur le fait que la Loi de similitude de Reynold, sur laquelle sont ordinairement basées les préparations des expériences dans les souffleries, était peu applicable aux expériences de soufflerie sur les accumulations neigeuses, du genre de celles auxquelles s'était livré M. Styles. Tout quiconque envisage de telles expériences devrait se référer à "Oyo Rikigaku (Mécaniques appliquées)" par E. Inoué, 7-7 (1948) 15, 4-22 (1951) 27.

Le Baron de Gerlache de Gomery (Belgique) doutant de la possibilité d'édifier toute une station surélevée sur des arêtes glacées, il lui fut répondu par M. Styles (Australie) qu'une structure surélevée pouvait offrir certains avantages, dans la mesure où les empattements se trouvaient munis de systèmes de vérin assurant aux bâtiments une élévation constante au-dessus de la surface du sol.

M. Sato (Japon) présenta un rapport, agrémenté de projections de diapositives, sur la récente construction de la Station Syowa (Document 18), en s'étendant sur les matériaux employés et les techniques auxquelles ont avait recouru pour chaque bâtiment de la Station.

Le Président Aureggi (Argentine) suspendit la Séance à 12:00 heures.

Séance d'après-midi
(14:00～16:40)

Sujet. Point No.1 à l'Ordre du Jour

<u>Délégations Présentes</u>	Argentine, Australie, Belgique, Chili, Japon, Nouvelle-Zélande, Norvège, Afrique du Sud, Royaume-Uni, Etats-Unis d'Amerique		
<u>Officiels</u>	Présidents	:	(i) Capitaine J.A. Aureggi (Argentine)
			(ii) M.D.F. Styles (Australie)
	Secrétaires	:	Dr K. Kusunoki (Japon)
			M. T. Misumi (Japon)
	Rapporteurs	:	M. Lavett (Australie)
			Baron de Gerlache de Gomery (Belgique)

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<u>Le Président Aureggi</u> (Argentine) ouvrit la Séance à 14:00 heures.

<u>M. Thomson</u> (Nouvelle-Zélande) exposa dans les grandes lignes la rapport de sa Délégation que traitait des effets parasitaires et de la contamination causée par l'activité de l'homme (Document 20). Il aborda les problèmes posés par l'élimination des ordures et des bruits de radio, et évoqua la nécessité de limiter les transports à des sites repérables à l'aide de colonnes itinéraires.

<u>M. Smith</u> (Etats-Unis) fit un résumé du rapport de son pays traitant des conceptions de l'installation de camps sur des calottes glaciaires permanentes (Document 23), tout en se référant aux exemples de diverses stations édifiées à la surface de la neige ou dans des tunnels. Il évoqua, pour suivre, l'imminence du remplacement de la station du Pole Sud, il déclara que l'importance de la dépense mettait la station surélevée hors de question.

<u>Le Capitaine Bernstein</u> (Etats-Unis) décrivit le rapport intitulé "Systèmes de carburant utilisés les Stations antarctiques par les Etats-Unis (Document 24), comprenant trois systèmes, à savoir, les réservoirs soudés, les réservoirs souples, et les fûts démontables.

<u>Lt. Cdr. Busico</u> (Argentine) donna lecture d'extrait des documents 3, 4, 5 et 6 traitant respectivement de la construction de la Station Almirante Brown, d'une nouvelle maison d'habitation à la Destacament Naval (Station navale) "Orcadas" sur une bôite en béton armé, d'un refuge antarctique

démontable et transportable par avion, et enfin de l'installation d'un générateur avec des moteurs à refroidissement d'air et l'utillisation de la chaleur.

M. Styles (Australie) résuma les documents 9, 12 et 47, de sa Délégation, traitant, respectivement, du logement pour une station temporaire sur le Plateau glaciaire d'Amery, des exigences de la chirurgie antarctique moderne, ainsi que de problèmes de bétonnage.

M. Brown (Australie) présenta le document 8 traitant de "Dessins techniques d'une station surélevée", et passant ensuite au document 10, "Programmation, plan et mise en chantier d'une station antarctique", il déclara que la station devait être achevée, dans les quatre années après son approbation. Il donna un compte rendu de l'avancement des travaux, mentionnant entre autres, les problèmes que posait la manipulation des explosifs; l'utilisation de la gélagnite AN60 semblait avoir apporté une solution à ces derniers. Il passa pour suivre au document 11, intitulé: "Intégration des systèmes de chauffage et de distribution d'eau, appliqués aux stations antarctiques australiennes". Il développa le thème de l'importance et de la variété des systèms de récupération de la chaleur, ainsi que des avantages du système de chauffage central, et décrivit également les systèmes de moteur à refroidissement par eau et de chauffage central en fonctionnement dans la station.

Répondant à une question du Baron de Gerlache de Gomery (Belgique), M. Brown (Australie), précisa quels bâtiments bénéficiaient du chauffage par ce système.

M. Thomson (Nouvelle-Zélande) demanda si on avait trouvé un moyen pour lutter contre la condensation, l'encrassement et la corrosion ainsi que l'excès de contre-pression, en réponse à quoi, M. Brown (Australie) préconisa un échangeur calorifique ou un pot d'échappement, en faisant remarquer toutefois que les exigences de chauffage de la station n'avaient pas encore nécessité de semblables dispositifs.

Sir Vivian Fuchs (Royaume-Uni) évoqua le problème de l'humidité engendré par les effets dessicatifs du chauffage électrique, et M.Brown (Australie) fit remarquer pour leur part les expéditions australiennes n'avaient pas rencontré de semblables problèmes grâce à la présence d'eau aux locaux d'ablutions dans les quartiers de couchage, et dans les cuisines. Les humidificateurs n'étaient pas nécessaires que dans la salle d'opération eu égard à la sécurité contre les explosions causées par l'électricité statique.

M. Smith (Etats-Unis) insista, chiffres à l'appui, sur l'excellent système d'énergie par récupération utilisé à Plateau Station, et offrit, lorsqu'il serait rendu aux Etats-Unis, de mettre à la disposition de quiconque le désirait les documents techniques se rapportant aux économies de combustible qui en résultèrent.

Le Président Aureggi proposa une intersession à 15:00 heures.

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La Séance reprit à 15:40 heures.

Le Président Styles (Australie) invita le Délégué australien alternant, de présenter son rapport intitulé "Essais sur les panneaux de construction, pour la robustesse de structure et la résistance au feu (Document 13)".

M. Brown (Australie) rapporta les divers essais de robustesse et de résistance à l'incendie auxquels il avait été procédé, et attira l'attention sur la distinction qu'il convenait d'établir entre la pénétration par le feu et l'indice de propagation du feu.

Le Président Styles (Australie) passa en revue les rapports qui avaient été présentés jusqu'à présent et invita aux débats.

Sir Vivian Fuchs (Royaume-Uni) souleva la question de la construction de stations sur la glace et décrivit le système employé par son pays qui consistait à poser les fondations sur un radier, ce qui palliait à l'affaissement; il mentionna l'innovation de l'utilisation, à Halley Bay, d'assises prolongées pour la fondation principale, ce qui évitait l'effondrement dans des cavités qui auraient pu se former sous les édifices. Répondant à une question de M. Brown (Australie), il déclara que l'accumulation normale annuelle pour cette zone était d'un metre de neige.

M. Smith (Etats-Unis), demanda des explications sur les entrées et sorties d'une station enfouie sous neige.

Sir Vivian Fuchs (Royaume-Uni) répondit qu'à la nouvelle Station d'Halley Bay, une voie d'accès était établie au bout de chaque bâtiment; ceux-ci étaient en plus reliés entre eux par un tunnel.

Il poursuivit, eu égard au problème de la déformation affectant les bâtiments enfouis, en faisant remarquer que les bâtiments chauffés y étaient davantage sujets que ceux qui ne l'étaient pas.

M. Brown (Australie) demanda à la Délégation des Etats-Unis de donner de plus amples détails concernant les déformations enregistrées à la Station Bird.

M. Smith (Etats-Unis) répondit que les déformations les plus considérables figurant sur les clichés du document des Etats-Unis (Document 23), se trouvaient localisées aux régions où la concentration de chaleur était la plus forte, et que les moyens pour y remédier avaient été: (1) un accroissement de la discipline chez les occupants des locaux, dans le contrôle de la chaleur, et (2) un dispositif de ventilateur placé dans la neige afin d'amener de l'air froid dans le tunnel. Il fit état du problème qu'il y avait à tenir le tunnel d'entree et de sortie des équipements lourds, toujours dégagé de neige. Sir Vivian Fuchs (Royaume - Uni) déclara que la méthode utilisée par le Royaume-Uni consistait à couvrir d'une trappe horizontale les entrées des tunnels d'accès pour véhicules. En réponse à une question du Président Styles, Sir Vivian Fuchs (Royaume-Uni) fit remarquer qu'il fallait déplacer chaque année les portes du tunnel, car celui-ci devait etre allongé de temps à autres.

Le Dr Nagata (Japon) demanda, à titre d'information, à la Délégation des Etats-Unis, des informations sur la réalisation d'installations de lancement de fusées.

M. Smith (Etats-Unis) proposa de reporter cette question jusqu'à l'arrivée de la Délégation française, la seule à posséder une expérience antarctique dans le domaine du lancement de grandes fusées.

M. Brown (Australie) évoquant la question des réservoirs escamotables souples, déclara que ceux-ci étaient à même de supporter des températures de moins 36°F. sans se fissurer, mais avec cependant des fuites de carburant, et également que lorsqu'ils trouvaient exposés à des vents violents, les vagues qui résultaient de l'agitation du liquide les faisaient se libérer de leur arrimage au sol, de type américain; on avait pu remédier à cet inconvénient grâce à un nouveau système d'arrimage et à la construction d'un muret protecteur. Il conclut en disant que les réservoirs d'aciers étaient à la fois plus économiques et plus durables.

M. Joubert (Afrique du Sud) demanda s'il n'y avait aucune suggestion à faire pour pallier aux odeurs dégagées par les installations sanitaires de la Station Sanaé.

Sir Vivian Fuchs (Royaume-Uni) suggéra le remplissage partiel mais continu à l'aide de neige, et parla de la méthode très simple de la mise à feu des nouvelles fosses avec du pétrole.

Revenant au problème de la déformation des bâtiments, due a la pression latérale de la neige, il signala la formation, dans le cas des bâtiments enfouis, d'un coin de pression entre les murailles et la glace environnante, qui se forme par regel de l'eau.

M. Smith (Etats-Unis) decrivit, à la demande du Président Styles, les opérations de préservations des murailles, sans oublier de relever le coût qu'entraînait l'alternative de la construction d'une arche surplombant le toit d'une base construite en surface et permettant ainsi la libre accumulation des neiges.

Le Président Styles (Australie) résumant les débats, déclara que la suggestion des Etats-Unis pouvait être une solution pour l'avenir.

Sir Vivian Fuchs (Royaume-Uni) souligna que la longévité des bâtiments et les risques d'incendie rendaient injustifiables les frais qu'entraînait la construction d'une arche, puisque ceux-ci se trouveraient de toute manière profondément enfouis avec le cours des années. M. Smith (Etats-Unis) s'accorda pour dire que l'on pouvait se passer d'une arche sur les plateaux des glaces flottants où la température était plus élevée, et mentionna d'autres facteurs militant en faveur d'une arche, pour la Station Pôle Sud.

Le Baron de Gerlache de Gomery (Belgique) mit en relief, à propos de l'effondrement des bâtiments, les avantages et les inconvénients qu'il y avait à utiliser des matériaux résistants.

Le Président Styles (Australie) rappela à l'Assistance qu'il ne s'agissait là que d'un résumé provisoire et qu'il comptait fort sur la contribution qu'apporteraient sur cette question les Délégations française et soviétique. Il pria ensuite le Secrétaire de procéder à la présentation des deux films: (1) Le Projet Plateau de Glaces, et (2) Vostok 900.

Ces deux films furent projetés à 16:40 heures.

MARDI, 4 JUIN

Séance du matin
(09:05~12:05)

Sujets	Points No.1 (continnation) et No.2 à l'Ordre du Jour
Délégations Présentes	Argentine, Australie, Belgique, Chili, Japon, Nouvelle-Zélande, Norvège, Afrique Royaume-Uni, Etats-Unis d'Amerique
Officiels	Présidents : (i) M. L. Parada (Chili) (ii) M. R. B. Thomson (Nouvelle-Zelande)
	Secrétaires : Dr K. Kusunoki (Japon) M. T. Misumi (Japon)
	Rapporteurs : M. J. Lavett (Australie) Baron de Gerlache de Gomery (Belgique)

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Le Président Parada (Chili), déclara ouverte la Séance à 09:05 heures.

Le Sécretaire Kusunoki (Japon) présenta le Commandant James Keith de la Force navale de Soutien dans l'Antarctique, que avait été adjoint à la Délégation américaine en qualité de Conseiller.

Le Baron de Gerlache de Gomery (Belgique) se référant à la proposition de la Délégation britannique qui était d'inviter l'Amiral Panzarini, Argentine, à assister aux travaux de cette Assemblée en qualité d'observateur, fit savoir qu'il avait été autorisé par son Gouvernement à accepter ladite proposition, puisqu'elle pouvait être agréable à la Délégation argentine, mais, à titre exceptionnel, et sous réserve que celle-ci ne soit pas une interprétation de la Recommandation IV-24.

Le Président Parada (Chili) après s'être assuré que les Délégations n'avaient plus ni rapports ni commentaires à présenter sur le Point No. 1 à l'Ordre du Jour, déclara celle-ci épuisée et proposa à l'Assemblée de passer au Point No. 2 à l'Ordre du Jour.

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Point No.2 A L'ORDRE DU JOUR:

Les transports sur neige; véhicules nouveaux, y compris ceux du type "à coussin d'air".

M. Brown (Australie), se référant au Document 25 présenté par lui-même et intitulé: "Expériences avec les chenilles nodwell RN110B", évoqua quelques épisodes qu'il avait vécus à la Station Wilkes avec le nodwell RN110B, grâce auquel son équipe avait pu surmonter la plupart des problèmes qui s'étaient posés avec les précédents modèles, tels les pannes dues au froid et l'allongement inégal des bandes de roulement caoutchoutées. Il conclut en déclarant que, sous réserve des capacités de travail limitées, aux basses températures, cette chenille s'était révélée un précieux véhicule pour les travaux de traverse. Comme cette intervention ne suscita ni commentaire ni question, le Président Parada (Chili) invita la Délégation australienne à passer à la présentation d'un autre rapport.

M. Brown (Australie) donna la description d'une "petite caravane pour les traversées antarctiques" (voir le Document 26); celle-ci se présente comme un habitacle monocoque robuste, de fibres plastiques, montée sur des ressorts à lames et des patins et pouvant supporter des charges de 1,5 tonne.

Sir Vivian Fuchs (Royaume-Uni) fit observer que pour les longues randonnées, il était parfois nécessaire de supporter quelques inconvénients, parce qu'une caravane pesant $1\frac{1}{2}$ tonne, représente quelque 250 jours de provisions de bouche et de carburant pour 4 hommes, tandis que les tentes pour 4 hommes ne pesaient que 50 kilos.

M. Nishibori (Japon), représentant de la Commission japonaise pour la Conception et la Réalisation des Véchicules de neige pour l'Antarctique, expliqua les problèmes ayant trait au développement des véhicules de neige et des vehicules de neige et à leur construction (voir le Document 28); il mentionna également la mise au point tout à fait satisfaisante des modèles KD 604, 605 et 606. Il retraça pour suivre la traversée de 2.500 Km., de la Station Syowa à la Plateau Station, entreprise par l'Equipe d'Observations japonaise, sous la direction du Dr Torii, et qui demanda trois mois de voyage.

Le Dr Torii (Japon) passa alors en revue, en agrémentant son exposé de projections de diapositives, les divers véhicules en service à la Station Syowa.

M. Styles (Australie) demanda à la Délégation japonaise combien de temps avait-il fallu à l'Expédition japonaise pour aller du rivage à la "Plateau Station", et à quel type de chauffage avait-elle eu recours durant son voyage.

Le Dr Torii (Japon) répondit que 40 jours avaient été nécessaires, du 5 novembre au 14 décembre 1967, et renvoya M. Styles a la Figure C du Document 28, pour ce qui se rapportait à la seconde question.

Le Dr Nishibori (Japon), en réponse à la question de Sir Vivian Fuchs (Royaume-Uni), expliqua que les bandes de roulement des chenilles des véhicules japonais étaient construites avec des chemins en acier spécial à haute résistance munis de ta uets en caoutchouc pour empêcher les chenilles de patiner.

Le Président Parada (Chili) proposa une pause à 10:20 heures.

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La Séance fut reprise à 10:40 heures.

Le Dr Nagata (Japon) demanda à ceux des Délégués qui avaient des questions particulières à formuler concernant les véhicules de neige japonais, de soumettre celles-ci au Dr Nishibori, en sorte que le M. Yamasita puisse leur préparer des réponses circonstanciées.

Le Secrétaire Kusunoki (Japon) annonça l'arrivée du Contre-Amiral Panzarini (Argentine).

Sir Vivian Fuchs (Royaume-Uni) présenta un document sur l'utilisation d'un hovercraft dans les régions polaires (document 33). Il decrivit les differents essais effectués au Canada et en Suède, avec les embarcations à coussin d'air (hovercraft) du type SR.N 5, et le modele supérieur, SR.N 6; il débattit les avantages et les inconvénients inhérents à leur utilisation dans l'Antarctique. Il rapporta qu'au cours de ces essais de nombreuses informations avaient été recueillies et que tous les problèmes relatifs a l'équipement auxiliaire pouvaient être aisement résolus. Il déclara pour terminer que leur rayon d'action (145 milles marins) restait toutefois trop limité pour les mission polaires d'envergure. Pour cette raison, et à cause de la difficulté dans la traversée des raidillons et des plaines "sastrugi", il fallait les considérer pour le moment comme utilisables seulement pour les travaux de transbordement du bateau au rivage. Il illustra son document par la présentation d'un film.

M. Styles (Australie) se montra désireux de savoir (1) si Sir Vivian Fuchs disposait de quelques données illustrant le rapport qui existait entre le poids utile et le rayon d'action, eu égard à la consommation en carburant du type SR.N 6; (2) s'il avait jamais été confronté avec des difficultés résultant de sa manoeuvrabilité malaisée, et également avec le problème du détectage d'une crevasse, suffisamment à temps pour pouvoir stopper la progression du véhicule, et enfin (3) s'il avait jamais envisagé la possibilité de la manipulation de ces véhicules relativement encombrants sur les bateaux de dimensions réduites utilisés par certains pays pour les explorations antarctiques.

Sir Vivian Fuchs, évoquant la question (1), invita M. Styles (Australie) à consulter certains détails techniques qui se trouvaient en sa possession. Concernant la question (2), il fit remarquer que tout dépendait dans ce cas de l'habileté du conducteur, et concernant la question (3), il déclara que l'encombrement et le poids pouvaient être réduits en enlevant les bordures (skirts) et les sections de chambres latérales, ce qui permettait de hisser l'engin a bord du navire utilisé.

Le Contre-Amiral Abbot, Jr. (Etats-Unis) demanda quels étaient les avantages que pouvait offrir l'embarcation à coussins d'air sur l'hélicoptère dans les explorations antarctiques.

Sir Vivian Fuchs (Royaume-Uni) fit remarquer qu'une embarcation à coussins d'air (hovercraft) démontrerait de manière péremptoire sa supériorité sur l'hélicoptère, dans des conditions de visibilité mauvaise.

En réponse à une question du Dr Kinosita (Japon), Sir Vivian Fuchs mentionna que la pente maximum que l'on pouvait s'attendre à voir escaladée par un hovercraft était d'un gradient 1/6. Une discussion s'engagea sur les aspects technigues de l'hovercraft.

Le Capitaine Bernstein (Etats-Unis) présenta un résumé du Document 34, intitulé "Systèmes routiers pour les véhicules sur neige ou glace", qui avait été préparé par des membres du Laboratoire du Génie Civil des Etats-Unis, de Port Hueneme, Californie, qui décrivait l'équipement et les techniques requises pour des routes de neiges de grande qualité, carrossables pour des véhicules à roues allant jusqu'a trente tonnes environ (75.000 livres). Treize diapositives illustrèrent les routes de neige, les méthodes de construction et l'équipement requis pour travailler la neige.

Séance d'après-midi
(14:10~16:50)

Sujets	Points No.2 (Continnution) et No.3 à l'Ordre du Jour
Délégations Présentes	Argentine, Australie, Belgique, Chili, Japon, Nouvelle-Zélande, Union Soviétique (deuxième partie de la séance seulement), Royaume-Uni, Etats-Unis d'Amerique
Officiels	Présidents : (i) Dr B. Roberts (R.U.) (ii) M.P. Smith (Etats-Unis) Secrétaires : Dr K. Kusunoki (Japon) M. T. Misumi (Japon) Rapporteurs : M. J. Lavett (Australie) Baron de Gerlache de Gomery (Belgique)

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Le Dr Roberts (R.U.), occupant la Présidence, ouvrit la Séacne à 14:10 heures.

M. Thomson (Nouvelle-Zélande) procéda au compte rendu de ses rapports portant sur le Point No.2 à l'Ordre du Jour. Le premier desdits rapports, intitulé "Pannes humaines et mécaniques sous températures inférieures à 60°F (Document 29)", décrivit les problèmes relatifs aux combustibles et lubrifiants, à la fatigue des métaux, défaillance des joints de soudure, durcissement des bandes caoutchoutées des chenilles, rupture des câbles, défaillances des chauffages, des batteries et équipements électriques, et contractures du verre. Il répondit par la négative au Capitaine Bernstein (Etats-Unis) qui lui demandait si les joints de soudure avaient été préalablement examinés aux rayons X, refondus ou bien couverts d'enduit.

Sir Vivian Fuchs (Royaume-Uni) préconisa contre la rupture des câbles électriques des isolants de silicone caoutchouté et méntionna la méthode qui consistait à faire circuler un courant alternatif dans les batteries afin de les chauffer. Il mit en garde contre le fait que le silicone caoutchouté se détériorait, lorsqu'il était en contact avec les hydrocarbones.

M. Brown (Australie) mentionna que son pays avait recours aux teste en chambre frigorifique pour étudier la résistance des caoutchouc et des plastics.

Répondant à la question de M. Styles (Australie) sur les expériences en chambre frigorifique américaine, M. Smith (Etats-Unis) dit que toute l'importance reposait sur les observations faites sur place, et Sir Vivian Fuchs (Royaume-Uni) approuva complètement cette remarque.

Le Président Roberts (Royaume-Uni) souhaita la bienvenue au Contre-Amiral Panzarini, en tant qu'invité.

M. Thomson (Nouvelle-Zélande) passant au rapport suivant intitule: "Méthodes efficaces de navigation sur le Plateau antarctique (Document 30), sous des conditions diverses", énuméra les divers équipments utilisés et souligna toute l'efficacité que comportait le système à miroir, vue à laquelle M. Brown (Australie) souscrivit entièrement. M. Brown passe ensuite à la présentation du rapport suivant qui traitait de l'utilisation des divers toboggans motorisée (Document 31), en s'étendant sur les modifications apportées à la robustesse du modèle Polaris 95; il insista sur la vitesse de ces engins qui ne devait pas excéder 5 ou 6 milles (8 - 10 kilomètres) à l'heure. Il s'étendit sur les avantages du modèle Polaris 2.500. Il conclut par l'énumération des avantages qu'il y avait à utiliser pour les petites distances des toboggans plutôt que des attelages de chiens.

A l'invitation du Président, Sir Vivian Fuchs (Royaume-Uni) fit état des expériences malheureuses qu'il avait eues avec les toboggans à moteur, malgré qu'il les eût équipés, souligna-t-il, de Skidoos renforcés. Il souligna la nécessité d'un petit toboggan sûr.

M. Brown (Australie) parla des expériences que son pays ces dernières années avait des Polaris K95, O16 et K75, un Skidoo, et, plus récemment, le Snow Cruiser, et s'enquit du comportement du Yamaha; le Baron de Gerlache de Gomery (Belgique) répondit qu'il n'avait éprouvé aucun ennui avec les Toboggans Polaris.

M. Smith (Etats-Unis) parla de l'usage que faisait son pays des toboggans motorisés pour les randonnées brèves, hors des laboratoires vers des stations telles que McMurdo, les traversées sur neige ou géologiques, le transport local, et les expéditions plus longues. L'Eliason fut introduit en 1961 pour les recherches glaciologiques sur le Ross Ice Shelf. Le Polaris K 95 fut largement utilisé, mais n'est désormais plus en fabrication. Récemment on a fait l'acquisition de toboggans manufacturés par la Fox Co. de Wisconsin. Ils n'ont été que fort peu essayés jusqu'à présent, mais se sont néanmoins révélés satisfaisants dans les opérations de 700 milles sur l'Ile Anvers.

Le Président Roberts (Royaume-Uni) souhaita que de plus amples informations sur le toboggan Fox puissent figurer dans les documents; il demanda ensuite s'il se trouvait quelqu'un qui eût une expérience pratique avec les modèles dernièrement conçus par les Suédois, à quoi M. Thomson (Nouvelle-Zélande) répondit que un de ces modèles suédois se trouvait justement à l'essai chez eux.

M. Thomson (Nouvelle-Zélande) présenta le rapport sur les Landrovers utilisées à la Base Scott (Document 32), et en décrivit les modifications. Il souligna l'efficacité des pneus sablés sans croissant, et conclut que ces véhicules pouvaient être destinées à des usages multiples et ne demandaient que peu d'entretien.

M. Brown (Australie) demanda de plus amples informations sur les progrès dans la fabrication de roues capables de se bien comporter sur la neige.

M. Thomson (Nouvelle-Zélande) dit que, dans la mesure de ses expériences, la Landrover était préférable à la Volkswagen modifiée, spécialement sur les neiges molles.

Le Contre-Amiral Abbot, Jr. (Etats-Unis) Il fit remarquer le peu d'entretien qu'exigeaient les véhicules à roue, par opposition avec le véhicule à chenille, aussi devait-il être préconisé de poursuivre et d'encourager des essais avec les véhicules à roues. Il retraça un projet avorté avec la Dodge Power Wagon, en fonction sur calotte glacière entre la Byrd Station et la VLF Station, distantes de 11 milles. Ce projet ne connut qu'un succès limité. Un second projet entrepris par la Fabco Co. consiste en un véhicule de neige à roues, qui utiliserait 2 arbres articulés dotés chacun de 8 grands pneus. Il énuméra les facteurs importants de la réalisation de ce véhicule à roues: (1) Puissance, (2) pression de l'empreinte, (3) débattement et (4) diamètre des roues.

M. Styles (Australie) rapporta que les expériences de son pays avec différents véhicules à roues avaient indiqué que, dans l'état actuel de leur perfectionnement, ils pouvaient être utilisés seulement sur voies très limitées entre les crevasses et les courants de neige fondante, dans la zone d'ablation près de Mawson. Quelques pouces seulement d'entassement suffisent pour arrêter le véhicule à roues.

Le Président Roberts (Royaume-Uni) commenta la demande qu'il y avait pour le développement de pneus de type ballon, à basse pression, et s'enquit auprès des Etats-Unis des trains de neige construits aux Etats-Unis ou au Canada pour les travaux arctiques.

Le Contre-Amiral Abbot, Jr. (Etats-Unis) assura qu'un train de tracteur terrestre avait été essayé avec succès, mais que ce projet avait été abandonné par l'Armée américaine.

Sir Vivian Fuchs (Royaume-Uni) suggéra l'emploi d'un Swamp Buggy, utilisé pour la prospection du pétrole dans les marais.

Le Baron de Gerlache de Gomery (Belgique) décrivit pour suivre l'AS 24, de construction belge qui était utilisé avec succès, il dit qu'il était équipe de roues à petits pneus ballons.

En réponse à la question du Président, concernant la dimension pratique maximale des véhicules à roues, eu égard aux aléas des crevasses, M. Smith (Eatas-Unis) dit que la largeur du pneu était tout aussi importante que son diamètre, étant donné que lorsqu'on aborde une crevasse avec un angle aigu, les penus étroits s'enfoncent dans le pont de neige. Il faut arriver à un compromis dans la conception de la roue, dit M. Smith, car des roues, avec un grand diamètre ont tendance à porter la table de chargement à une plus grande distance de la surface de la neige, ce qui rend le chargement difficile.

M. Styles (Australie) parla de l'importance de l'équilibre entre basse pression au sol et traction, soulignant que le manque de traction constituait un désavantage du Swamp Buggy. Il suggéra comme solution que l'on prévoie la possibilité de modifier la pression du pneu, pour la rendre adéquate aux conditions de la neige.

Le Contre-Amiral Abbot, Jr. (Etats-Unis) s'enquit du délai nécessaire pour obtenir des informations aux fins d'enregistrement; le Président Roberts (Royaume-Uni) répondit que le Secrétaire en donnerait communication plus tard.

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La Séance reprit à 16:00 heures, sous la présidence de M. Smiths (Etats-Unis).

Point No.3 à l'Ordre du Jour: "Transports aériens et aérodromes".

M. Smith (Etats-Unis), à la place du Représentant des U.S.A. qui présentait un rapport, accueillit la Délégation soviétique et annonça que celle-ci remettrait dès demain matin un rapport prévu pour le Point No.1 à l'Ordre du Jour.

La Délégation soviétique promit de distribuer les documents en temps utile.

Lt Cdr Búsico (Argentine) résuma le Document 35 intitulé: "Préparation spéciale des avions de type C-47, pour les vols antarctiques", ainsi que le Document 36 "Equipement portatif pour le chargement de carburant sur les avions".

Le Dr Sanuki (Japon) posa des questions sur (1) heures de vol du C-47 et (2) la disposition sur ce dernier de la turbine à gaz Marbore.

Lt Cdr Búsico (Argentine) répondit que cet engin comptait 1.500 heures de vol depuis les nouveaux aménagements, et que la turbine avait été fixée à la partie arrière du fuselage.

M. Styles (Australie) présenta le rapport sur le balisage dans l'Antarctique (Document 37), ajoutant que l'usage des repères devait se rapprocher autant que possible des normes édictées par l'ICAO, dont il rappela les dispositions contenues dans l'Annexe 14.

Le Capitaine Bernstein (Etats-Unis) manifesta sa crainte que les balises coniques recommandées par le document ne soient enfouies rapidement s'il ne se trouvait personne pour les dégager constamment, et il fit en outre remarquer que celles-ci n'avaient pas le pouvoir réfléchissant des cylindres, lors des dernières approches de la piste par radar interne.

M. Styles (Australie) répondit que les balises en question ne seraient pas laissées sans gardien.

Le Baron de Gerlache de Gomery (Belgique) parla de la commodité que préseentait l'uniformité du balisage; tout en se rangeant à l'avis de ce dernier, Sir Vivian Fuchs (Royaume-Uni) fit toutefois remarquer qu'étant donné la nature éphémère des bandes, terrains d'aviation, la disponibilité des futs rendait ceux-ci satisfaisants comme balises.

Le Président Smith (Etats-Unis) résuma en déclarant qu'on était encore loin de la standardisation complète, à cause de la grande variété des opérations aéronautiques.

Le Contre-Amiral Abbot, Jr. (Etats-Unis d'Amérique), après une exposition succincte du Document 39, intitulé: "Soutien de l'aviation pour le Programme de recherches antarctiques américain", se déclara prêt à répondre aux questions éventuelles sur les opérations aériennes.

M. Styles (Australie) posa une question se rapportant à la méthode de compression de la neige pour faciliter l'atterrissage des aéronefs de poids majeur.

Le Contre-Amiral Abbot, Jr. (Etats-Unis) précisa que, chez eux, on se servait d'un "Hercule" muni de skis, ce qui supprimait la tâche de comprimer la neige; il suffisait en effet de la niveler.

M. Styles (Australie) décrivit les problèmes rencontrés par les appareils à l'atterrissage, sur le Plateau près de Wilkes, où une formation lenticulaire influençait le choc d'atterrissage.

Le Dr. Korotkevich (Union Soviétique) questionna la Délégation américaine sur le passé et l'avenir du Starlifter, à quoi le Contre-Amiral Abbot, Jr. répondit en brossant un tableau des succès remportés par cet appareil, ainsi que des projets de vols futurs. En 1966-67, un C-141 Starlifter atterrit sur la piste de l'Annual Ice, démontrant ainsi la possibilité d'utiliser cet aéronef pour le transport de passagers et de marchandises. Des C-141 Starlifter seront mis en service lors de la saison estivale australe 1968-69; cinq à six vols seront prévus pour le transport de passagers et de marchandises.

Sir Vivian Fuchs (Royaume-Uni) décrivit les péripéties d'une expédition de secours aéroportée des Etats-Unis à partir de Mac Murdo jusqu'à Halley Bay où une piste d'attérissage de fortune avait du être aménagée moyennant un préavis très court. Il exprima ses sentiments de gratitude pour la maîtrise avec laquelle cette opération avait été menés.

Le Président Smith (Etats-Unis) clôtura sur cette évocation le Point No.3 à l'Ordre du Jour.

Le Secrétaire Kusunoki (Japon) demanda des informations complémentaires sur les toboggans et autres sujets figurant dans les documents, à envoyer au Ministre de l'Education, avant la fin du mois.

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La Séance fut levée à 16:50.

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Un film sur l'Expédition belgo-néerlandaise de 1965 fut projeté à 17:00.

MERCREDI, 5 JUIN

Séance du matin
(09:00~12:00)

Sujets	Point No.4 à l'Ordre du Jour
Délégations Présentes	Argentine, Australie, Belgique, Chili, Japon, Nouvelle-Zélande, Afrique du Sud, Union Soviétique, Royaume-Uni, Etats-Unis d'Amerique.
Officiels	Présidents : (i) M. D. Joubert (Afrique du Sud)
	(ii) Dr. E.S. Korotkevich (Soviet Union)
	Secrétaires : Dr K. Kusunoki (Japon)
	M. T. Misumi (Japon)
	Rapporteurs : M. J. Lavett (Australie)
	Baron de Gerlache de Gomery (Belgique)

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Le Président Joubert (Afrique du Sud) ouvrit la Séance à 09:00 heures. Sur la proposition du Président, le Dr Torii (Japon) fit un rapport sur l'usage du compas gyroscopique portatif qui s'était révélé fort utile à son équipe pour relever sa position au cours d'une traversée antarctique. En réponse à la question de M. Styles qui désirait connaître jusqu'à quel point le gyroscope s'était révélé efficace dans des conditions même très mauvaises, il dit que ce dernier avait toujours rempli les services que l'on attendait de lui.

Lt. Cdr. Búsico (Argentine) résuma le Rapport de sa Délégation, intitulé "Bateau en plastique utilisé à la Station navale antarctique", Doc. 40, et énuméra les avantages de ces derniers qui se trouvaient en service à la Station de Laurie Island, à savoir, grande résistance, bonne manoeuvrabilité, légèreté, facilités de nettoyage et de réparation, ainsi qu'entretien peu coûteux, sans oublier toutefois les inconvénients, à savoir, la tendance à la détérioration des boulonnages par les glaces immergées, et ses surfaces intérieures glissantes lorsque'elles étaient mouillées.

Sir Vivian Fuchs (Royaume-Uni) fit remarquer que les embarcations de Plastique, particulièrement lorsqu'elles étaient utilisées par les Plongeurs, avaient une fâcheuse tendance à l'instabilité, à quoi Lt. Cdr. Búsico (Argentine) rapporta qu'au cours des expériences, ces bateaux s'étaient révélés tout à fait satisfaisants et que les plongeurs préféraient même utiliser les bateau de plastique pour leur travail.

M. Styles (Australie) présenta le rapport intitulé "Bornes d'amarrage pour les bateaux sous des conditions de vent de l'ordre de 100 noeuds" (Document 41), qui décrivait les diverses conceptions et les techniques utilisées en sorte qu'elles puissent retenir des navires de 2.000 tonnes sous des vents de 100 noeuds à l'heure, dans les Stations antarctiques australiennes.

Devant l'absence de questions et de commentaires, le Président Joubert (Afrique du Sud) pria la Délégation australienne de passer à la présentation de son rapport suivant.

M. Styles (Australie) présenta son rapport suivant intitulé "Opérations des brise-glaces dans les mers antarctiques (Document 42)", que débattait le problème de la limitation de l'utilisation des briseglace comme escorte ouvrant le passage aux autres navires. Il suggérait, comme projet d'étude future, la possibilité de combiner en un seul bateau les fonctions du brise-glace et du navire d'expéditions, et discuta deux exemples, le m/s OB de l'Union soviétique et le m/s Fuji du Japon.

Sir Vivian Fuchs (Royaume-Uni) fit remarquer que la forme de la coque conçue pour transporter des chargements de 2.000 tonnes, ou davantage, ne correspondait pas à la forme traditionnelle des brise-glaces; il conclut en disant que la longueur d'un navire duquel on attendait une bonne manoeuvrabilité ne devait pas excéder 300 pieds à moins qu'il ne devienne lui-même un brise-glacé. Il demanda en suite quel serait, dans le cas précis du m/s Fuji, les importances relatives données au caractère brise-glace et au celui du caractère cargo.

M. Styles (Australie) commenta que la forme absolue ne posait aucun problème insurmontable, sinon d'ordre financier, pour autant que le profil, la ligne de flottaison, le frottement, et le plan du navire restaient proportionnés à sa puissance.

Le Dr Nagata (Japon) fit remarquer, en réponse à la question de Sir Vivian Fuchs, que le m/s Fuji était plus un brise-glace qu'un cargo.

L'Amiral Honda (Japon) présenta son document sur les transports maritimes et aériens à la Base Syowa (Document 43). Il décrivit les méthodes de transport par air utilisées par l'Equipe japonaise d'Observations antarctiques--transport à l'intérieur de l'hélicoptère même or par bandoulière, cette dernière méthode étant résolument la plus commode eu égard au gain de temps qu'elle permettait de réaliser. Il s'étendit sur un rapport et les records des dernières performances, et conclut en disant que le système par élingue était très efficace pour les transports de cargo faible importance qui s'effectuaient du navire au rivage.

M. Styles (Australie) émit le commentaire que le transport par air du carburant jusqu'au rivage laissait à désirer, à moins qu'il y ait la possibilité de faire usage d'hélicoptères assez grands ou d'hovercrafts. Il demanda ensuite à l'Amiral Honda si les opérations japonaises de transport aerién s'étaient trouvées handicapées par des conditions de ciel nuageux et aussi comment s'y était-on pris pour décharger des hélicoptères des chargements encombrants, tels que des constructions démontables, et ce particulièrement par les jours venteux.

L'Amiral Honda (Japon) répondit que vers la fin janvier -- époque de l'arrivée du Fuji à la Station Syowa -- l'équipe japonaise avait bénéficié de bonnes conditions atmosphériques, ce qui lui avait permis d'opérer durant la plus grande partie d'un mois; la visibilité devait être de 5 milles ou plus pour la plupart des opérations. Pour la question du transport aérien de chargements encombrants, il renvoya M. Styles à la page 6 de son rapport (Doc. 43) où figurent les limitations.

Le Dr Nagata (Japon) rapporta que les chargements maximums transportés par bandoulières atteignaient 6 x 2 mètres et tonnes.

L'Amiral Panzarini (Observateur) établit une classification des navires polaires selon l'usage auquel on les destinait: (1) ceux destinés aux opérations de ravitaillement, (2) au travail scientifique général en mer et (3) aux relevés hydrographiques, et fit remarquer également qu'ils avaient à opérer dans des conditions dissemblables, distinguant en effect (1) ceux qui opéraient sur des mers aux glaces épaisses et (2) ceux qui opéraient dans les eaux libres avec de bonnes conditions de glaces. Il termina en disant qu'en définitive, les diversités de conceptions appliquées aux navires, répondant à la diversité des usages auxquels on les destinait, et répondant aussi à la diversité des conditions physiques dans lesquelles on comptait les utiliser, donneraient les meilleurs résultats, même si elles devaient être coûteuses.

Le Dr Korotkevich (Union Soviétique) présenta son rapport intitulé "Nouveaux bateaux d'expédition pour les recherches antarctiques soviétiques". (Document 44)

* * La Séance fut interrompue à 10:50 * *

La Séance reprit à 11:20 heures sous la présidence du Dr. E. S. Korotkevich (Union Soviétique)

Sir Vivian Fuchs (Royaume-Uni) présenta un rapport intitulé: "L'emploi des clichés des satellites des Etats-Unis d'Amérique, dans la navigation maritime de la Mer glaciaire Antarctique (Document 45). Il rapporta qu'en 1967, son Gouvernement avait accepté l'offre des Etats-Unis de mettre à sa disposition des photographies des régions antarctiques, prises du Satellite Polaris ESA, sur orbite polaire; ces photographies s'étaient révélées d'un grand intérêt pour déterminer le meilleur point d'entrée dans les glaces pour un navire d'expédition. Il fit montrer 7 diapositives de la région, qu'il enrichit de commentaires.

M. Styles (Australie) dit oue les photographies par satellite avaient aussi été utilisées pour aider les expéditions australiennes à traverser la banquise.

M. Smith (Etats-Unis) résuma le rapport de sa Délégation intitulé "Installations de débarquement et de mise au bassin, aux Stations MCMURDO et PALMER" (Doc. 46), et évoqua les problèmes du lancement de jetées pour ces stations.

La Séance fut levée à midi.

Séance d'après-midi
(14:05 – 17:15)

Sujets	Points No.1, 5 et 6 à l'Ordre du Jour		
Délégations Présentes	Argentine, Australie, Belgique, Chili, Japon, Nouvelle-Zélande, Afrique du Sud, Union Soviétique, Royaume-Uni, Etats-Unis d'Amérique.		
	Observateur :		Contre-Amiral R. M. Panzarini.
Officiels	Présidents	:	(i) M. J. A. Aureggi (Argentine) (ii) M. D. F. Styles (Australie)
	Secrétaire	:	M. K. Kusunoki (Japon) M. T. Misumi (Japon)
	Rapporteurs	:	M. J. Lavett (Australie) Baron de Gerlache de Gomery (Belgique)

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Le Président Aureggi (Argentine), à la Présidence, déclara ouverte la Séance à 14:05 heures. Ensuite il invita aux questions sur le document des Etats-Unis relatif aux "Installations de débarquement et de mise au bassin (Document 46).

M. Styles (Australie), se référant au résumé présenté par M. Smith (Etats-Unis) demanda un éclaircissement sur la mise en place des pièces verticales, pour le dressage du dock à McMurdo.

M. Smith (Etats-Unis), en réponse, décrivit d'abord l'aire et la mise en place des embases dans des trous percés sous eau, et ensuite la mise en place des pièces verticales, des barrières de protection pour le dressage du dock, et le rebouchage de l'aire située entre le dressage et le banc de glace du dock lui-même.

Le Président Aureggi (Argentine) invita la Délégation soviétique à présenter son rapport sur le Point No.1 à l'Ordre du Jour.

Le Dr Korotkevich (Union Soviétique) donna lecture du Document 21, intitulé: "Construction des locaux d'habitation et officiels à la Station Molodezhnaya", et exposa des points détaillés relatifs à la structure et aux matériaux employés.

M. Smith (Etats-Unis) se déclara impressionné par les techniques de génie expérimentales, et formula une question relative aux dimensions de l'espace souterrain réservé à l'emmagasinage des vivres gelées, qui avait été construit dans la roche ferme, à la Station.

Le Dr Korotkevich (Union Soviétique) répliqua que lesdites dimensions étaient de 50 mètres carrés environ sur une hauteur d'environ 3 mètres.

M. Styles (Australie) demanda si cet espace libre sous les bâtiments, mentionné dans le rapport, suffisait pour éviter l'accumulation d'amas neigeux.

Le Dr Korotkevich (Union Soviétique), en réponse, montra des photographies de la station et mentionna la faible accumulation annuelle de neige, qu'il attribuait en grande partie au fait qu'on ne se trouvait pas dans une aire d'accumulation. Répondant à la question de M.Styles (Australie) sur la durée de l'expérience avec ces bâtiments, il l'informa que la station avait été établie en 1962, mais que le premier bâtiment avait été érigé en 1964.

M. Styles (Australie) passa alors à une autre question concernant le matériau de silicalcite; le Dr Korotkevich (Union Soviétique) répondit en expliquant que, en raisons du poids, on préférait les planches en aluminium à l'arbolite et que la silicalcite était du silicate de chaux écumée. En réponse à la dernière question de M. Styles, le Dr Korotkevich dit que les déchets étaient déversés à la mer.

Devant l'absence d'autres questions, le Dr Kortkevich procéda à la lecture du Document 22, intitulé: "Construction de réservoirs à essence à l'Observatoire Mirny et la Station Molodezhnya, dans l'Antarctique".

Sir Vivian Fuchs (Royaume-Uni) demanda à l'Assemblée son avis sur les réservoirs horizontaux du type cylindrique, par opposition aux réservoirs verticaux; le Contre-Amiral Panzarini (Observateur) et M. Thomson (Nouvelle-Zélande) précisèrent qu'ils faisaient usage de réservoirs de cette espèce, quoique de dimensions plus réduites; M. Brown (Australie) décrivit le déchargement des tanks de 8.500 gallons ainsi que les méthodes utilisées pour les acheminer vers leur emplacement.

Le Dr Torii (Japon) dit que les tanks horizontaux étaient en usage à la Station Syowa, et en réponse à la question de Sir Vivian Fuchs (Royaume-Uni), il déclara que les prix des réservoirs de 20 et 50 tonnes étaient sensiblement les mêmes.

Le Président Aureggi (Argentine) proposa de passer au Point No.5 à l'Ordre du Jour et pria l'Australie de présenter son Document No. 47.

M. Brown (Australie) esquissa les grandes lignes du rapport de sa Délégation, intitulé "Chirurgie antarctique: quelques éléments d'élaboration", et dit que la rareté des accidents ne devait pas faire néglaiger de prendre des mesures pour les cas d'urgence; il souligna également l'importance de la réduction des jaillissements toujours possibles d'étincelles, à cause de l'utilisation d'oxygène et les gaz anesthésiques inflammables dans la salle d'opération.

Le Secrétaire Kusunoki (Japon) donna quelques communications concernant les conférences de presse.

* * Une intersession eut lieu à 15:20 * *

La Séance reprit à 15:45 heures, sous la présidence de M. Styles (Australie).

Le Président Styles (Australie), après avoir expédié quelques détails ayant trait aux conférences de presse, pria la Délégation australienne de présenter son document suivant.

M. Brown (Australie) traça les grandes lignes du Document 48, intitulé "Entraînement sur place en Australie pour les expéditions antarctiques", et insista sur la nécessité du recours aux techniques d'alpinisme, ce qui constituait un excellent moyen pour apprendre aux hommes à se tirer des crevasses.

Le Dr Nagata (Japon) interrogea M. Brown sur (1) la durée de cet entraînement, et (2) le manque d'entraînement sur neige dans le programme australien disant que le Japon mettait, pour sa part, tout l'accent sur ce dernier.

M. Brown (Australie) répondit que l'entraînement avait duré trois jours et deux nuits, mais que l'entraînement sur neige n'était pas pratiquable.

M. Joubert (Afrique du Sud) dit que son pays avait des problèmes identiques à ceux de l'Australie, à savoir l'absence de neige et donna une description de l'entraînement en Afrique du Sud.

Le Baron de Gerlache de Gomery (Belgique) retraça l'entraînement qu'avait subi l'équipe expéditionnaire de son pays, faisant remarquer que certains pilotes avaient reçu en Suisse un entraînement de pilotage d'avion muni de skis.

M. Thomson (Nouvelle-Zélande) dit que dans son pays les hommes recevaient leur entraînement sur les crevasses, et qu'une attention toute particulière était donnée aux méthodes de lutte contre l'incendie Sir Vivian Fuchs (Royaume-Uni) déclara que son pays avait recoures à un système de chevauchement des postes, ce qui permettait aux nouveaux arrivés de bénéficier de l'expérience des anciens. Il relata qu'ils avaient prévu un grade d'"Assistant général" expérimenté dans les excalades sur neige et sur glace, qui pouvait être utilisé comme homme de confiance dans les travaux sur le terrain. Après avoir également fait mention des pilotes qui recevaient un entraînement en Suisse ou au Canada, il aborda le problème du choix des dirigeants et conclut que dans ce domaine le caractère était plus important que l'expérience.

Ne relevant plus aucune autre question, le Président Styles (Australie) proposa de passer au rapport de la Délégation soviétique.

Le. Dr Korotkevitch (Union Soviétique) donna lecture du Document 49, intitulé "Mesures de Sécurité adoptées par l'Expédition soviétique dans l'Antarctique".

Le Président Aureggi (Argentine) évoquant le document dont il avait été donné lecture, releva la suggestion de la Délégation soviétique qui était de remplacer par le Symbole "T" l'indication de sécurité d'atterrissage, au lieu du triangle qui avait été adopté lors du Symposium de Boulden.

Le Contre-Amiral Panzarini (Observateur) suggéra que la lettre "T" indique à l'avion le sens dans lequel devait s'effectuer l'atterrissage.

En réponse à la question du Président concernant la possibilité d'obtenir le livret traitant des "Mesures de Sécurité pour le Personnel de l'Expédition", le Dr Korotkevich (Union Soviétique) dit que ce livret n'avait pas encore été publié mais qu'il le serait d'ici quelques mois.

Sir Vivian Fuchs (Royaume-Uni) proposa de remettre à plus tard toute décision concernant l'utilisation de la lettre "T" et du triangle, vu l'absence de personnel volant.

Le Président Styles (Australie) proposa de passer au Point No.6 à l'Ordre du Jour, "Equipement personnel".

Lt. Cdr. Busico (Argentine) résuma le Document 50 intiutlé "L'équipement vestimentaire antarctique".

Comme il n'y avait aucune question, la Président Aureggi (Argentine) demanda à la Délégation argentine de présenter un résumé du rapport suivant.

Lt. Cdr. Búsico (Argentine) résuma donc le Document 51 intitulé "Préservation des viandes dans l'Antarctique", qui traitait des fructueux essais tentés sur des quartiers de viandes mis à séjourner pendant une année dans un tunnel pratiqué dans le glacier.

Sir Vivian Fuchs (Royaume-Uni) rapporta qu'un semblable essai s'était révélé malheureux, aussi s'enquit-il de la température; à quoi il lui fut répondu par Lt. Cdr. Búsico (Argentine) que celle-ci était de -4°C au niveau supérieur de l'endroit de stockage. Il avait été nécéssaire d'insuffler de l'air froid pour réduire la température du niveau inférieur ou la viande était entreposée.

M. Brown (Australie) passa ensuite aux grandes lignes du Document 52, "Expérience australienne en matière de vêtements dans l'Antarctique", dans lequel ressortait l'importance qu'il fallait attacher au style et à la couleur, tout en les subordonnant cependant au dessin physique, ainsi qu'à la résistance à l'accumulation de l'électricité statique.

Sir Vivian Fuchs (Royaume-Uni) préconisa les sacs de couchage rembourrés de "térylène", à la fois pour des raisons de confort et de nettoyage aisé. Répondant à la question de M. Brown qui désirait connaître la compacité de ces sacs, il répondit que ceux-ci pesaient environ 1 1/2 kilos de plus que les autres sacs de nuit mais qu'ils étaient de loin plus chauds.

Une interruption fut annoncée à 17:00 heures.

La Séance reprit à 17:05 heures.

Le Président Styles (Australie) annonça l'arrivée de la Délégation française, et demanda la nòmination du Rapporteur français pour le restant des travaux de l'Assemblée.

Le Dr Nagata (Japon) recommanda donc M. Victor (France), et le Président Aureggi (Argentine) ayant accepté cette désignation remercia le représentant de la Belgique pour sa coopération.

M. Victor (France) présenta ses excuses pour le retard de la délégation française et proposa de remettre la distribution des documents de sa Délégation au lendemain.

M. Thomson (Nouvelle-Zélande) donna quelques mots de préambule au film "140 Jours sous le Monde".

Le film fut projeté à 17:54 heures.

JEUDI, 6 JUIN

Séance du matin
(09:10~12:25)

Sujets	Points No.1, 3, 6, et 7 à l'Ordre du Jour
Délégations Présentes	Argentine, Australie, Belgique, Chili France, Japon, Nouvelle-Zélande, Afrique du Sud, Union Soviétique, Royaume-Uni, Etats-Unis d'Amérique
Officiels	Présidents : (i) Baron de Gerlache de Gomery (Belgique) (ii) M.C. de Bartillat (France)

Secrétaires : Dr K. Kusunoki (Japon)
M. T. Misumi (Japon)

Rapporteurs : M. J. Lavett (Australie)
M. P.-E. Victor (France)

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Le Président de Gerlache de Gomery (Belgique) ouvrit la Séance à 09:10 heures et proposa que la parole soit donnée à la Délégation française pour présenter ses rapports sur les Points 1 et 3, dès que la Délégation japonaise aurait terminé le sien sur l'Equipement individuel. Toutes les Délégations présentes donnèrent leur accord.

Le Dr Torii (Japon) passa en revue les divers essais auxquels il avait été procédé en vue de rechercher des fibres synthétiques adéquates et des matériaux de rembourrage qui ne soient pas coûteux, d'entretien facile, et pratiques aux basses températures; il rapporta que les bottes de polyvinylchloride et de laine feutrée, qui n'absorbent pratiquement pas d'eau tout en permettant à la vapeur de la transpiration de se diffuser, mais sans, pour autant, perdre leur pouvoir isolant, s'étaient révélées les plus chaudes dans des températures de 60°C. sous zéro. (Des échantillons de ces bottes cirulèrent parmi les Délégués)

En réponse à une question de M. Victor (France), M. Torii (Japon) répondit qu'une paire revenait à 25 dollars.

M. Thomson (Nouvelle-Zélande) recommanda chaudement ces bottes comme étant la "botte de l'Antarctique"; toutefois le seul défaut qu'il leur trouvait, mais auquel il pouvait être remédié, imparfaitement cependant, par l'adjonction d'une patte plus large, était une tendance à s'enrouler.

M. Victor (France) parla de ses expériences avec des bottes de fabrication danoise, qui étaient affectées de la même tendance à l'enroulement, mais étaient plus lourdes que les bottes japonaises.

Le Président de Gerlache de Gomery (Belgique) annonça que les débats revenaient sur le Point 1 à l'Ordre du Jour et pria la Délégation françcaise de présenter ses rapports.

M. Victor (France), résuma donc le rapport de sa Délégation, intitulé, "Alimentation en Eau potable de la Base DUMONT d'URVILLE" (Document 14), et rapporta la solution imaginée par son équipe, solution caractérisée par deux points principaux: (1) l'utilisation de trois stades de récupération de la chaleur des moteurs diesel à commande électrique, (2) le système automatique de sécurité prévu pour empêcher le gel des canalisations en cas de panne.

N'ayant à répondre à aucune question ou commentaire, M. Victor (France) passa à la présentation de son deuxième rapport, intitulé "Utilisation de Mastic bitumeux à la Base DUMONT d'URVILLE" (Document 15), qui décrivait les techniques de construction de quai à l'aide de ciment bitumeux.

M. Victor (France) passa ensuite à son troisième rapport, intitulé: "Mur Pare-vent pour Hélicoptère" (Document 38), et décrivit l'expérience de son équipe en Terre Adélie, qui avait pu grâce à un mur de 3 mètres de haut, casser des vents de 250 kilomètres pour les ramener à 50 kilomètres à l'heure.

En réponse à la question du Dr Nagata (Japon) qui désirait savoir si les vents en Terre Adélie changeaient de direction selon la saison, M. Victor (France) l'informa que les vents violents y soufflaient toujours de la direction sud-est.

M. Victor (France) commenta dans les grandes lignes les quatre rapports que sa Délégation avait préparés à l'intention de présenter au Congrès mais pas encore reçus depuis Paris: (1) Reconstruction et développement de la Base Dumont d'Urville, (2) Les nouveaux bâtiments à la Base Dumont d'Urville, (3) Unités mobiles utilisees à la Base Dumont d'Urville pour le lancement des Rockets à sonder l'ionosphère, (4) Le nouveau véhicule polaire français HB 40.

Le Dr Nagata (Japon) lui ayant rappelé l'ajournement, convenu à la reunion précédente, de la discussion sur la question relative aux installations de mise à feu de fusées, le Président de Gerlache de Gomery (Belgique) pria à M. Victor (France) de donner des informations sur cette question.

M. Victor (France) déclara que, en raison du retard dont avait souffert la préparation des rapports, tous les détails ayant trait au sujet seraient donnés au cours de la réunion du Groupe Logistique du SCAR qui se tiendrait la semaine prochaine. Il relata pour suivre les expériences vécues par son équipe avec les véhicules HB 40, appelés "Castor", capables de remarquer sans difficulté 4 à 5 tonnes, ce qui le distinguait des deux tonnes de traction de la "Belette".

M. Smith (Etats-Unis) demanda à M. Victor de lui faire une description plus détaillée des systèmes de chenille et de suspension du véhicule.

M. Victor (France) s'exécutant, lui dit que cette dernière avait une largeur de 40 à 50 centimètres, qu'elle était de caoutchouc et de coton synthétique, ou bien de caoutchouc synthétique et de nylon, la première combinaison s'étant toutefois révélée supérieure à la première.

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Le Préidend de Gerlache de Gomery (Belgique) proposa de passer au Point 7 à l'Ordre du Jour: "Projets spéciaux et futurs d'Entretien".

M. Thomson (Nouvelle-Zélande) résuma son rapport intitulé "Recherches et Besoins logistiques futurs de la Nouvelle-Zélande" (Document No.58), en y relevant les points principaux suivants: (1) décentralisation du travail de laboratoire, dans des petites cabanes éloignées de la Base Scott, et ceci particulièrement pour les sciences géophysiques, (2) développement des actuelles bases éloignées, (3) consturctions de cabanes supplémentaires dans les petites bases situées dans des régions présentant un intérêt géologique ou de biologie marine, spécial, et (4) recours continu à l'hélicoptère et réduction plus draconienne des attelages de chiens.

En réponse à la question de Sir Vivian Fuchs (Royaume-Uni), M. Thomson expliqua que son équipe utilisait, en plus des hélicoptères, des véhicules Hercule C-130, capables de transporter les hommes et le ravitaillement jusqu'à des distances éloignées de 450 à 500 milles de la Base Scott.

M. Victor (France) rapporta que son équipe utilisait des "Alouette-2" capables de parcourir 1,000 kilomètres à une altitude de quelque 3,000 mètres.

* * Interruption à 10:35 * *

La Séance reprit à 11:05 heures, sous la présidence de M. de Bartillat (France). Passant au Point No. 7 à l'Ordre du Jour, "Projets spéciaux et futurs d'Entretien", il céda la parole au Délégué britannique.

Le Dr Robin (Royaume-Uni) présenta le Document 59, soulignant le fait que la logistique et les recherches dépendent l'une de l'autre et donna une importance spéciale aux techniques de repérage à distance par avion et satellite, sur l'équipement amélioré des stations principales, et aussi à l'utilisation appelée à devenir plus large, des réseaux de stations géophysiques. A l'aide de dispositives, il décrivit certaines opérations de détectage à distance ainsi que les résultats qu'elles avaient donnés, disant que cette précieuse information pouvait facilement s'obtenir grâce au support logistique. La base d'un support logistique efficace réside dans les communications, et particulièrement en ce qui concerne l'information météorologique. Il préconisa une collaboration plus étroite entre les trois organisations intéressées aux communications antarctiques. Un risque peut également résider dans le fait que la coopération logistique antarctique reçoive des recommandations de deux organismes agissant indépendamment -- les Assemblées consultatives du Traité sur l'Antarctique et le SCAR. Il formula le voeu que tout conflit d'intérêt soit évité.

Le Baron de Gerlache de Gomery (Belgique) s'enquit si (1) la nature de la surface influençait la qualité des sons renvoyés, et (2) si l'instrument pouvait être utilisé sur des appareils Loutre.

Le Dr Robin (Royaume-Uni) répondant au point (1) dit que la nature de la surface ne jouait qu'un faible rôle, et au point (2), que cet instrument avait été utilisé sur une "Loutre", de même que sur d'autres petits avions, ajoutant qu'un minimum de deux hommes sont nécessaires pour la manipulation; pour des croisières plus longues, une équipe de trois ou quatre hommes permettait des périodes de repos; il mentionna pour terminer que des ouvrages avaient été publiés sur les travaux menés sur l'Ille Ellesmere.

M. Styles (Australie) évoquant les recommandations du Dr Robin, qui préconisait de transporter 50 ou 100 tonnes de carburant là où il y avait un balisage adéquat, afin d'encourager le support logistique pour les avions à long rayon d'action, demanda aux Etats-Unis s'ils pouvaient consacrer du temps à une telle opération.

Le Contre-Amiral Abbot, Jr. (Etats-Unis) répondit que cela dépendait de la praticabilité de l'opération et de la sécurité du projet proposé et aussi de ses interférences avec le Porgramme de la Fondation Nationale Scientifique. Toute proposition spécifique devrait donc être soumise à une étude attentive.

M. Victor (France) dit alors que, étant donné que la seule raison d'être de la logistique était la recherche scientifique, la coordination entre les deux était donc essentielle. Il regretta qu'il n'y eût aucun membre du groupe de Travaille Logistique du SCAR présent à la Séance, et conclut en disant que les experts sur la logistique devraient avoir une compréhension du but scientifique des opérations pour pouvoir donner à leurs travaux une efficacité maximum.

Le Dr Nagata (Japon) recommanda une plus étroite coopération entre les savants scientifiques et les fonctionnaires gouvernementaux intéressés aux problèmes relatifs à l'Antarctique et pria au Dr Robin de fournir l'Assistance de quelques recommandations en vue d'améliorer les contacts entre SCAR, les puissances membres du Traité sur l'Antarctique et WMO.

Le Dr Robin (Royaume-Uni) répondit qu'en ce qui concernait la logistique, les deux organismes pourraient organiser des rencontres au cours desquelles ils confronteraient leurs observations. Dans le cas de la présente Assemblée, cela était possible par la convocation de réunions successives. En égard aux communications, les trois organismes concernés pourraient mettre sur pied un group unique de coordination qui représenterait tous les trois, ou peut-être aussi arranger des rencontres simultanées pour les intéressés, qui pourraient alors travailler de conserve afin d'aboutir à des conclusions communes.

La Séance fut levée à 12:25 heures.

Séance d'après-midi
(14:05~16:45)

Sujets	Point No. 7 à l'Ordre du Jour
Délégations Présentes	Argentine, Australie, Belgique, Chili, France, Japon, Nouvelle-Zélande, Norvège, Afrique du Sud, Union Soviétique, Royaume-Uni, Etats-Unis d'Amérique.
Officiels	Président : (i) M. L. Parada (Chili) (ii) M. R. B. Thomson (Nouvelle-Zélande)
	Secrétaires : Dr. K. Kusunoki (Japon) M. T. Misumi (Japon)

Rapporteurs : M. J. Lavett (Australie)
M. P.-E. Victor (France)

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M. L. Parada (Chili) prenant la Présidence ouvrit la séance à 14:05, et invita la Délégation des Etats-Unis à présenter le Document 39.

Le Capitaine Bernstein (Etats-Unis) résuma le Doc. 60 intitulé "Emploi des données obtenues des satellites météorologiques, comme aide à la prévision des programmes de travaux dans l'Antarctique", qui décrit l'utilité des satellites, pour la détermination de la formation des systèmes climatiques dans l'Antarctique et sur les Océans, en ajoutant que cette branche était seulement complémentaire aux autres observations techniques qui doivent aussi contribuer aux méthodes de prévision du temps pour les vols.

Répondant à M. Styles (Australie), à propos de l'élaboration du système de satellites, le Capt. Bernstein (Etats-Unis), dit qu'il existait deux types d'antennes, celle à spires et celle de direction; la première, si elle donnait de meilleurs résultats, était cependant plus coûteuse; répondant à une autre question, l'Amiral Abbot (Etats-Unis) dit qu'un système de lecture à infra-rouges avait été projetée pour les opérations des Etats-Unis, mais qu'il ne possédait encore aucune expérience à ce sujet. Répondant à la question du Docteur Nagata, il dit que le programme horaire des orbites et d'autres informations de captage pouvaient s'obtenir à Sutland, Maryland.

Aucune autre question n'étant plus posée, le Président Parada (Chili), invita les Etats-Unis à présenter leur rapport suivant.

M. Smith (Etats-Unis) présenta donc le Document 61 de M. Jenny et de lui-même traitant de la "Praticabilité d'observatoires géophysiques automatisés, dégarnis de personnel", qui sont destinés à envoyer directement leurs informations aux Etats-Unis; des diapositives illustrèrent l'exposé qui résume une étude plus détaillée faite par des Laboratoires de science radio de l'Université de Standford. Le système qui est invisagé par les Etats-Unis utilisera des radio-isotopes thermo-électriques ou des génératrices à éoliennes pour fournir une puissance d'environ 65 watts à la station automatique. La Station, enregistrant une gamme complète de phénomènes géophysiques de la haute atmosphère, transmettra les données aux Etats-Unis au moyen d'un satellite de communication synchronise.

M. Styles (Australie) fit remarquer les difficultés inhérentes aux stations sans personnel à cause principalement des défaillances dans les organes, et parla que les solutions possibles de ce problème seraient la désignation des stations à une série de unités doubles arrangées de telle sorte qu'une autre unité fonctionne automatiquement lorsqu'une unité a une panne.

Le Dr Nagata (Japon) mentionna qu'il envisageait la création d'une station d'observations atmosphériques sans personnel, aussi s'enquit-il de la consommation d'électricité et du poids des systèmes de radioisotopes, en réponse à quoi M. Smith (Etats-Unis) le renvoya au document et offrit de donner ultéveurement un rapport plus circonstancié sur cette question. M. Thomson (Nouvelle-Zélande) fit remarquer l'existence d'un type anglais de producteur d'énergie, qui pourrait être employé par la Nouvelle-Zélande pour sa station Vanda.

Le Docteur Robin (Royaume-Uni) demanda jusqu'à quel point le projet d'un observatoire géophysique automatisé, sans personnel, pouvait être décomposé, et si une étude avait été entreprise sur les avantages d'étapes intermédiaires vers l'automatisation complète telles que l'automatisation des systèmes de communications ou d'autres composants.

M. Smith (Etats-Unis) répondit que certaines phases de l'étude, telles que le système de communications étaient applicables à des stations menées par du personnel, et que des stations automatiques enregistrant moins de mesures seraient plus petites et moins complexes. Le but de l'étude du Stanford était de faire un exposé de tous les pboblèmes de sorte qu'une étude ultérieure d'un projet puisse en découler.

M. Homewood (Australie) demanda si le satellite à orbite polaire avait été envisagé. M. Smith répondit qu'il avait été envisagé, mais qu'un satellite synchronisé était le plus pratique, car le satellite sur orbite polaire n'avait pas la capacité de recevoir la quantité importante de données émises par une station géophysique complète.

A l'invitation du Président, M. Nagata (Japon) donna lecture du Document 40 intitulé "Plan d'une Installation de Fusées d'observations japonaises dans l'Antarctique" le document donne une déscription detaillée des plans japonais pour les installations à Syowa et fournit des indications sur les étapes des premières constructions.

M. Victor (France) entreprit de décrire la petite unité mobile de lancement de fusées, tout en promettant de distribuer les documents qui s'y rapportaient quand ils seraient disponibles; il ajouta encore que des informations plus circonstanciées pourraient vraisemblablement être obtenues au Comité National des Etudes spatiales à Paris. Il poursuivit par une description du système de préparation du lancement des fusées, et ceci pour répondre à une question du Dr Nagata (Japon).

Le Docteur Nagata s'enquit du laps de temps qui s'était écoulé entre le temps de la décision du lancement de la fusée et le lancement lui-même. M. Victor répondit qu'après avoir attendu pendant un mois que les conditions atmosphériques deviennent favorables, la fusée fut lancée une heure après la décision, et trois autres fusées furent ensuite larguées dans un laps de 2 1/2 heures; M. Smith (Etats-Unis) proposa que ceux qui s'intéressaient au programme des fusées se réunisent à nouveau quand les documents francais seraient disponibles.

Le Président Parada (Chili) reprit pour suivre la question déjà traitée des relations des parties contractantes du Traité Antarctique et du SCAR en matiére de logistique.

Le Baron de Gerlache de Gomery (Belgique), se référant à la Recommandation IV-24 du Traité dit que l'interprétation de son Gouvernement des termes "other experts may be invited to attend" etait que ce sont des experts d'autres pays que ceux appelés "Consultative Parties" qui pourraient être invites comme observateurs aux réunions d'experts du Traité. En ce qui concerne les rapports entre le SCAR et le Traité, il précisa que son gouvernement estimait que les réunions du Traité et celles du SCAR devaient rester distinctes en sorte que le SCAR puisse se trouver libre de toute pression gouvernementale. Reconnaissant que la recherche scientifique pouvait dépendre de la logisitique il estima qu'il fallait en conséquence rechercher la meilleure coordination possible entre les organismes existants qui s'occupent pour l'antarctique de questions scientifiques et logistiques.

Il considera que c'était déjà un facteur favorable de coordination entre le groupe des experts en logistique du Traité et le groupe logistique du SCAR que certains mêmes délégués participent aux réunions distinctes de ces deux organismes. Il dit ensuite qu'il trouvait regrettable la similitude des ordres du jour de cette réunion des experts du Traité et de celle du groupe logistique du SCAR qui allait suivre.

De nombreux problèmes logisitiques, et dans certains pays tous les problèmes, sont de la responsabilité des gouvernements. Il y aurait lieu d'éviter que des problèmes logistiques purs soient traités simultanément ou successivement par les deux groupes. La discussion des mêmes problèmes ne devrait intervenir dans les deux groupes que quand il y a interférence évidente entre la science et la logistique et que le chevauchement est alors non seulement inévitable mais utile.

Le Baron de Gerlache de Gomery suggéra que les réunions du groupe logistique du SCAR précèdent de quelques mois les réunions du groupe des experts du Traité et qu'elles servent à émettre des avis au groupe des experts du Traité. Il suggéra également que le groupe des experts du Traité envisage un rapporteur permanent par pays pour arriver à une meilleure information et coordination dans chaque pays entre la logistique traitée par le groupe des experts du Traité et les divers organismes antarctiques nationaux scientifiques et logistiques. Il suggéra enfin de proposer des réunions plus fréquentes du groupe des experts en logistique du Traité. Il conclut en assurant qu'il communiquerait fidèlement à son gouvernement les commentaires et les suggestions émises par les autres délégations sur ces questions.

Sir Vivian Fuchs (Royaume-Uni) insista sur la nécessité d'échanges continus d'informations et de discussions. Il fut d'avis que cela avait été possible et que cela continuerait à l'être dans le cadre de travail du SCAR. D'autre part, il lui sembla qu'il n'y avait pas de mécanisme dans l'organisation du Traité par lequel cela pouvait se réaliser. Il ajouta qu'il ne semblait pas souhaitable d'avoir deux organisations traitant les mêmes matières, surtout si une majorité de representants participant à l'une et l'autre organisation devait apparemment être constituée des mêmes personnes.

Le Docteur Roberts (Royaume-Uni) s'étendit sur trois points qui avaient été soulevés :

1) L'on s'est plaint de ce que les informations échangées par les gouvernements ne parvenaient pas à ceux qu'elles intéressaient en premier lieu. La distribution, à ceux qui en ont besoin, des informations échangées par les gouvernements en vertu de l'Article VII(5) du Traité Antarctique, est du ressort interne de chaque pays.

2) Commentant la suggestion faite par le Baron de Gerlache de Gomery selon laquelle seuls les gouvernements étaient habilités à traiter de questions logistiques, il rappela que toutes les recommandations du Traité nécéssitent l'unaminité avant qu'une action puisse être prise, et qu'elles ne sont pas obligatoires avant qu'elles n'aient été approuvées par les douze gouvernements. Il peut en résulter un délai de deux ans, ce qui est tout à fait inaproprié pour des recommandations sur des sujets tels que les communications. Des discussions moins officielles, qui n'obligent pas les gouvernements à agir, seraient beaucoup plus efficaces.

3) Toute tentative de trop rapprocher les gouvernements du Traité et le SCAR présente de risques.

La liberté d'action du SCAR a été un succès parce que cet organisme agit sous la protection du Traité et qu'il a été préservé de difficultés politiques. Il est de la plus grande importance de préserver cette liberté de toute interférence politique dans le travail scientifique. Mais cela ne doit pas faire perdre de vue le besoin de rapprocher les hommes de science et les logisticiens.

M. Joubert (Afrique du Sud) déclara que selon lui le SCAR devrait agir indépendamment, et mentionna la solution d'un comité de coordination comme il en existait dans son pays. En ce qui concernait une étroite coopération entre les pays, il déclara que ceci devait être laissé au jugement des pays intéressés.

M. Victor (France) dit qu'il considerait que la suggestion du Baron de Gerlache de Gomery était constructive.

Le groupe logistique du SCAR pourrait servir d'organisme consultatif pour les réunions du Traité Antarctique traitant de problèmes logistiques.

Les membres du groupe du SCAR qui, en leur qualité d'hommes de science, font usage de la logistique, semblent à même d'arriver à des décisions sans en référer à leurs gouvernements, quoiqu'il évident que certains décisions ne peuvent être prises qu'à un niveau gouvernemental.
Il semble souhaitable que le SCAR étudie la question et fasse des recommandations à une réunion du Traité Antarctique.
Ceci devrait être traité à une réunion du Traité.

Contre-Amiral Abbot, Jr. (Etats-Unis) déclara que l'octroi des ressources constituait un problème gouvernemental et non une question purement consultative.

Le Dr Nagata (Japon) trouva qu'il serait préférable d'établir des Minutes dont serait saisie la prochaine Réunion consultative du Traité de l'Antarctique, qui devait se réunir en novembre, plutôt que de mettre au vote chaque proposition.

Le Baron de Gerlache de Gomery (Belgique) dit qu'il avait espéré voir naître une discussion sur le problème du redoublement des points à l'ordre du jour de ce Congrès et ceux à l'ordre du jour du Comité logistique du SCAR, de même que sur celui de la fréquence des Assemblées d'Experts sur le Traité.

M. Victor (France) exprima son accord avec le Dr Nagata qui avait suggéré que les échanges de vues se fassent sans mettre au vote des recommandations.

Le Docteur Nagata, en sa qualité de Président de la séance d'ouverture et de la séance finale, suggéra que les conclusions de la réunion soient comprises dans le rapport et que cette matière soit transmise au comité de rédaction.
Cette suggestion fut acceptée, et M. Parada (Chili) mit fin à la séance de l'après-midi.

Le Président Parada (Chili) clôtura la discussion du point. 7 de l'ordre du jour.

Le Président Thomson (Nouvelle-Zélande) demanda au secrétaire de preparer la présentation du film français: "Terre Adélie Année Spatiale N° 1"

* * Un film fut projeté à 16:45 * *

SAMEDI, 8 JUIN

Séance de Clôture
(09:50 ~ 10:20)

Délégations Présentes — Argentine, Australie, Belgique, Chili, France, Japon, Nouvelle-Zélande, Norvège, Afrique du Sud, Union Soviétique, Royaume-Uni, Etats-Unis d'Amerique

Officiels

Président	:	Dr T. Nagata (Japon)
Secrétaire Général	:	M. K. Shibuya (Japon)
Secrétaires	:	Dr K. Kusunoki (Japon)
		M. T. Misumi (Japon)
Rapporteurs	:	M. J. Lavett (Australie)
		M. P.-E. Victor (France)

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Le Président Nagata (Japon) ouvrit la Séance à 09:50 et rapporta que la Commission de rédaction s'était réunie par deux fois, jeudi soir et samedi matin, et que des amendements au projet de rapport original avaient résulté des débats. Il pria le Secrétaire Kusunoki de donner lecture du projet de rapport amendé. (voir le texte annexe).

Se référant au second projet qui avait préalablement été distribué, le Président Nagata (Japon), rapporta que (1) les paragraphes 1 et 2 avaient été adoptés lors de la seconde réunion de la Commission de projet, et ceci sans aucun amendement, que (2) le chiffre "59" avait été inséré entre les mots "et" (fin de la première ligne du paragraphe 3) et "rapports" (début de la deuxieme ligne, ibidem), qu'(3) une nouvelle phrase, "Ces rapports seront transmis aux gouvernements des pays participants", avait été ajoutée après la première phrase du paragraphe trois, que (4) le paragraphe 4 avait été adopté sans correction ni amendement, que (5) les mots venant après "support", dans la troisième ligne du paragraphe 5, à savoir "dispositions, et discussions des principes établissant les arrangements ordinaires et proposés," avaient été rayés et qu'avait été ajoutée une nouvelle phrase disant: "Les principes gouvernant le soutien logistique furent également discutés", après la première phrase du paragraphe 5, et enfin que (6) le paragraphe 6 avait été adopté sans aucun amendement. (*)

A la suggestion du Baron de Gerlache de Gomery (Belgique), M. de Bartillat (France) lut le texte du rapport en Français.

M. Parada (Chili), se référant aux Règles 22 et 23 du Règlement d'Ordre, désira connaître quand et par qui le rapport serait-il traduit en langues russe et espagnole. Il ajouta ensuite qu'en vertu de ces Régles, l'Assemblée devait donner son approbation aux versions espagnoles et russes du rapport.

M. Styles (Australie) fit remarquer qu'il incombait à l'Assemblée de donner son approbation au rapport mais non à ses traductions.

M. de Bartillat (France), se référant à la version en langue française du projet de rapport suggéra que le début de la quatrième phrase du paragraphe 6, "Ils exprimèrent le voeu. . .", soit modifié en "Ils estimerent . . ." Le Baron de Gerlache de Gomery (Belgique) approuva l'amendement proposé à la version en langue française.

M. Parada (Chili) exprima de nouveau son désir de savoir qui allait traduire le rapport vers l'espagnol et le russe, et le Secrétaire Kusunoki (Japon) l'informa que le Secrétariat de la Réunion en avait déjà préparé la traduction en espagnol et russe et invita les Délégués de langue espagnole présents à commenter cette communication. M. Aureggi (Argentine) déclara qu'il serait heureux d'offrir du service au Secrétariat pour compléter ladite traduction.

Sur la suggestion du Baron de Gerlache de Gomery (Belgique), le Président Nagata (Japon) porta à la connaissance des Délégués présents que le titre du document mentionné avait été modifié et que le nouveau titre était: "Rapport final".

En réponse à la question de M. Bartillat (France), le Secrétaire Misumi (Japon) déclara que le rapport complet, mentionné dans le rapport, serait mis à la disposition des intéressés avant le début d'octobre.

Devant l'absence d'autres commentaires, le Président Nagata (Japon) déclara adopté le Rapport final.

(*) Référence au texte en langue anglaise N.d.t.

Il pria ensuite au Secrétaire Kusunoki (Japon) de donner lecture du projet de communiqué pour publication dans les journaux, étrangers et locaux, en eclaircissant que les listes des participants et des rapports présentés seront annexées au communiqué. Le Secrétaire Kusunoki (Japon) donna lecture du text du communiqué.

Ne relevant aucun commentaire sur le communiqué, le Préssident Nagata (Japon) déclara celui-ci adopté, et ensuite demanda s'il n'y avait personnes qui voudraient parler des affaires diverses.

M. Smith (Etats-Unis) exprima, au nom des Délégations participantes, les sentiments de gratitude éprouvés par tous à l'adresse du Président, du Secrétaire général, des Secrétaires ainsi que de tous les membres du Secrétariat pour l'efficace et admirable organisation qu'ils avaient apportée à cette Assemblée.

Sur la proposition de M. Styles (Australie), l'Assemblée décida d'envoyer le message suivant à toutes les Stations antarctiques:

"La Réunion d'Experts sur la Logistique du Traité sur l'Antarctique qui s'est tenue à Tokyo, du 3 au 8 juin, envoie ses chaleureuses salutation à toutes les Stations antarctiques. Elle souhaite que les fructueux échanges de vue qui se sont déroulés serviront à améliorer les dispositions logistiques, dont dépend la réalisation de toute entreprise scientifique dans l'Antarctique".

Le Président Nagata (Japon) saisit l'occasion pour exprimer, au nom de son Gouvernement, ses remerciements les plus sincères à l'adresse de toutes les délégations participantes pour leur aimable et amicale coopération.

La Séance fut levée à 10:20.

PART II

PART II

CONTENTS

1. DESIGN OF BUILDING AND BUILDING SERVICES; INCLUDING WASTE DISPOSAL AND WATER SUPPLY

ESTABLISHMENT OF THE SCIENTIFIC STATION ALMIRNTE BROWN IN PARADISE HARBOUR, ANTRACTIC PENINSULA

Fedrico W. Muller *

Summary

This paper is a report dealing with the basic concepts and practical logistic methods applied to establish and equip an Antractic scientific station for biological, physiological and ecological research, to be operated by small wintering over party, and under the limitations imposed by short resources and little operational support.

1. Equipment of the Scientific Station Almirante Brown

The reasons and requirements for the establishment of a scientific station on the western part of the Antarctic Peninsula were considered during 1962.

This site chosen for this purpose was Paradise Harbour, on Danco Coast (lat. 64° 53'S, long. 62° 53' W). It was established on buildings remaining from the previous Naval Station Almirante Brown, that had started work in early 1951 and was closed at the beginning of 1960.

Logistical Statement

A project was made in order to perform the scientific programme. It shows the entire advisable work on biological research, considering the state of antarctic biology of the country in general, and that of the Instituto Antártico Argentino in particular, in accordance with the geographical possibilities of the place, trained personnel available for this work and the way to develop its desirable evolution.

The project covers survey on biology, human and animal physiology, ecology, and meteorology of the place to obtain data on marine zoology, botany, ornitology, mammals, bacteriology, micology, endocrinology, air, glacier, water, ground and sea observations, and tide gauge readings.

* Instituto Antártico Argentino, Buenos Aires, Argentina.

The Scientific Station Almirante Brown is established on a rockey and limited area, partially free of snow during the summer season.

The microclimate of the place is mild and it helps the development of the scientific survey planned. The average climate values are: annual temperature ranges from a mean of -2.6^{o} C with a monthly agerage from $1,8^{o}$ C to $- 6.8^{o}$ C; and absolute maximum of 10^{o} C and minimum of -29.2^{o} C.

The medium annual wind speed is 2m/s, with a maximum of 19% of winds from the south, a minimum of 1% from the east and northwest, and 46% of calm spells.

The annual cloudiness is of a high medium level, ranging up to 6.4 eights; full cloudy days cover a 72%, partially cloudy days a 20%, and with clear sky the average is 8%.

Real sunlight and crepuscular regime is of 6 hours in winter time (long lasting dawns) with a state of permanent light from early December to March.

The site, Paradise Harbour, offers a good anchoring ground for supply ships. There is a landing place for the easy unloading of fuel and packed goods. Work can be done in the area during nearly the whole summber season, from early November to March.

Due to economical reasons, the opening of the base was planned in five steps as follows:

a) First Step: Performed during the 1964-65 summer; five survey laboratories were provided and a temporary main house and buildings for the principal and emergency generators.

b) Second Step: During the 1965-66 summer the main house and the buildings for the principal and emergency generators were opened.

c) Third Step: During the 1966-67 summer the station was furnished with a motor boat and a temporary platform was constructed to remove the boat from the sea if necessary.

d) Fourth Step: During the 1967-68 summer a house was opened for scientists undertaking research work during the season.

e) Fifth Step: During the 1968-69 summer the location of nine metal tanks will be over. Their total capacity is of 100,000 lts. The concrete platform will be ready to enable removel of the motor boat from the sea. The supply of a stock of drugs and general element for analysis was planned, as well as that of medicines and material in accordance with the personnel at the station and the medical assitance avaliable. The construction of a proper craft was designed for the development of marine ecology and oceanographic observations.

2. Elements for the Losistical Support at the Station

The complex problem of planning echnical especifications of the elements that should be installed for a good functioning and a total fullfilment of the scientific programme preestablished, was made in accordance with the following criterion:

Main House

To avoid much investment, the least possible work was done in the main house, except some modifications that would conform good living conditions to the winter groups. As the climate of the place is mild, it was considered that the main house already built with further modifications would lodge the winter groups without inconvenience and with some confort.

It is built of wood with partitions insulated by corrugated paper 2" wide. It is founded on concrete pillars with lateral walls made of cement and stone up to the floor level, accomplished with hard wood. The heating boiler is placed on a concrete structure and in the same place there is a metal tank of 2,000 lbs capacity for fresh water supply.

The gable roof has the same interior insulation as the wall partitions. Outside it is covered by two layers of 15 lbs asfaltic fiber (about 1 mm thick) hot applied and additional tar layer. The house floor and the wall partitions have a similar insulation.

The main house lodges 12 persons, members of the winter groups. It has a dining-room and a living room, a place for the kitchen equipped with a stove, refrigerator, kitchen table, and a dish heater. By means of a coil in the stove, water can be heated for an intermediate tank for further use in the bathroom.

The laundry is equipped with an electric machine and an ironing board. The heating system installed is standard, with hot water radiators with thermosiphon circulation. The boiler's capacity is 60,000 kilocalories/hour, fed by a Petro gas oil burner.

At an end of the main building a freezing chamber has been placed to keep supplies and reseach specimens under freezing conditions. It is a conventional construction 3.10 m wide, 5.75 m long, with walls, roof and floor made of wood partitions 35 cm wide, insulated with granulated cork. It has a door of the same type as other constructions.

Two motor-compressors for freon gas 12, provide cold to the chamber, their freezing power is of 1 ton (12,000 BTU/hour). They are fed by two circuits made up for a total of 12 cold storage plates that keep a regulated interior temperature of -13° C. These storage plates have inside an eutectic alloy of sodium chloride that serves to accumulate heat when passing from solid to liquid state at -21° C (56.4 kilocalories/

kg), if the compressors are damaged and stop running this cold reserve keeps the chamber at a proper temperature during 24 hours or more.

The freezing chamber has a 30 cubic meter capacity, and stores 4 tons of meat in good conditions. This food capacity covers the annual supply and an additional 6 months reserve for 12 men. It was planned for a daily diet of 3,500 kilocalories per head, which keeps a men living at the station in perfect physical conditions all through the winter season. The diet components for the Antarctic personnel were obtained from the National Nutrition Institute. The freezing deposit for research specimens has a capacity of 15 m^3.

Emergency House

It is similar to the above mentioned main house, and made of wood; it was modified to lodge 10 persons in 2 bedrooms with 6 and 4 beds each. The beds are superposed, like litters. Each bedroom has enough wardrobes and chests of drawers to keep the personnel's effects. The stove at the kitchen is fed by gas oil. There is a bathroom with cold and hot water, a shower and sanitaries.

There is also a dining and living room, furnished with comfortable armchairs, a HiFi record player for resting time. There is also enough space for a scientific library.

The heating designed for this house is provided by hot air, supplied by a Potez gas oil heater, gravity system, with a constant level container and a capacity of 20,000 kilocalories/hour. When calculating the heat capacity of this system, the loss of heat in each room was determined paying special attention to the weather conditions of the place.

Laboratories

The loboratories were placed in an hangar-shed already existing. It is a metallic construction 16 mt long and 10 mt wide with walls and roof of corrugated sheets of galvanized iron, the concrete floor is founded on the rocks with columns at intervals. Inside this shed a wood construction was built, with insulated walls and roof to serve the seven rooms of the complex.

A thermix balance of the rooms was calculated in relation to the environmental conditions and then, the elements for the construction were designed. Wood partitions with a mineral wool insulation 5 cm wide and 4 cm free space were used in the outside walls. Inside partitions have an air insulation of 9 cm. The roof and the exterior walls are insulated in the same way.

These rooms serve as: a) Biological Laboratory, b) Physiological

Laboratory, c) Chemical and Oceanographic Laboratories, d) Photographic Laboratory, e) Meteorology Room, f) Drugs Store, Desecator and X Rays, and g) Heaters Room.

As the main object at the station is biological, physiological and ecológical research, great care was taken for the proper design of fresh and salt water services as well as the heating system.

Fresh Water System

In its design the need to supply the laboratories with at least 500 lts of fresh water daily was considered. This amount is sufficient to attend to all services including an electric filter of 5 lts/hour that produces distilled water for laboratory use. The system consists of a snow melter, storage tanks and distributions pipe lines.

a) Snow melter: It is composed by a rectangular container made of stainless steel with a capacity of approximately 1 m^3. A Petro gas oil burner, of 30,000 kilocalories/hour is placed at the bottom. Combustion gases evacuate easily so as not to disturb the free running of gases. Its design allows a 500 lts production every 4 hours. This amount provides and easy supply of water to the station in 4 hours shifts for use in laboratories, kitchen and bathroom.

b) Pipe lines and storage tanks: Water is canalized by gravity through pipe lines to the storage tank at the laboratories or to that at the main house. This pipe line has a blow-off valve to secure a complete drainage after its use, and hence avoid freezed liquid remains. The storage tank at the laboratories has a 1,000 lts capacity and is located in a heated place. As it was mentioned before, the fresh water system at the main house is supplied by a tank with a 2,000 capacity which also provides water to the emergency house.

During the summer season the fresh water supply is increases by a natural stream produced by snow melted by heat accumulated in the rocks. This stream is canalized from a small dam to the snow melter through a pipe line.

Salt Water System

Great care was taken when planning this system. It was required that the sea water for the laboratories should not run through a polluted sea water circuit. It was planned in such a way that sea water does not get in contact with any metal until it reaches the aquarium. The pump used to carry water from the sea is of a self feeding rotative type. It is made entirely of plastic material, with a capacity of 4,500 lts/hour against a water column of 13 mts.

The pipe and valves are made of vinile polichloride. The storage tank with a capacity of 1,000 lts is made of fibrous concrete. It is located in a heated place in the laboratories. From this system sanitary services are supplied. All pipes were designed with blow-off valves to secure a complete drainage to avoid freezed remains.

Heating System

As the economic support was limited when planning the station's equipment it was esteemed that the main house would keep the heating system used by the previous naval station. It consists of a boiler with a Petro gas oil burner, of 60,000 kilocalories/hour, with radiators and hot water running by thermosiphon. These keep the rooms in good living conditions.

At the laboratories where temperature should be constant and aid purified throughout the year, an equipment was placed in accordance with the thermic balance obtained.

It is composed by two Jet Heet heaters, of 19,000 kilocalories/hour. The hot air enters the rooms through conductors and pipes conveniently insulated. At the end of the conductors a mixer Venturi tube system was placed. It mixes the air of the rooms with the hot air coming through the pipe, and diffuses the heat through the rooms. It has a thermostatic regulator and electronic control that work whenever a damage is detected in the normal functioning of the generator.

For the emergency house, the studies on room thermic balance determined a heading power range of about 20,000 kilocalories. A Potez heater was installed for a good heat supply produced by a silent equipment of a simple and easy functioning with the least possible trouble regarding space parts and maintenance. It has burner, gas oil gasifier of constant level and hot air circulation by forced system. The room air is heated by the furnace of the generator and injected to the chambers by means of a low revolutions fan. The Equipment has a thermostat for room temperature control. Gas oil is fed to the combustion chamber by means of a deposit of constant level, the volume of burnt gas oil can be gradually regulated.

Communications

Two equipments consisting of Collins transmitter and receiver sets for telegraphic and radiophonic communications, working in single side band, with radio-amateur frequency in bands from 3.4 to 21.6 megacycles per second make radioelectric linkage with the Instituto Antártico Argentino radio station and the National Network of public telephones. One of these equipments is used as principal station and the other one as auxiliary station.

Motor Boat

The boat designed is a fishing model, 6.50 m long, 2.20 m wide, 1.20 m high and nearly 3 tons of displacemnet. Its speed is 6 knots.

It has 2 davits for taking sea water samples and sea temperature at different depths, as well as bathymetric observations. The boat has bitts for dragging plankton nets and it has also a derrick and tackle to manouvre capture nets. For general storage there is a holt of 2 m^3 with an exterior water tight opening. The "U" shaped wooden cask, has a double sheathing, inside it is transversal and outside longitudinal, bearing painted canvas insertions in between. The careen is covered by a felt layer 0.3 cm thick on which a copper sheet was fixed to avoid cask damages produced by ice or wood lice.

It is equipped with a diesel motor, Borgward, 50 CV. The motor's cooling system is a closed circuit of fresh water cooled by sea water. The sink and motor partition have a draining system.

It is furnished with a simple magnetic compas, a transreceptor set for radio communications in band of 3.5 to 3.75 megacycles per second, with crystal control, for used in communications with the base, a Raytheon echoic sounding register used in deep sea soundings down to 240 feet and also other security equipment commonly used in navigation.

For emergencies it is equipped with a mainsail and a jib. A launching way of tubes and wheels was built to remove the boat from the sea and its further placement of the wooden ramp.

Tidal Station

On a platform especially desigend made of concrete a tide recorder was placed in front of the station. A barrel register, Keuffel type, is used. It is operated by a buoy lodged in a barrel following the tidal movements of the sea.

To avoid loss in continuous tide gauge readings taken during the winter season when water in the barrel is freezed, a special buoy was designed. It is heated interiorly by an electric resistance of 250 W that keeps the instrument defreezed.

Power Plant

Calculating the necessary energy for the functioning of all the instruments mentioned in previous paragraphs, it was understood that an electric power of 20 kw would supply the station's consumption leaving a margin for further enlargements. The three-phase alternate current system of 380/220 V, 50 HZ was chosen as it is the system used in the whole country and it makes the necessary changes easier.

The electric network is fed by two Diesel generators, Fiat, of 32.5 KVA each. These have parallel connections to avoid tension variations when changing engines and at the same time they provide a wide loading marging to absorb the high picks of consumption that occur when SeaBee groups work with engines of a high temporary electrical consumption, such as welding machines and cranes.

Usually the service is provided by only one generator reserving the other one which is connected whenever a damage is detected in the running generator.

As an auxiliary generator, a Skoda Diesel group, 6 KVA power was installed. It covers the services needed to survive in an emergency.

Fuel

The annual fuel consumption was esteemed in 70,000 lts of gas oil which plus a six months coverage represents a total of 100,000 lts.

For the supply at the laboratories and eventually at the kitchen, the station counts with propane gas in 45 kg barrels. The liquid fuel is stored in nine metal tanks placed on a storage platform 60 m off the buildings to prevent possible damage in case of fire.

The tank's bearings are made of concrete, propping the beam system by means of columns based on the nerby rocks. To provide a strong support, rocks were blown off making an irregular surface for the foundations. Concrete used for this purpose was obtained by mixing one part of cement, plus 2.5 parts of sand and 2.5 of gravel. The water used was taken from a natural stream, heated before use. A quick setting material was added to the water in the proportion of 1 to 7 parts of water.

When planning the initial opening of the station, considering the narrow area remaining from the previous naval station and the short time available for the construction of a stowage, it was decided that fuel would be stored on the ramp near the hangar, in two Pillow tanks, of 38,000 lts capacity each. The fuel carried by the re-supply ships to the launching boats, provided with two rectangular tanks of 2,000 lts capacity each, is pumped by a conventional centrifugal engine and subsequently sent to the Pillow tanks placed on the ramp. When the metal tanks used for normal storage are in service these Pillow tanks will be folded and remain at the station for emergency use.

Garbage Elimination

Garbage elimination as well as polluted water from the sanitary system at the station does not offer any trouble since it is placed near the sea coast and this procedure can be performed directly or by means of a standard pipe system, as freezing does not occur entrirely.

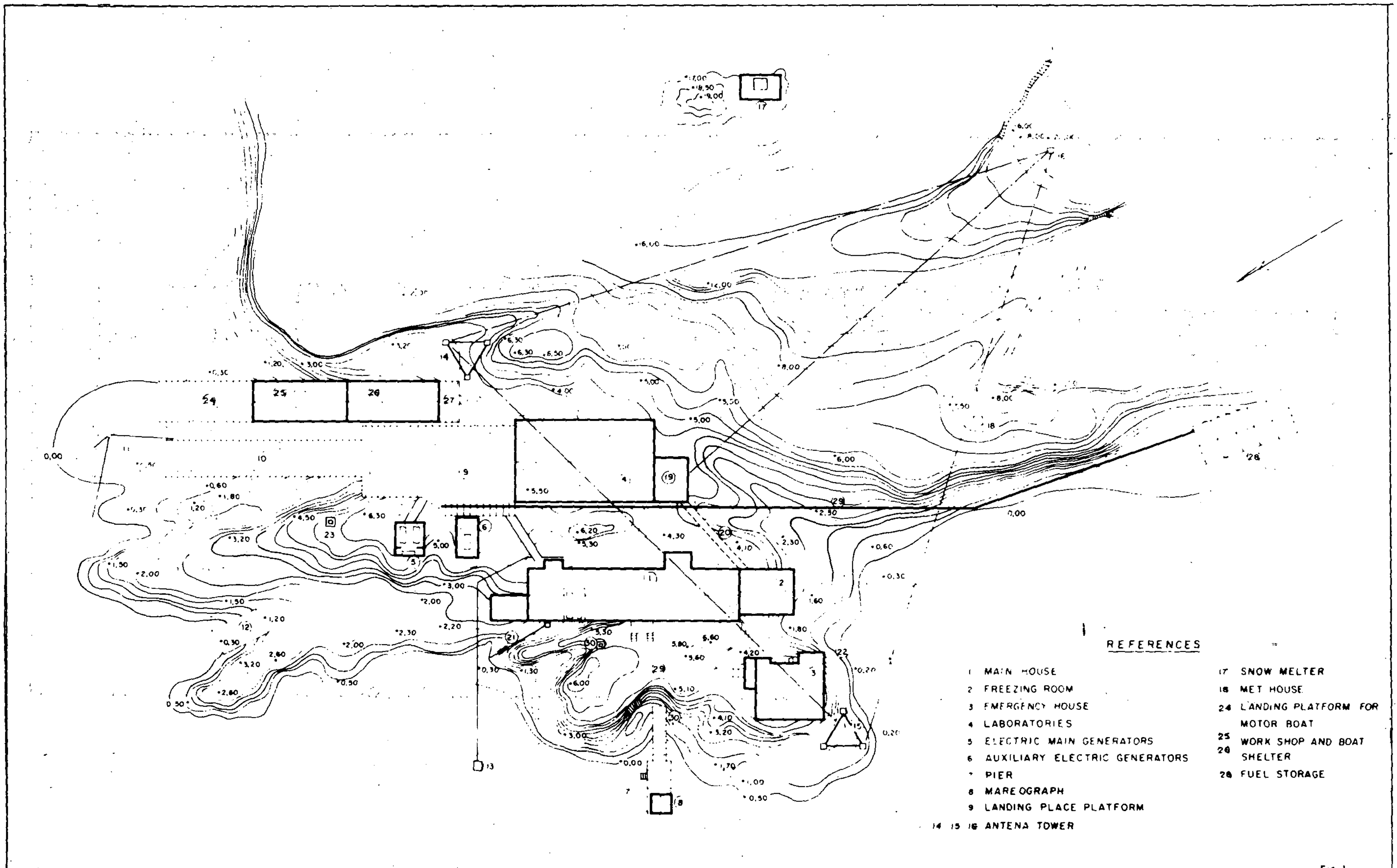

REFERENCES
1 MAIN HOUSE
2 FREEZING ROOM
3 EMERGENCY HOUSE
4 LABORATORIES
5 ELECTRIC MAIN GENERATORS
6 AUXILIARY ELECTRIC GENERATORS
7 PIER
8 MAREOGRAPH
9 LANDING PLACE PLATFORM
14 15 16 ANTENA TOWER
17 SNOW MELTER
18 MET HOUSE
24 LANDING PLATFORM FOR MOTOR BOAT
25 26 WORK SHOP AND BOAT SHELTER
28 FUEL STORAGE

Fig 1

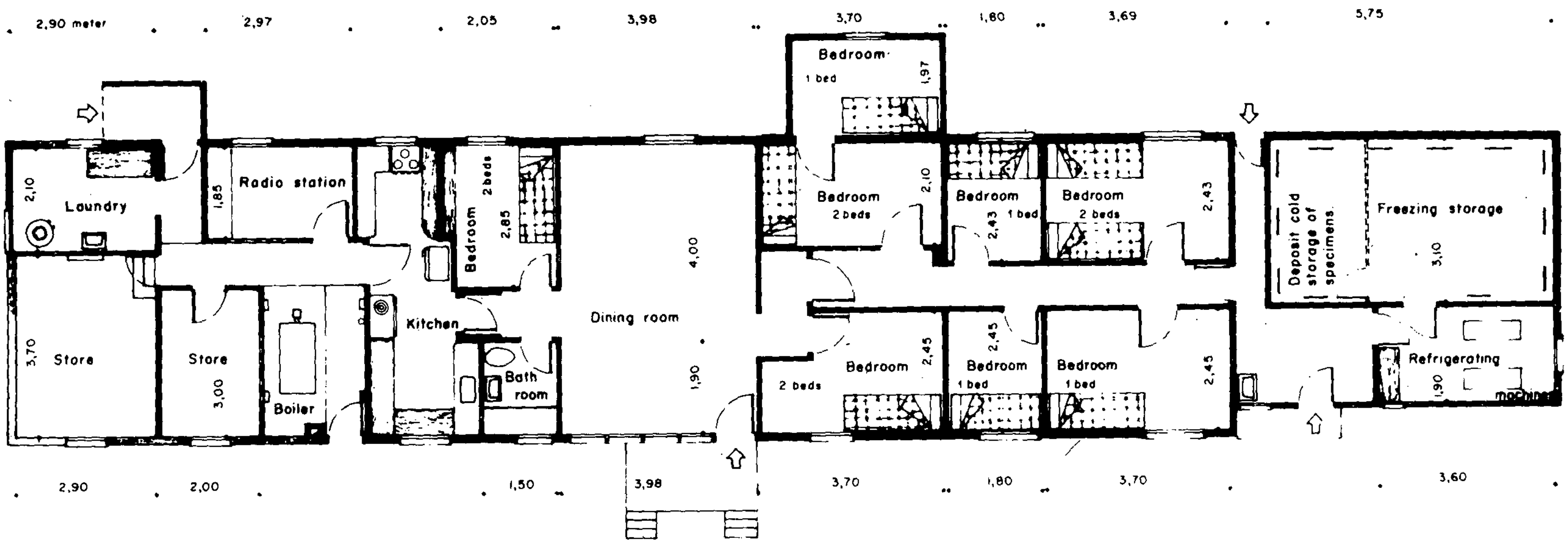
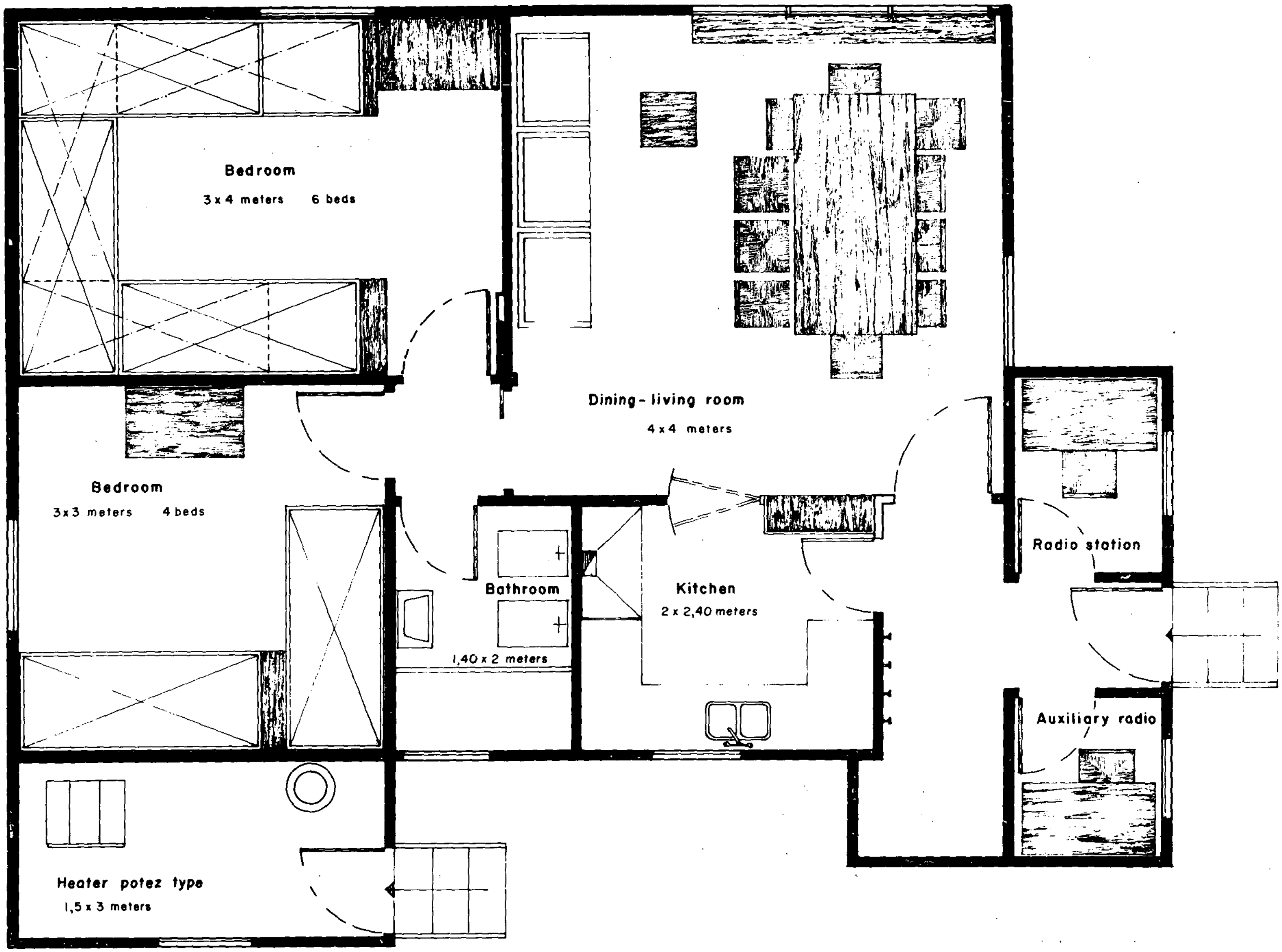

2,90 meter
2,97
2,05
3,98
3,70
1,80
3,69
5,75
Bedroom
1 bed
1,97
Laundry
2,10
Radio station
1,85
Bedroom
2 beds
2,85
4,00
Bedroom
2 beds
2,10
Bedroom
1 bed
2,43
Bedroom
2 beds
2,43
Deposit cold storage of specimens
Freezing storage
3,10
Store
3,70
Store
3,00
Boiler
Kitchen
Bath room
Dining room
1,90
2 beds
Bedroom
2,45
Bedroom
1 bed
2,45
Bedroom
1 bed
2,45
Refrigerating
1,90
machines
2,90
2,00
1,50
3,98
3,70
1,80
3,70
3,60

Fig. 2



Bedroom
3 x 4 meters 6 beds
Dining - living room
4 x 4 meters
Bedroom
3 x 3 meters 4 beds
Radio station
Bathroom
Kitchen
2 x 2,40 meters
1,40 x 2 meters
Auxiliary radio
Heater potez type
1,5 x 3 meters

Fig. 3

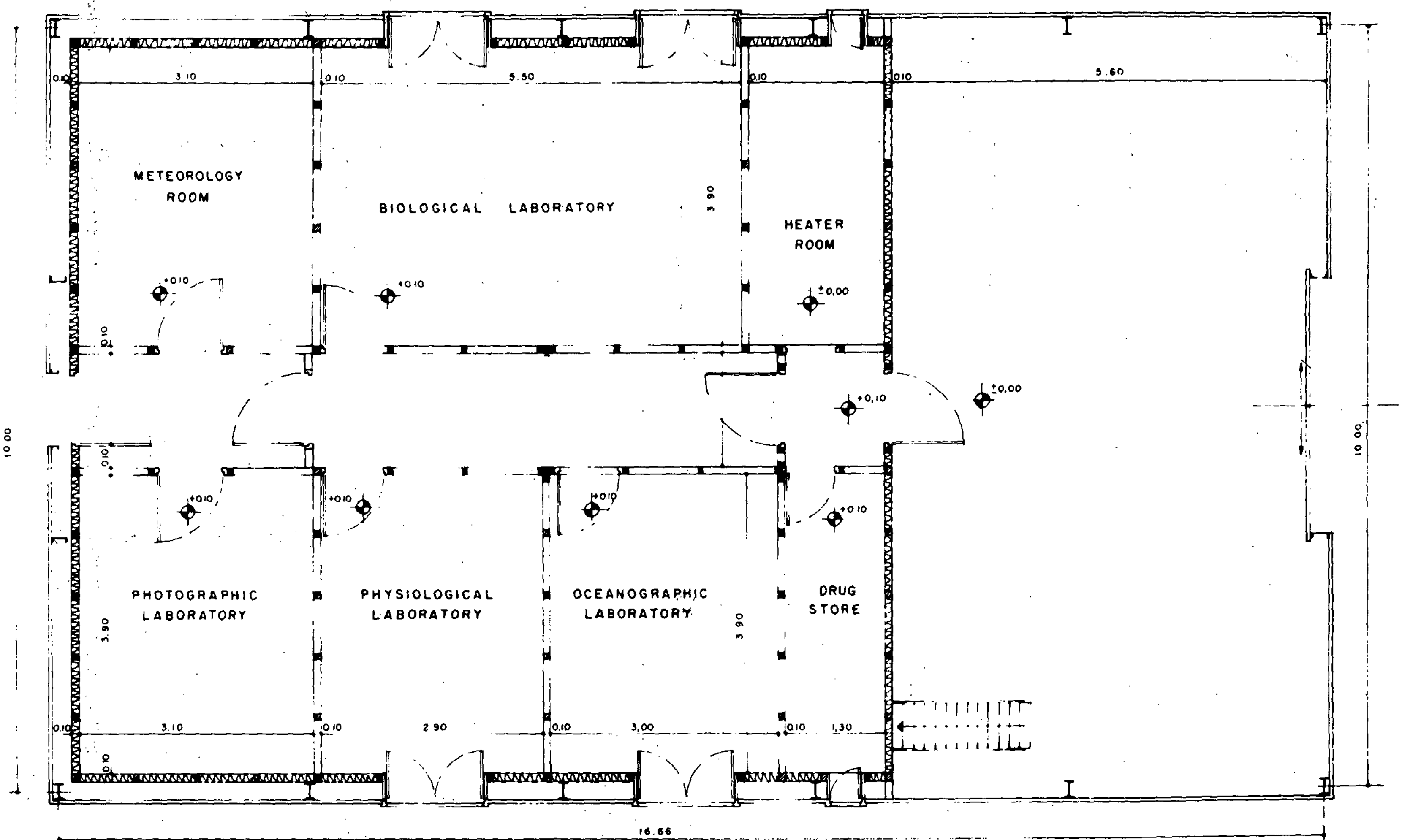

METEOROLOGY ROOM
BIOLOGICAL LABORATORY
HEATER ROOM
PHOTOGRAPHIC LABORATORY
PHYSIOLOGICAL LABORATORY
OCEANOGRAPHIC LABORATORY
DRUG STORE
3.10
5.50
5.60
0.10
3.90
2.90
3.00
1.30
+0.10
±0.00
10.00
16.66

Fig. 4

SNOW MELTER

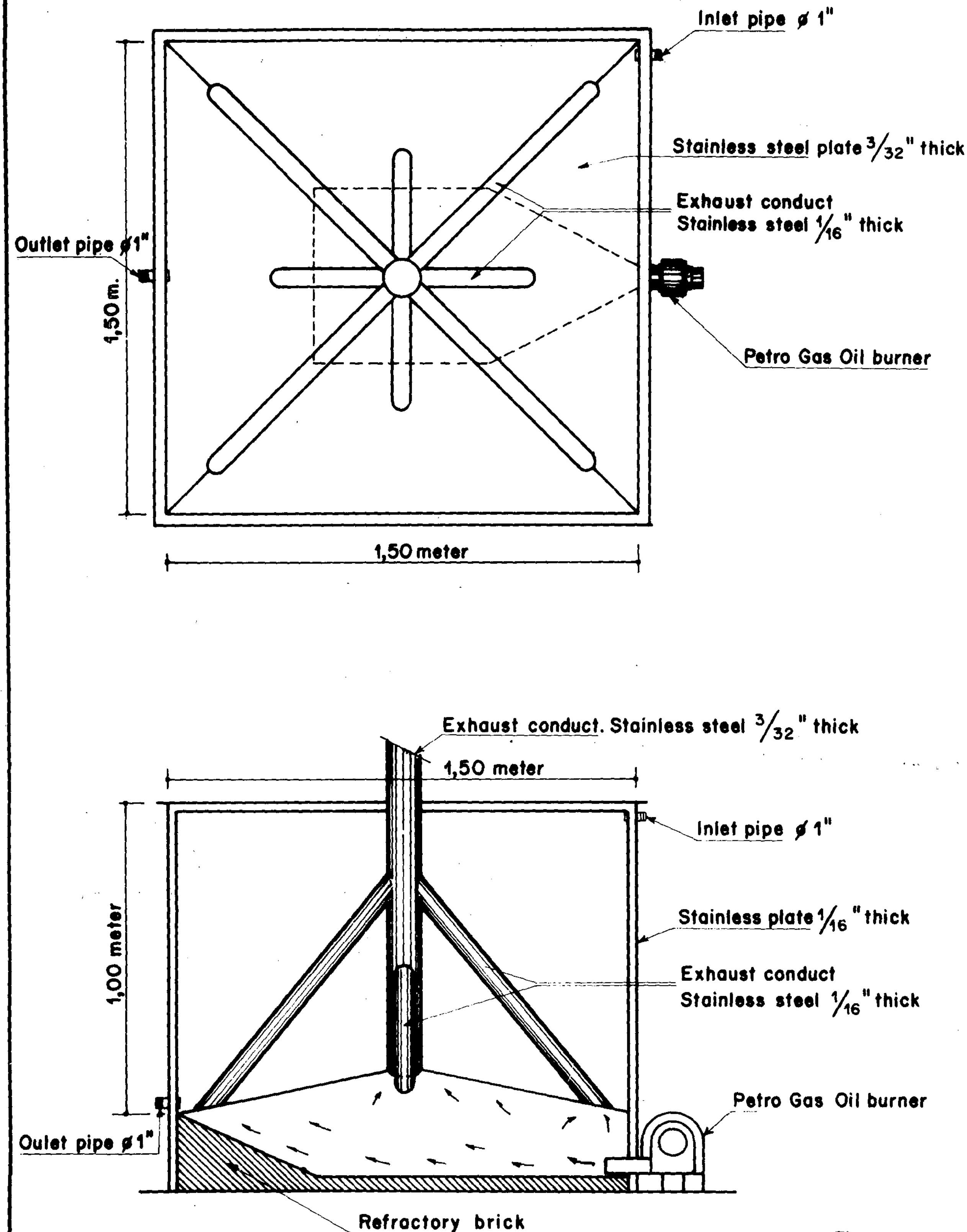
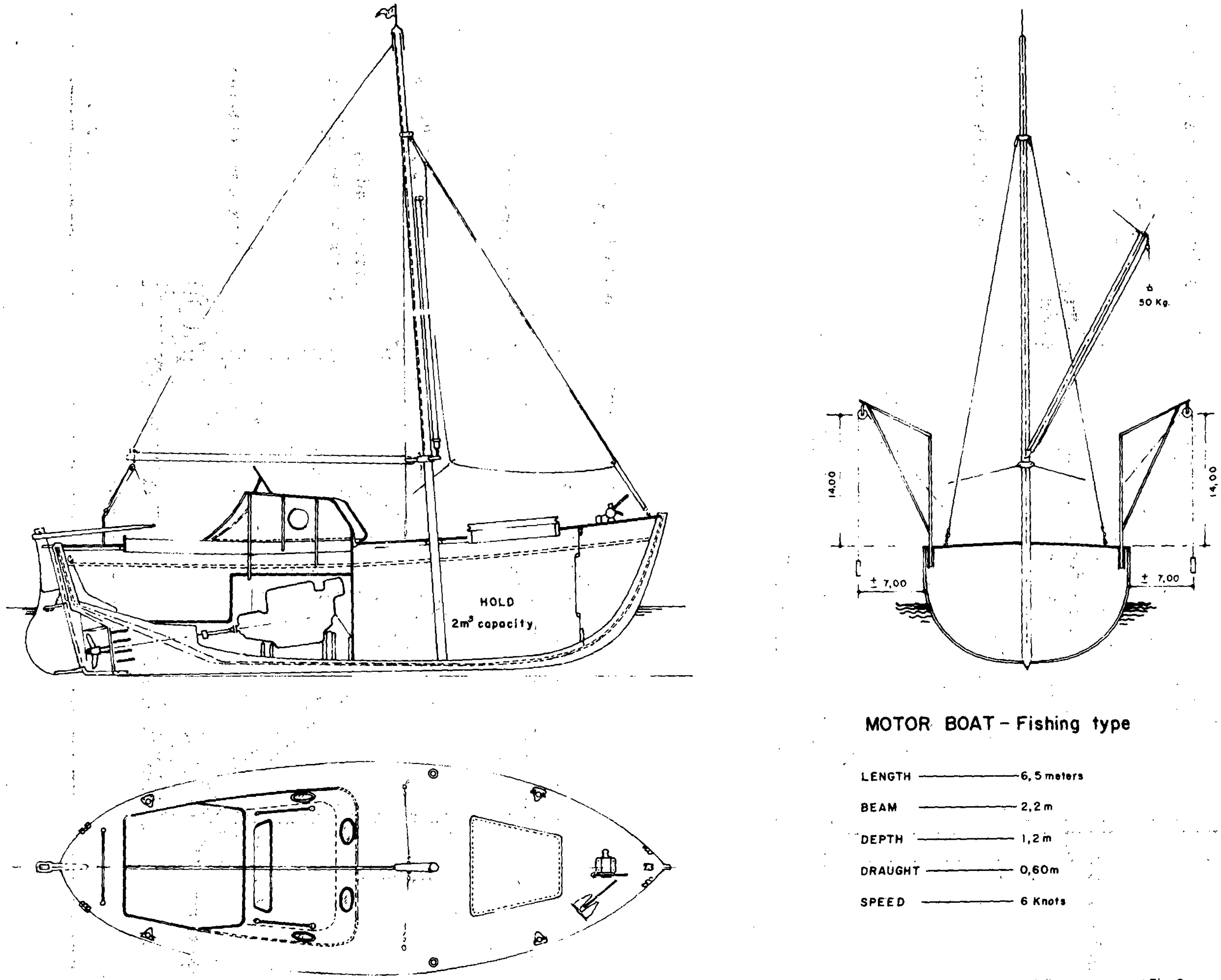
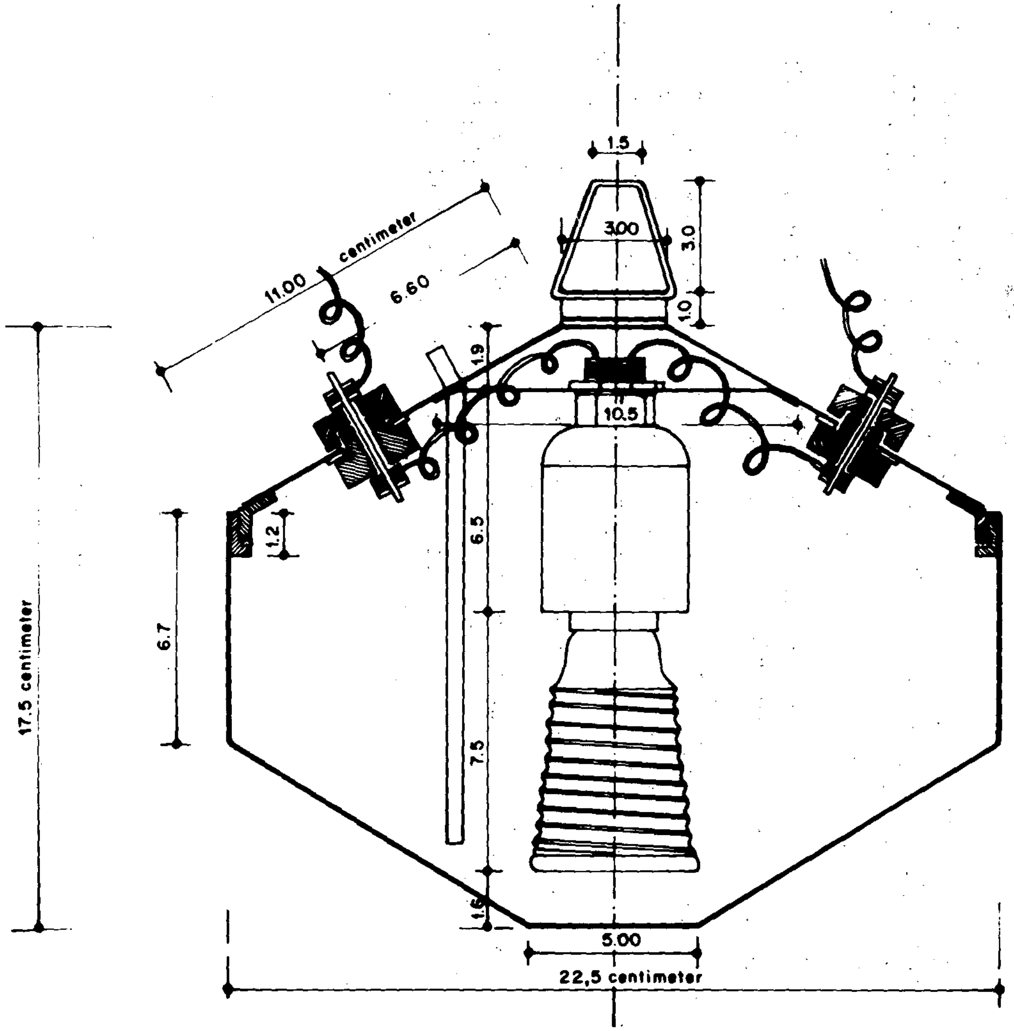


Fig. 5



MOTOR BOAT – Fishing type

Fig. 6



Heated mareograph floater

Scale natural

Fig. 7

NEW DWELLING HOUSE CONSTRUCTED AT DESTACAMENTO NAVAL (NAVAL STATION) ORCADAS, OVER A REINFORCED CONCRETE BOX

Enrique Jorge Pierrou
and
Ricardo Alberto Magnelli

I. Summary

The new dwelling house constructed at Destacamento Naval(Naval Station) Orcadas, Laurie Island, South Orkney Group, was designed using a new technique in Antarctica which was that of burying a large reinforced concrete box, and building on it the dwelling house made of wood.

The box mentioned, which doubles as a cellar, was used as warehouse, engine and boiler room, water tank, septic tank, sewage disposal tank, etc.

It was designed by the Dirección de Instituciones Fijas Navales (Bureau of Naval Fixed Installations), at the request of the Antarctic Division, Argentine Navy Hydrographic Office, which established the requirements on the basis of the experience obtained in the other structures constructed in the rest of the Antarctic Naval Stations.

II. Introduction - General Considerations

Naval Station Orcadas, the Argentine Republic's oldest in Antarctica, is the first occurrence of permanent human life in the White Continent. The Argentine flag was raised there on 22 February 1904, and from then on the settlement has been maintained uninterruptedly to this day.

Another milestone in connection with this Station was the opening, on 30 May 1927, of the first permanent radio station.

Its building, not including the last that was constructed, consisted of two wooden living quarters, similar one to the other, both assembled on wooden pillars. Other structures are two tin plate, cement floor, warehouses, and three wooden cabins for geomagnetic and absolute observations, and for the manufacture of hydrogen for sounding balloons.

The last living structure has been in use more than 30 years, and its general condition did not offer any great protection against climatic hardships. These were the reasons that intervened in the decision of building a new dwelling house with adequate conveniences for the area.

III. Description of Orcadas del Sur (South Orkney) Area

This is an archipelago situated some 600 miles to the SE of Isla de los Estados, between the parallels 60° and 61° S, and the meridians 44° and 47° W. It is made by a compact group of about 40 islands and islets, most of them very small, which add up in total an area of 1,000 sq km approximately.

The proximity of the Weddell Sea originates the freezing of its coasts, being accesible to navigation only during the whole summer period.

1. Meteorology

As these islands are situated over the path of the cold current of the Weddell Sea, and as the prevailing temperate winds from the W blow over them, the resulting climate is cold - colder than that of the NW coast of Tierra de San Martin (the Antarctic Peninsula), and with a high percentage of hazy or foggy days.

2. Laurie Island (Site of the Station)

Its length is approximately 12 miles from E to W. Its width is very variable because its N and S coasts show great indentations. Thus, its narrowest part measures 2 cables and it is here where the installations of the Station are located, limiting to the NW with Uruguay Bay, and to the SE with Scotia Bay.

The prevailing wind at Observatorio Argentino is NW; its percentage is a little high as compared with that of the whole area because it comes in freely through Uruguay Bay, whereas winds are perturbed by the hills which interfere their progress in the direction of the observatory. A secondary maximum is that of SE winds, for which there is also a free approach through Scotia Bay. Storms are felt from the NW quadrant, especially those of an intensity equivalent to 9 or more of the Beaufort scale.

Mean temperatures have ranged from -10.6° C (13° F) to 0.4° C (39.20° F), having been observed minimums of -40.1° C (-40.2° F), and maximums of 12.2° C (54° F) along 64 years of continuous records.

3. Nature of the Soil

The narrow and low isthmus where the installations are situated unites the Mossman and Mackensie peninsulas with the rest of the island. This isthmus is bordered to the NW and SE by Uruguay and Scotia Bays, respectively. The "La Monja" ("The Nun") glacier closes the approach from the NE and the Mossman hills oppose their craggy wall which obstructs the passage in a SW direction. In the isthmus proper a layer of recent glacimarine boulders lie over a bed of folded sedimentary rocks; and it is covered during the greater part of the year by a layer of ice or sleet, only exposing its central part in the months of January and February. The Mossman hills consist of a series of rugged headlands, the maximum altitude of which reaches 110 m, and which, with their SE-NW orientation, cut across the isthmus between Scotia and Uruguay Bays. They are made up by sedimentary rocks of sandy-clayish facies, folded, the age of which has been credited by Pirie (1905) to the Lower Siluric on the basis of the discovery of graptolites in points situated in the eastern end of the island.

IV. Selection and Development of the Place Chosen for the New Dwelling

1. Selection

Having been established by different prospections that the geologic structure of the isthmus was the same throughout, and taking into consideration the existing buildings, besides safety reasons against the fire hazard in some of the structures, the operability of Scotia and Uruguay Bays, facilities for obtaining water, and for the disposal of refuse liquids, the extreme SW of the isthmus was chosen as the most adequate place to build the new dwelling house, inasmuch as it offered the following advantages:

a) Its proximity to Scotia Bay, which is the safest anchorage, and which possesses a landing beach usable in all its length and under all tide conditions. It also makes it possible to pump fuel from an oil barge directly to the storage tanks.

b) Its relative location as regards the rest of the buildings, because of the fire hazard (65 m to the nearest other building) and its closeness to Scotia Bay for fire-fighting taps (40 m).

c) A very short distance to the above mentioned bay for the disposal of refuse liquids.

d) Facilities to make fresh water from the bay ice in winter, and from the springs in the Mossman hill in summer.

2. Development of the Place Chosen

On the arrival of the Antarctic Construction Battalion in the month of December, the isthmus was covered by a coat of snow which averaged 0.30 m, for which it was necessary to clear the chosen place, using to that end an Otto Deutz tractor, with rubber tires and a trawling shovel of 1 cu. m in capacity, with which the area was totally cleared of snow.

Having accomplished that task, it was found that the glacimarine boulders which make up the foundation of the isthmus were firmly stuck together by a layer of ice which obstructed their removal. It was necessary, therefore, to wait one or two days, according to weather conditions, in order to be able to delve into about 0.20 m in the boulder bed, and so on. This prolongued the estimated time for the construction, with the result that the decision had to be taken to build the structure in two stages.

In 15 days and in spite of the inconveniences mentioned above, about 1,000 cu. m. of boulders were removed, the bed of folded sedimentary rocks (1.30 m) having been reached. There remained, therefore, an excavation of 60 x 15 x 1.30 m.

V. Conception of the House

Taking into account the behavior of the reinforced concrete foundations and those of the maneuvering strips for aircraft constructed at other naval stations, the idea was conceived to plan the construction of the new house in two stories, namely:

1. A ground floor or cellar which would consist of a reinforced concrete box totally closed and buried until it rested on the sedimentary rocks.

2. An upper story to be constructed in wood, and which would be the dwelling house proper.

The ground floor would serve as warehouse and for storing all the elements necessary for the operation of the station, while the upper part would have lodgings, laboratories, radio room, and everything that is required for the scientific work.

In this way, any fire hazard (which is the biggest enemy of the Antarctic bases) would permit the station to keep its services in operation for the emergency house and supply sheds.

The fires which occured at Navy Stations Esperanza (1958) and Almirante Brown (1957), which completely destroyed the installations that were attacked, did not affect in the least the makeshift cellars of reinforced concrete upon which the gutted buildings had been constructed.

VI. Construction of the House

1. Ground Floor or Cellar - Campaign 1966 - 67

A. Perimeter

Once the excavation for the construction of the ground floor was finished and staked out, the framework was prepared with 1 inch sheathing and buttresses of 2" x 3" beams. The 120 m of the framework had a height of 2.85 m and a width of 0.20 m, which permitted to construct a wall of reinforced concrete with rods of 10 mm and 6 mm in diameter.

This perimeter of the cellar was concreted in 23 hours with 35 men using portable cement mixers.

The reinforced concrete mixture was prepared in the following proportions: 1 part of rapid setting cement; 3 parts of sand of the area (medium grain size); 3 parts of boulders of the area (size 3 to 5), adding to the mixture hot water at 40° C (104° F) and setting accelerator in a proportion of 10% in water.

B. Mid-floor

This was also constructed in reinforced concrete, using the same elements and mixture proportions as for the perimeter of the ground floor or cellar. The mid-floor was made to rest on beams supported by reinforced concrete columns placed 4 m apart. The beams had iron rods 18 mm in diameter, and the columns 10 mm rods, being the section of the former 0.15 x 0.55 m, and that of the latter 0.22 x 0.22 m. The whole mid-floor, with its columns and beams was concreted by 35 men in 15 hours, the slab having been finished with a thickness of 0.12 m, and 8 mm rods every 0.20 m.

C. Ground floor story or cellar.

The work carried out in the floor had to be confronted in a special way taking into account the leakages that occurred during the summer once the perimeter and the mid-floor had been assembled; this because of the proximity of "La Monja" ("The Nun") glacier (130 m) and the "Mossman" hills (90 m).

To that end a floor base was prepared first, using the same elements employed in the rest of the construction. The approximate thickness of this floor base was left at 0.10 m.

Over this base an asphaltic membrane made of asphaltic felt and pitch was laid, applied at a high temperature for better adherence. Over this membrane the floor proper was constructed of simple concrete 0.10 m thick.

The proportion of the elements employed was the same as that used for reinforced concrete, that is, 1 part rapid set cement; 3 parts of sand of the area; 3 parts of boulders of the area (size 3 to 5) and setting accelerator in the proportion of 10% in hot water.

Prior to the construction of the floor described, the reinforced concrete bases for the motors were prepared. These bases were made to rest on the rock, with 1.95 x 0.90 m bed plates which permit the motor to work, and naturally vibrate, independently from the floor. Tanks, including those for fresh water, septic tank, etc. were also constructed.

A dummy expansion connection was prepared all along the interior perimeter and around the bases of the motors, which was later filled with pitch. This product makes it possible to obtain an acceptable expansion and to forestall possible water leakages from below.

D. Ways of access

There are three main entrances and an emergency double purpese one that give access to the ground floor or cellar, namely:

a) An entrance in the SE extreme E side.

b) A second entrance in the center E side.

c) A third entrance in the NW entrance W side.

d) An special entrance in the NW extreme E side, with a ramp for generators, boilers and other pieces of equipment of cumbersome maneuverability, and which also may serve as an emergency exit from cellar.

The object of the first is to give direct admittance to the lodging section in the upper story, and to the gymnasium in the cellar.

The second solves the problem of the admittance to the scientific observational stations and the personnel's mess room in the upper story, and to the workshops and tanks in the ground floor.

The third one provides a way of access to the logistic maintenance services, such as kitchen, pantry, larder, etc., and storerooms in the ground floor.

The main entrance indicated in d) permits, because of the ramp installed towards the interior, the easy movement, in or out, of generator groups and boilers, while it can also be used as an emergency exit from the cellar.

The first three entrances are similar, and are protected by reinforced concrete walls, with stairs of the same material leading to the upper story or to the ground floor. Three doors close the entrance - one in the access proper, another at the entrance to the upper story, and a third one in the access to the cellar.

The entrance with the ramp, also protected with reinforced concrete walls, has two two-wing gates which close the access to the downward incline, and to the entrance to the cellar, respectively.

E. Interior layout

The NW third section of the ground floor or cellar is intended to lodge all the elements that are necessary for the general services of the house, such as septic tank with its respective disposal tank, fuel tanks for feeding boilers and motors, fresh water tanks, electric generator groups, boilers, etc.

The rest of the ground floor is occupied by: storerooms, workshops, and an entertainment lounge for the personnel.

2. Upper Story - Campaign 1967 - 1968

This part of the house is to be destined preferably for lodgings and technical uses. Its construction is of the modular type with prefabricated panels in pinewood, 1" thick, jointed and with interior insulation of fiber glass 2" thick.

A. Assembly

The assembly of the panels is generally done by means of bolts, lag screws and special iron pieces which permit their total dismantling in case of possible transfers, enlargements, changes or repairs inside the housê itself. This system also permits to assemble the outer walls and the roof very quickly making it possible to accomplish the rest of the work without the inconveniences that severe weather conditions might pose, and which notably and frequently delay constructions in the Antarctic area. The time of assembly of this story, with all its general installations, required the employment of 35 men during 54 days.

B. Interior structure - Panels - Ceiling

The outer panels have a double lining: the outer one made of jointed pinewood 1" thick, and the inside one of the same wood but ½" thick, both isolated by a layer of 15-lb asphaltic felt and fiber glass 2" thick. Their assembly, as well as that of the inner ones, is rapidly accomplished, as has already been explained, by means of bolts, lag screws and special pieces.

All the panels are generally jointed one to the other by means of clamps, and made fast to the floor and the ceiling by adequate anchorage.

Ceilings are of similar construction and they rest on the wall panels, and are clamped one to the other and to the side walls by clamps of special design in order to prevent shiftings.

The central panels of the ceiling over the passageways have, in their upper part, a pinewood jointed planking 1" thick in order to permit the circulation of the personnel responsible for checking the running of the fresh water tanks and others located above the ceiling. This place is reached by means of a removable rope ladder placed in the laundry and through a trap door.

C. Roofing

The roof of the building is made up by 3" x 6" pinewood trusses, and 3" x 3" cross-beams which are anchored to a peripheral reinforced concrete beam.

On top of the cross-beams a 1" x 6" boarding of jointed pinewood placed, and over this a 15-lb asphaltic felt, nailed, and further on top a plain aluminum plate 1 mm thick, overlapped in their edges. Then, wooden laths which run parallel to the joints placed three to each plate, namely, two over the lapels and one in the center. The laths are fastened with galvanized nails, and their object is to strengthen the plates so as to prevent that prevailing strong winds might pull them out.

Aluminum plate was used in the outer part of the roof to avoid permanent rusting and corrosion, thus permitting to economize on future workmanship. Up to date results have been very positive.

D. Composition of the floor

The floor of all the rooms is made of bright color Flexiplast (Plastic tiles) laid directly over the sub-floor. Those of the bathrooms, kitchens and ante-kitchens are of granite tiles, finely polished and of bright colors. The stairs are of smooth finished cement.

E. Interior layout

In the basic design of the project, the following aspects were taken into account: a) to separate the entertainment space from the sleeping quarters; b) the grouping together of the services; and c) the detachment of the spaces to be devoted to scientific tasks and to routine chores.

In the SE extreme there is an officers' compartment and cabins, following which are a laboratory, a consulting room, a dispensary and an infirmary. The central part comprises washrooms, showers, kitchen, ante-kitchen, pantry and personnel's mess. The NW extreme includes the weather and radio rooms, and a clerks room.

All these premises are connected by a central passageway of 2.50 m in the sleeping and sanitation section, and 1.20 m in the kitchen, pantry and personnel's mess section.

F. Inner conveniences

Ample premises were planned and constructed for the wardroom and dining room, with large windows in order to offer a good view of both bays-Scotia Bay to the officers' wardroom, and Uruguay Bay to the radioroom.

On the basis of the experience obtained at other Naval Stations, the floor plan was expanded and the number of cabins was increased with regards to the staff in such a way that each man might have his own cabin, and also lodge in it his replacement during the relief period.

All the cabins have double bunks and lockers, besides heating, and individual electric fittings; antenna connections for radio sets and a small desk with its chair. Ventilation is obtained by means of double windows.

The sanitation section was also modified with regard to that existing in other Naval Stations, being made to include three separate premises, to wit: Physician's consulting room, with adequate instrumentation for surgery cases; despensary and laboratory. These premises are of the same ventilation, heating and electric installation systems, etc.

The section of washrooms was also improved. One bathroom-water closet for commanding officers, a shower room, and a water closet having also urinals were designed and constructed, the last two for the use of the subordinate personnel.

As regards the kitchen, its functional size and layout was taken into account very specially.

It was located over one of the entrances to the house in order to facilitate the passage in and out of the personnel working in it. It was divided into two sections in such a way as to have in the kitchen proper the cooking utensils, and in an ample ante-kitchen, an oven to bake bread, and space to prepare and distribute the meals.

An ample pantry was also added, which permits to keep there the foodstuffs for one month close by to the kitchen. The kitchen has two kitchen ranges, a gas one and a gas oil one, of which only the first is used for the sake of convenience and swiftness, the other remaining as emergency unit.

The personnel's mess is situated close to the entrance opposite to the kitchen; it is spacious and fitted out with all the elements necessary for the fulfillment of its purpose; its capacity is for 25 men.

Lastly, the weather and radio rooms, as may be seen in the pertinent photographs and drawings, are spacious, ventilated by large windows and located in independent places, of relatively easy access.

VII. Power Plants - Electric Installations

Three Diesel generators, 30 kv each General Motors, Model 3-71, water cooled, supply 220-v, three-phase AC. The operation of only one generator is sufficient to take care of the regular requirements of the station, but the generators are prepared to be connected in parallel, when circumstances so require it.

There is also an emergency generator placed in the emergency house. This generator is a General Motors Model 2-71, water cooled, that supplies the same current, but with a power of 20 kw.

The four generators are prepared to supply electric current to all the buildings that make up the Naval Station.

The electric installation adopted is of the exposed type, using to the purpose enamelled, semiheavy steel pipes. This system was adopted with the object of locating failures immediately, also of avoiding breaking open walls and ceilings in such cases. This system is similar to that employed on board ships.

It has been further divided into 6 circuits with the object of not loading the whole of the installation on one line. Thus, in the case of any breakdown or short circuit, the station is not left without electric light and motive power.

1. Ground Floor or Cellar

It has a general panel T1 with a general switch, and one that commands each circuit.

Switch 1 is of the 3-pole shielded type and has fuses for 100 amp - 380 v.

Switches 2 and 3 are also of the shielded type, 2-pole, with fuses for 30 amp - 220v, and they command the thermotanks located in the upper story.

Switch 4 is a 3-pole shielded one, with fuses for 20 amp - 380 v. It commands circuit 5 and feeds panels T2, T3 and T4 (motive power with a panel for each pump unit).

This temperament was adopted because, being each equipment on its own, in the event of any inconvenience in any of them, the others keep on working.

Switches 5 and 6, 2-pole automatic ones, for 10 amp - 220v, command circuits 4 and 6 (light outlets and current sockets).

Switch 7, a 3-pole shielded one, with fuses for 30 amp - 220v, commands circuit 3.

Numbers 8 and 9 are single-pole switches for 6 amp - 220 v; they command the watch lights.

2. Upper Story

The electric installation in this story has been divided into 8 circuits, following the policy of not loading in each of them more than 20 outlets. It has one general panel, T5, with control switches of each circuit. Out of the 8 circuits, 6 are for control of the interior lights and the remaining two for external lights.

3. Material Used

A. Conductors

The conductors used are of electrolytic copper, plastic insulation, 6,000 v, different sections.

B. Piping

The pipes are of semiheavy steel, black enamelled, and different diameters according to requirements.

C. Boxes

They are of stamped steel, semiheavy, octogonal, and of large and small sizes. Others are rectangular or square, of stamped steel, semiheavy in accordance with the places where they are affixed.

D. Outlets

They are of the embedding type, and are placed in duraluminum exposed boxes.

E. Light switches

Same as for the outlets.

F. Thermotanks

Electric heated, with a capacity of 100 and 200 liters of water. They have safety and retainer valves for a water temperature of 50° C. Electric power demand 1 to 3 kw.

G. Electric pumps

One is for a 10 cu.m/hour flow and a pressure of 1.5 kg with support type FMO-A, IRUMA trademark, with 3-phase electric motor (3 x 220/380 v) of adequate power. It is placed on a case iron support connected to the pump by means of a semielastic coupling to the transmission shaft with anchoring and clamping devices.

The other electric pump is for sewage liquids, flow 6 cu. m/h and pressure 1.5 kg for a cesspool of 2-m depth, vertical axis, with 3-phase electric motors (3 x 220/380v).

4. Panel T1 (General)

Embedded in metal cabinet, constructed in No. 16 ironplate, with door and Yale lock, having the following elements inside:

a) One shielded 3-pole switch, 380 v 100 amp, with fuses (general command).

b) One shielded 3-pole switch, 380 v 50 amp, with fuses (command feeding circuit upper story panel).

c) Two automatic two-pole switches, 220 v 10 amp.

d) One shielded 3-pole switch, 380 v 20 amp with fuses (command feeding circuit to T2, T3 and T4).

e) Two single pole switches for 6 amp 220 v which command the watch lights.

f) Two shielded two-pole switches for 220 v 30 amp each.

All these elements are assembled in a frame, and below each one of them their use is indicated.

5. Panel T2 (Command Electric Pump for Sewage Liquids)

Embedded in metal cabinet, containing the following elements:

a) Three fused switches, with fuses for 15 amp 380 v.

b) Two automatic 3-pole switches for 380 v 10 amp.

6. Panel T3 (Command Hot Water Circulation Pumps, and Boiler Burners)

Also embedded in metal cabinet and containing the following elements:

a) Three fused switches, with fuses for 15 amp 380 v.

b) Four automatic 3-pole switches for 380 v 10 amp.

7. Panel T4 (Command Water Electric Pumps)

In a similar panel to those described above, and containing the following elements:

a) Three fused switches, with fuses for 15 amp 380 v.

b) One two-way hand lever, 3-phase, 15 amp.

c) Two protection switches against overloads, lagging phases and low tension. Suitable for remote command.

8. Panel T5 (Genral Command Upper Story)

Similar to those already described and containing the following elements:

a) Three fused switches, with fuses for 50 amp 380 v.

b) Eight automatic 2-pole switches, 10 amp 220 v.

c) One single pole switch, 6 amp 220 v (for lighting up the watch lights).

Each one of them has in the panel the indication of its use.

VIII. Heating System

The heating system adopted for the dwelling house is by force-feed hot water circulation.

The system has been divided into two circuits for construction reasons, and with the object of avoiding, in the case of any obstruction in some part of the installation, that the building might be left without heating.

The system of upper feeding is obtained with convective radiators, circulator pumps which can work separately or in parallel, the same as the collector.

Pipes are all exposed in order to facilitate the location of possible leakages, also to make repairs and to take full advantage of its calories in all the premises. It has been computed an inside temperature of +20° C(68° F) with - 20° C(-4° F) outside.

1. Boilers

The boilers are sectional, wrought iron units, with a capacity of 120,000 cal/h as a minimum, suitable for liquid fuels and adaptable to burn solid fuels.

They all have adequate additional parts for their proper and efficient performances, including insulating jacket, dial thermometer, hydrometer, damper regulator, drain cock, firebrick lining, etc.

The boiler is a TAMET make, and has been provided with the most necessary spares, such as a set of grids, thermometer, cocks, etc.

2. Burners

The burners are semiautomatic, specially adaptable to burn Arctic gas oil CARLIN make, 100% USA product, with Minneapolis Honeywell chimney stack control. All the working elements are mounted in a single block, comprising the following units:

Electric motor for 3-phase alternating current 220/380 v, blower, pump, filter, automatic discharge valve, pressure gauge, air and fuel control, etc.

3. Electric Pumps

The electric pumps for hot water circulation, Horizontal Centrifuge type, have a minimum yield of 5,500 lt/h and a 2 m back pressure of water column. They have electric motors for 3-phase alternating current, 220/380 v.

4. Expansion Tank

The expansion tank placed over the ceiling and intended to avoid that the boilers run dry, is a truncated cone in shape, made in No. 14 black plate, electric welded, and dip galvanized in block. They have a capacity of 100 lt and a hinged cover, copper float, connections and spill.

It has a discharge 25 mm in diameter through its draining valve.

5. Radiators

The radiators are sectional ones, in wrought iron, 4 columns each, 0.61 m in height, with legs, crossed connections 13/13 mm in diameter from 5 to 23 sections, in accordance with the premises where they have been installed.

6. Fuel Tank

The fuel tank is of No. 14 galvanized iron plate, 1 m x 1 x 0.50 m, with a pressure cap 0.20 m in diameter on its upper surface.

It has ½" bronze tap, a ½" long galvanized iron niple, 2 ½" elbow, also in galvanized iron, and three 1" to ½" reductions.

IX. Water Supply - Distribution

The supply of water is accomplished taking advantage of the thawing of springs in the summer, and in winter by means of a snow or ice melter, 400 lt in capacity, with a copper coil inside coupled to the heating system.

The water thus obtained is deposited in a cistern tank placed in the ground floor or cellar, this tank having a capacity of 30,000 lt. This water is raised by means of two electric pumps of 1,000 l/h each, and of 10 m gauge height, to a tank placed above the ceiling which has a capacity of 2,000 lt.

For eventual damages in the electric pumps, hand pumps installed in the same cistern tank are available.

Water is supplied to the kitchen, the thermotank and the sanitary fixtures from the tank placed above the ceiling.

The hot water is turned out by two thermotanks which distribute the water thus:

a) To the fittings installed in the kitchen, and

b) To the showers and wash basins

The pipes are in galvanized iron and of different diameter in accordance with apecific requirements.

X. Sanitary Installations - Sewerages

1. Sanitary Installations

This was designed in accordance with the regulations of Obras Sanitarias de la Nación (the Argentine Department of Sanitation Works).

The use of these installations is to discharge all the sewage liquids into a septic tank, by means of cast iron pipes of different diameters. The installations are prepared for a personnel of 30 men.

The sanitary installations are located in the cellar and in a closed premise with heating, with the object of keeping a mean temperature of +18°C (64.40°F), thus avoiding the cooling of the water, which is the essential condition for its proper operation and for a better work by the aerobe and anaerobe microbes.

As the decomposition of the different wastes takes place, the water passes into a waste disposal tank of 6,000 lt useful capacity, also heated, which is drained outside (to the Scotia Bay) by means of two 6,000 lt/h electric pumps each and of 15 m gauge height. This also has a hand pump installed for emergency cases.

2. Sewerages

They are made of cast iron, all the fixings having adequate siphons.

All the downward pipes meet in an inspection chamber located at the head of the septic tank.

The bathrooms have toilets, wash basins and wall urinals.

The kitchen has cabinets and stainless steel sinks, with hot and cold water.

The drainages of the wash basins, urinals and kitchen sinks are made of lead pipes which discharge into floor drains and thence into the main sewer.

3. Ventilation

The ventilation of the septic tank, as well as that of all the fixings is accomplished by means of the cast iron 102 discharge and ventilation piping. This piping, three branches in total, go outside through the top of the roof.

The ventilation of the cistern is accomplished by means of a galvanized iron pipe 0.025 m in diameter which reaches a suction grid.

4. Safety Conditions

In order to avoid the inconvenience of unpleasant fumes, the septic tank and the waste disposal tank have been placed in the cellar, as already stated, in a closed place having cement walls, the same as all the pumps. In this way, in the event of some inconvenience, this can be overcome without interfering with the living quarters.

As the cast iron pipes are caulked with lead, leakages and unpleasant odors are avoided. All the galvanized iron pipes are screwed up, the plumbing part being soldered with 33 per cent tin.

XI. General Ventilation

The general ventilation of the installation is accomplished by means of double windows which open 30 degrees pivoting on its upper axis and are adjustable in all its amplitude.

This system of ventilation in the area where the station is located turns out to be very adequate as it permits the free passage of the air with no problems as regards the entrance of snow or direct air draughts.

It is likewise possible to keep open the windows under anyweather condition.

XII. Fire Prevention

The house is equipped with CO_2 fire extinguishers, distributed in all the lodgings and in such number that they mean an effective barrier against possible accidental fires.

A portable pumping unit is also available, with water intake from Scotia Bay in summer, and from the general purpose water cistern during the winter.

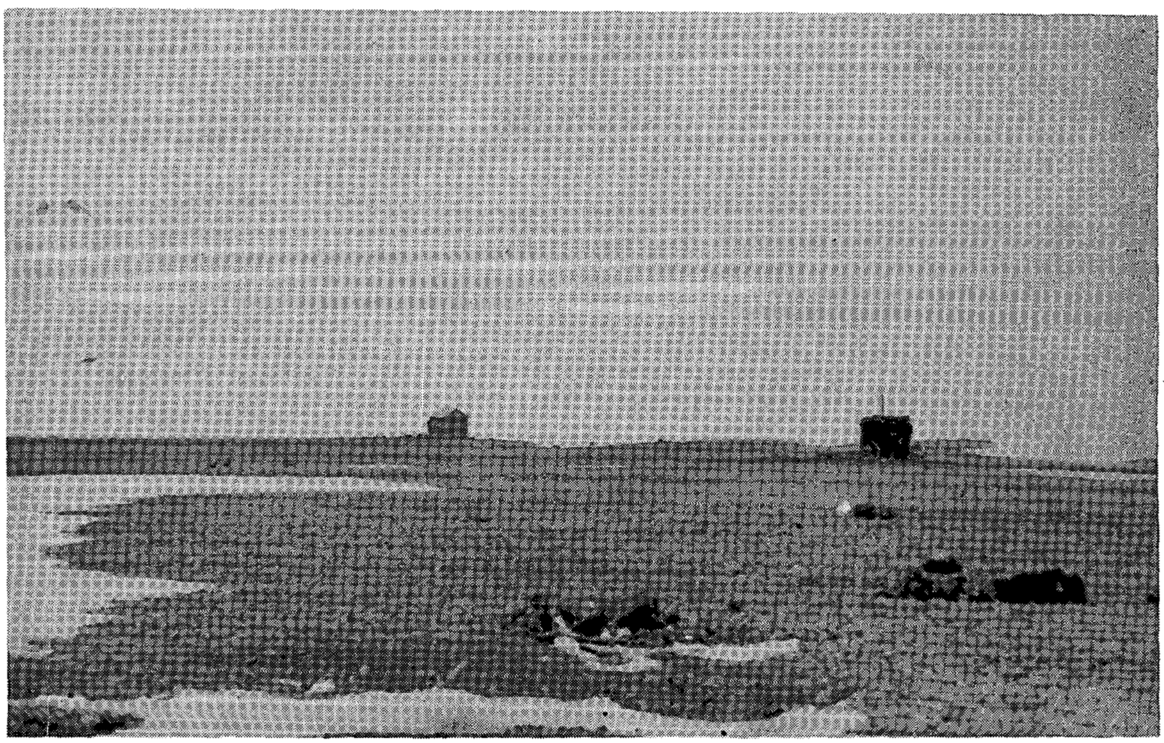
XIII. Decauville Narrow Gauge Rails and Trucks)

There is a system of narrow gauge rails and hand trucks which is used to go from any one building to the others. This facilitates in summer the transportation of supplies from the beach to the storage places. The truck line has a length of 380 m and it has spurs in the direction of each one of the entrances to the buildings. This is facilitated, in turn, by existing turntables. Loads up to 4 tons can be carried without inconvenience.

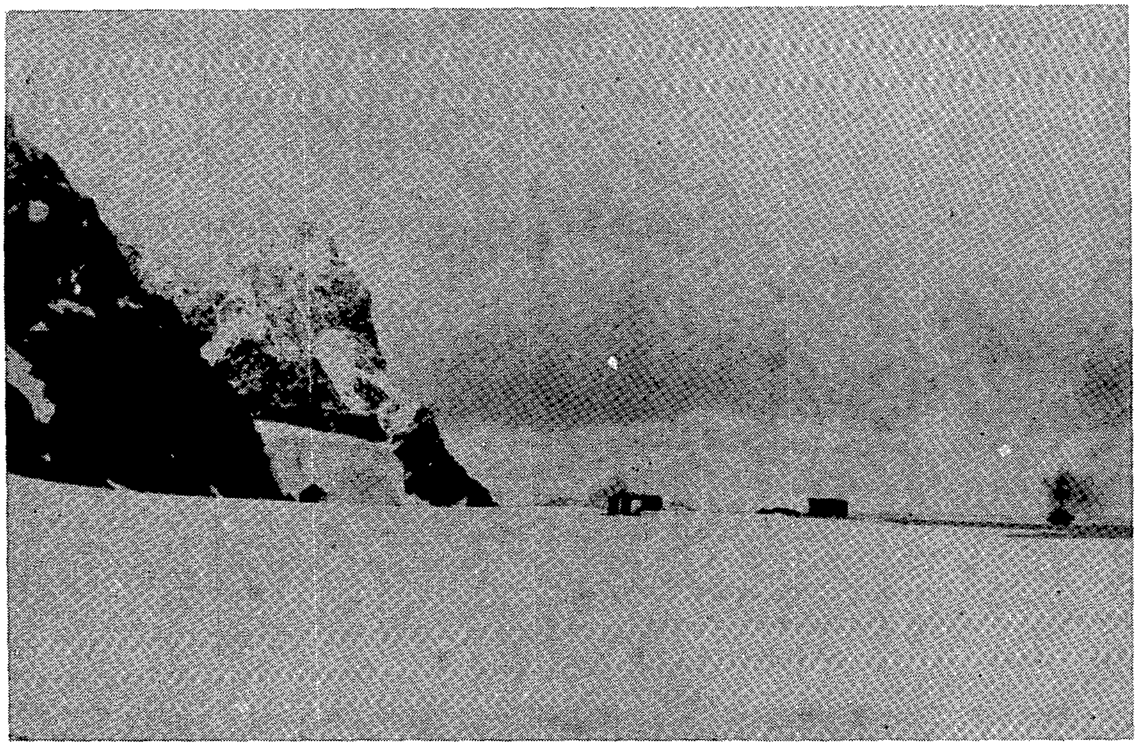
XIV. Final Considerations

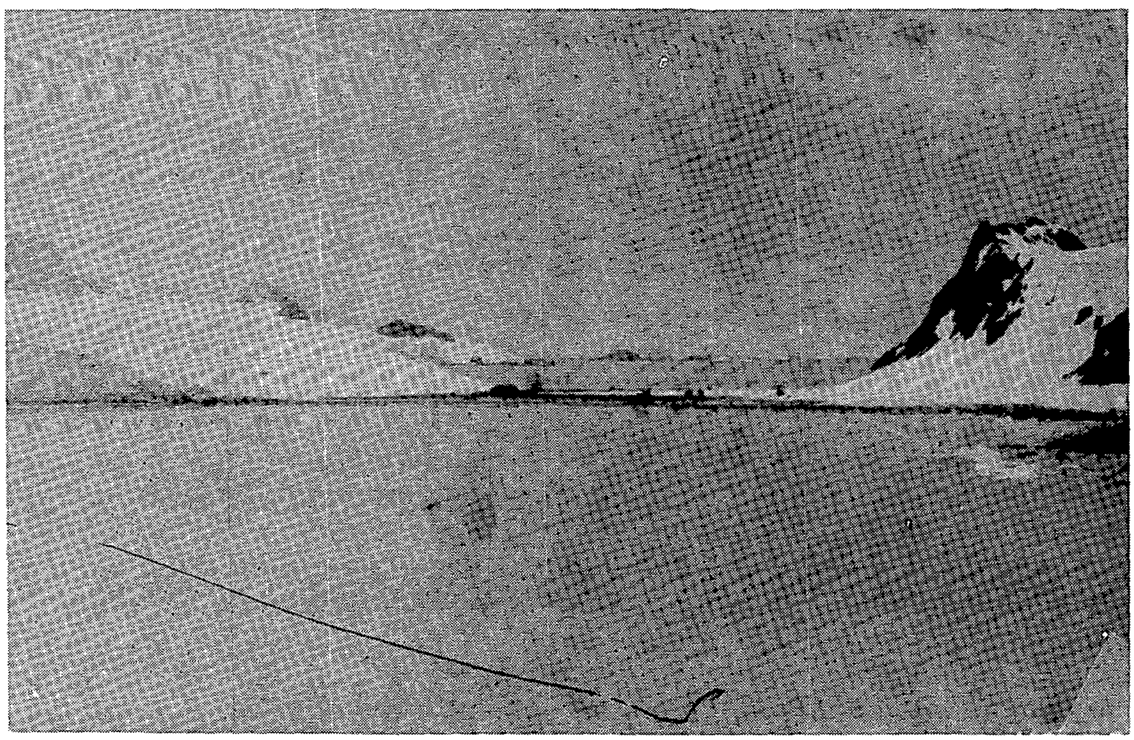
Summarizing what has been stated in the course of this paper, it can be declared that this is the first time that a building of such magnitude and with a reinforced concrete usable foundation has been constructed with optimum results in the Argentine Antarctic sector.

As regards the dwelling section of the buildings, the conveniences are very comfortable. Ventilation is very good, cabins are ample and so are the beds, there is central heating, very good sanitary services, etc. Spacious lounge, which also offers a magnificent view. Ample and comfortable kitchen, oven to bake bread. Spacious and well ventilated premises both for work and for leisure. This all means, with no risk of incurring in a misstatement, that it is one of the most modern and comfortable buildings constructed in Antarctica.

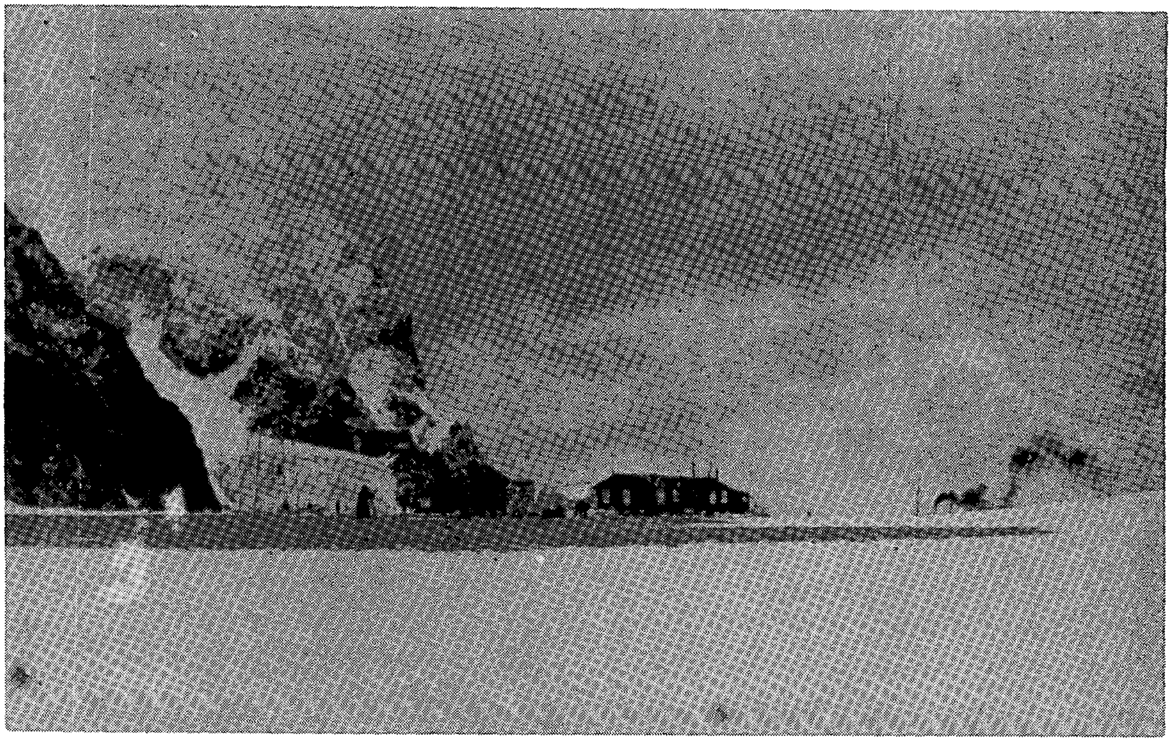


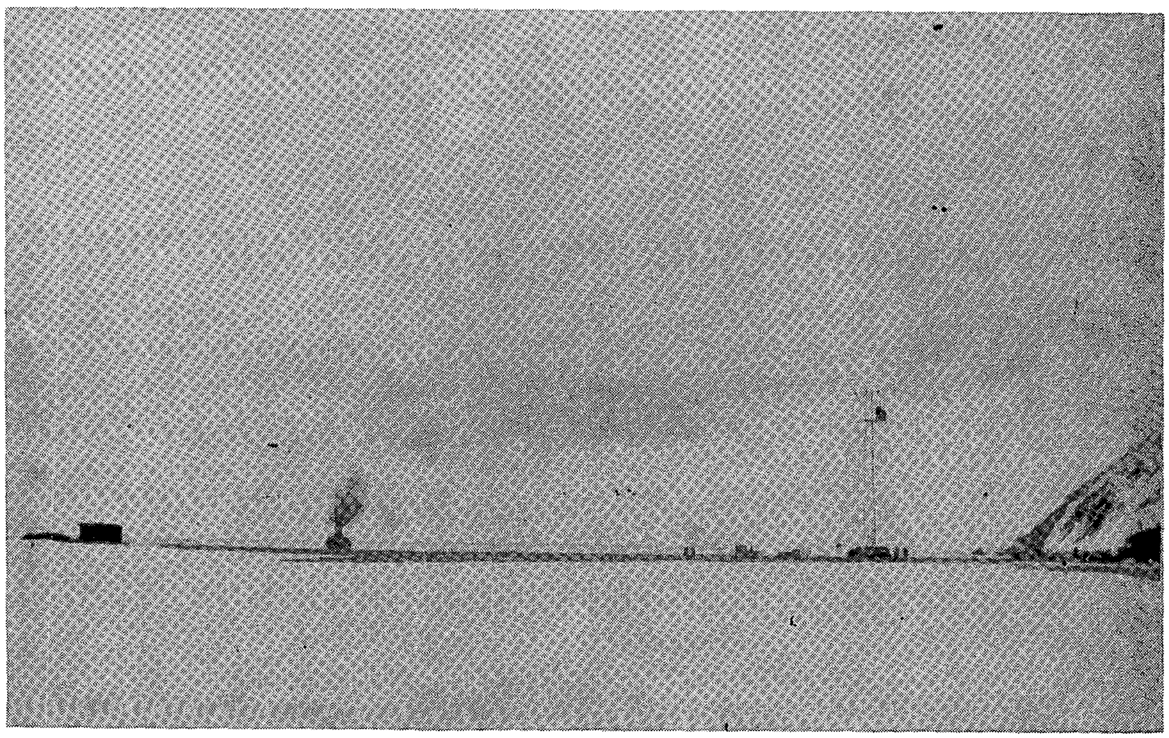
New house setting up area-summer 1967



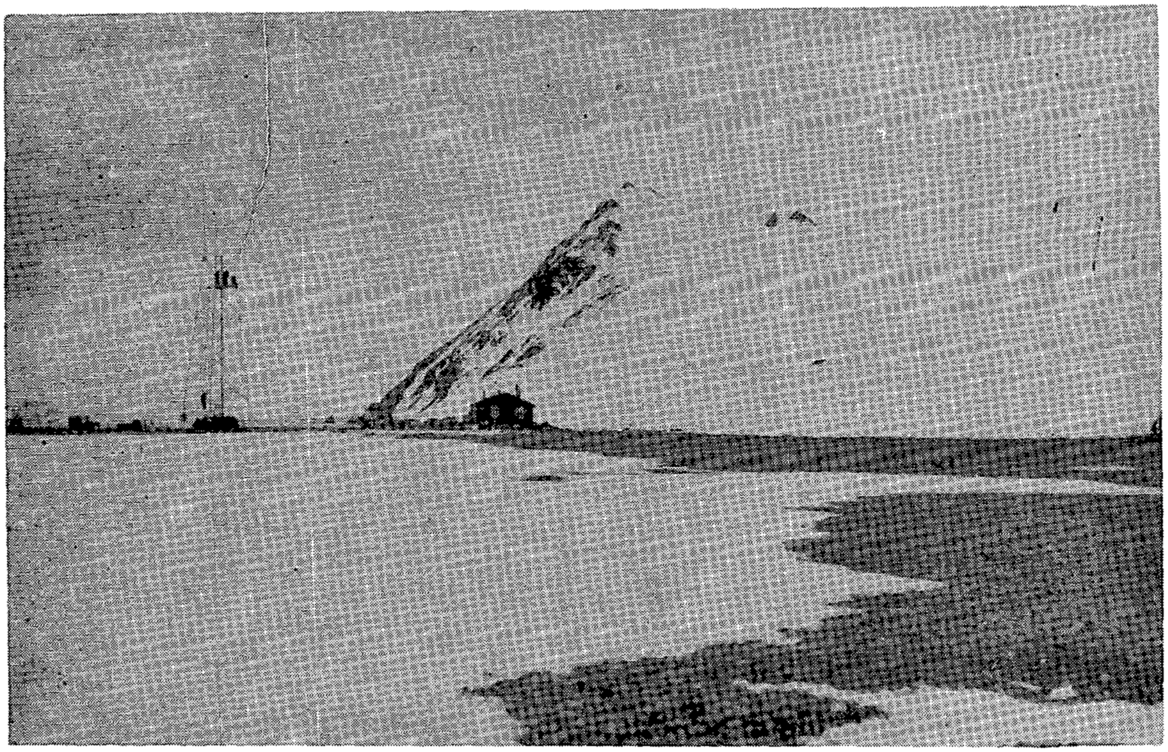


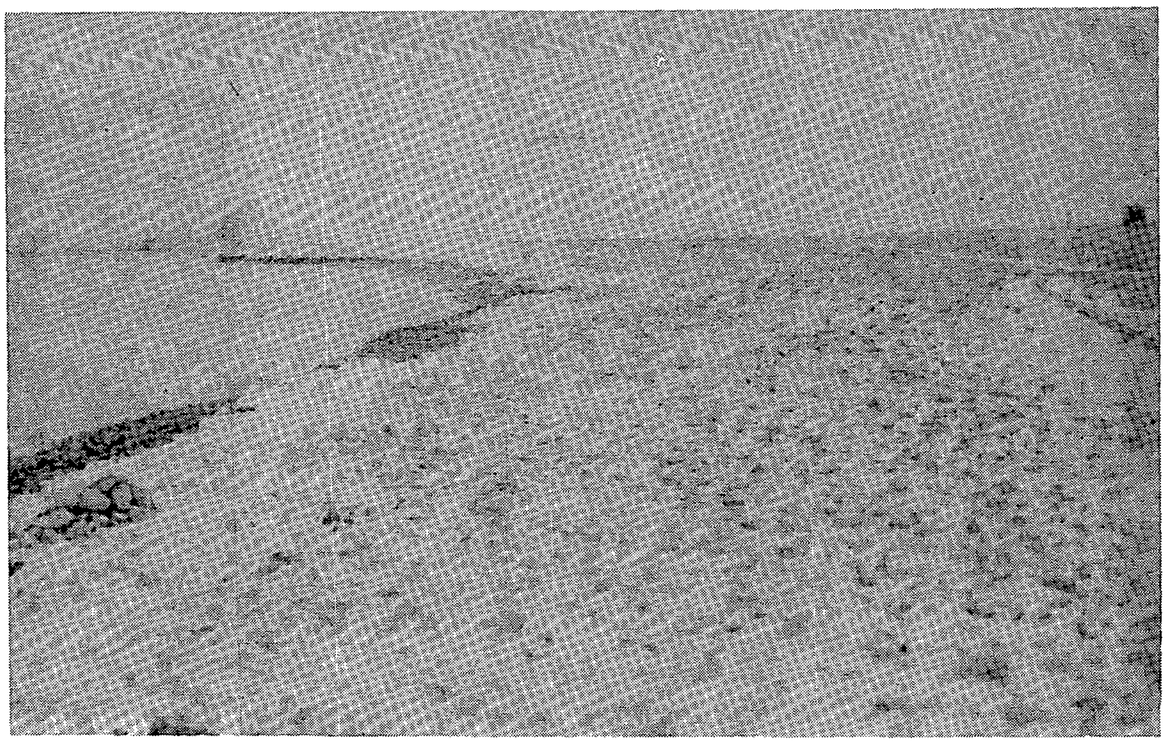
General view of installations in Órcadas National Detachment



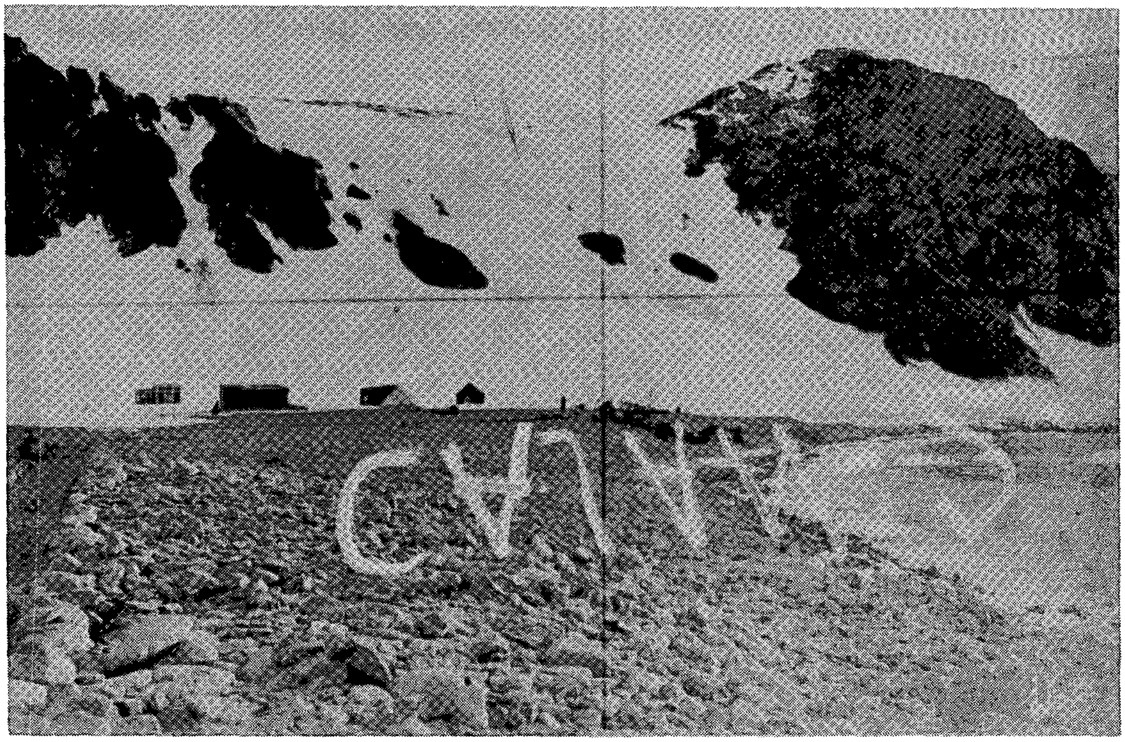


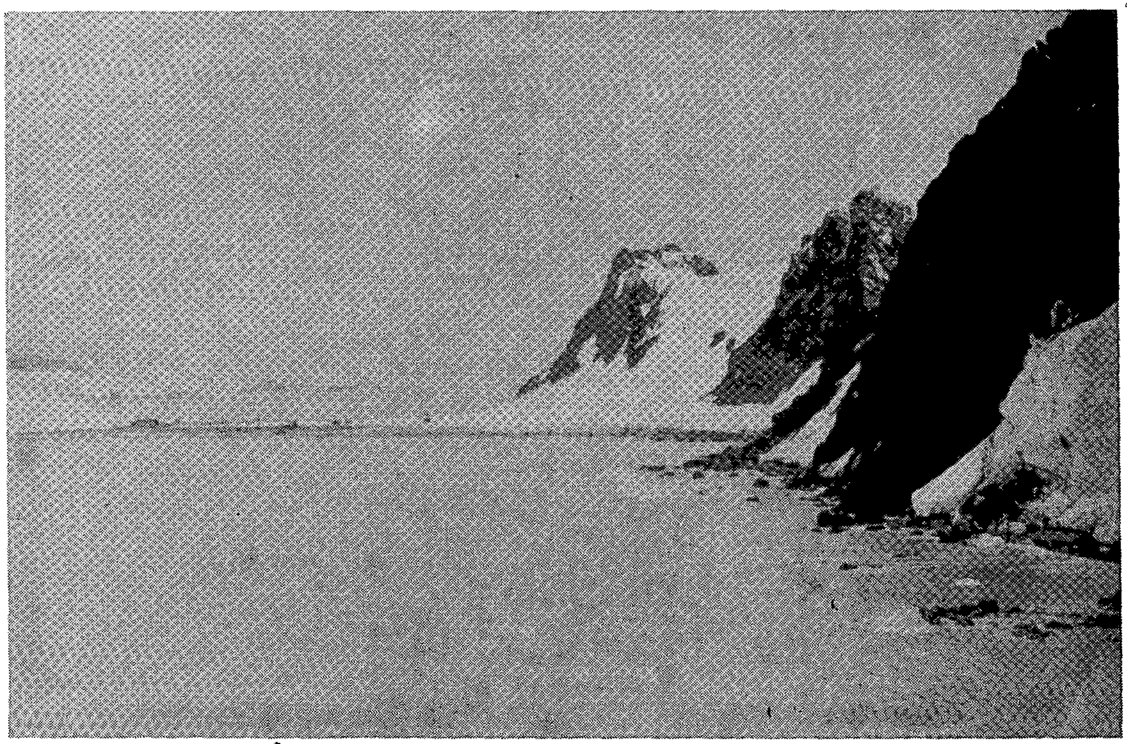
New house setting up area-summer 1967



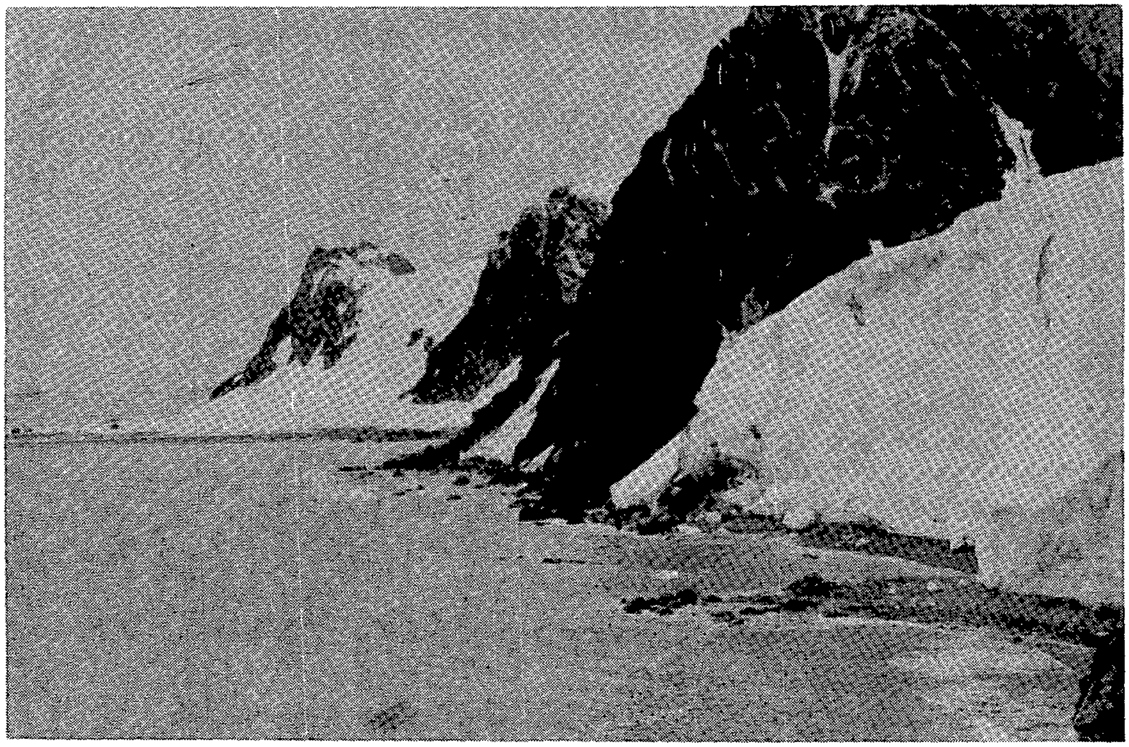


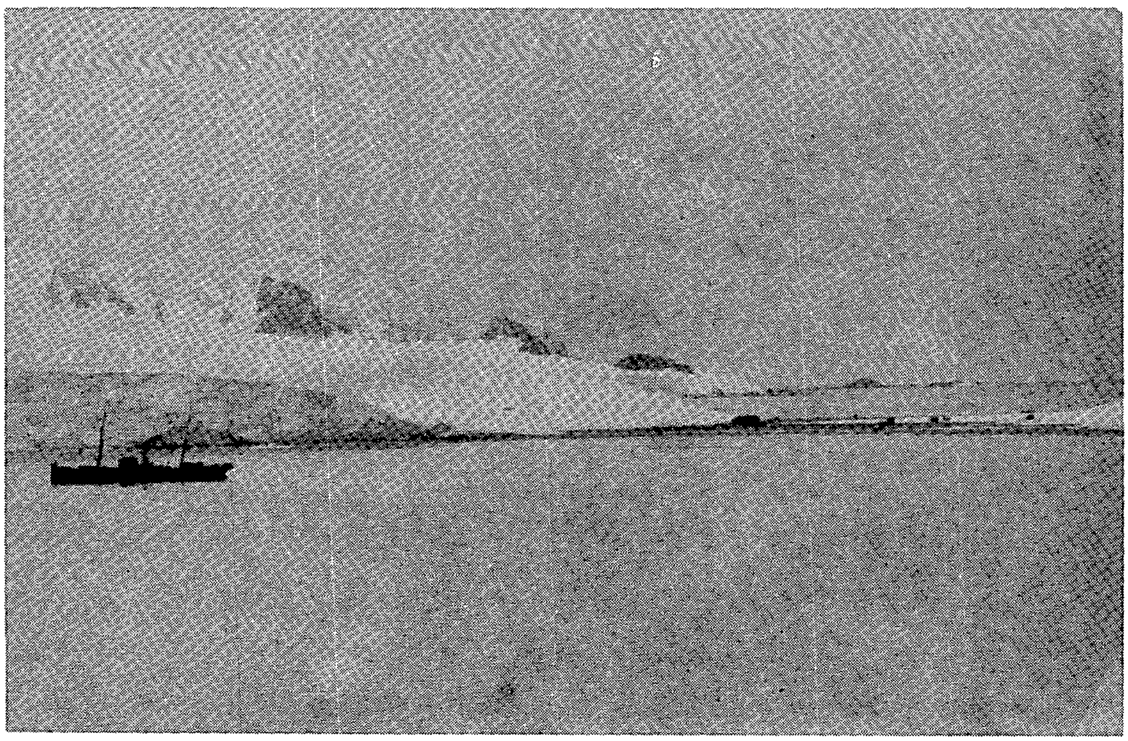
Access beach to D. N. Órcadas



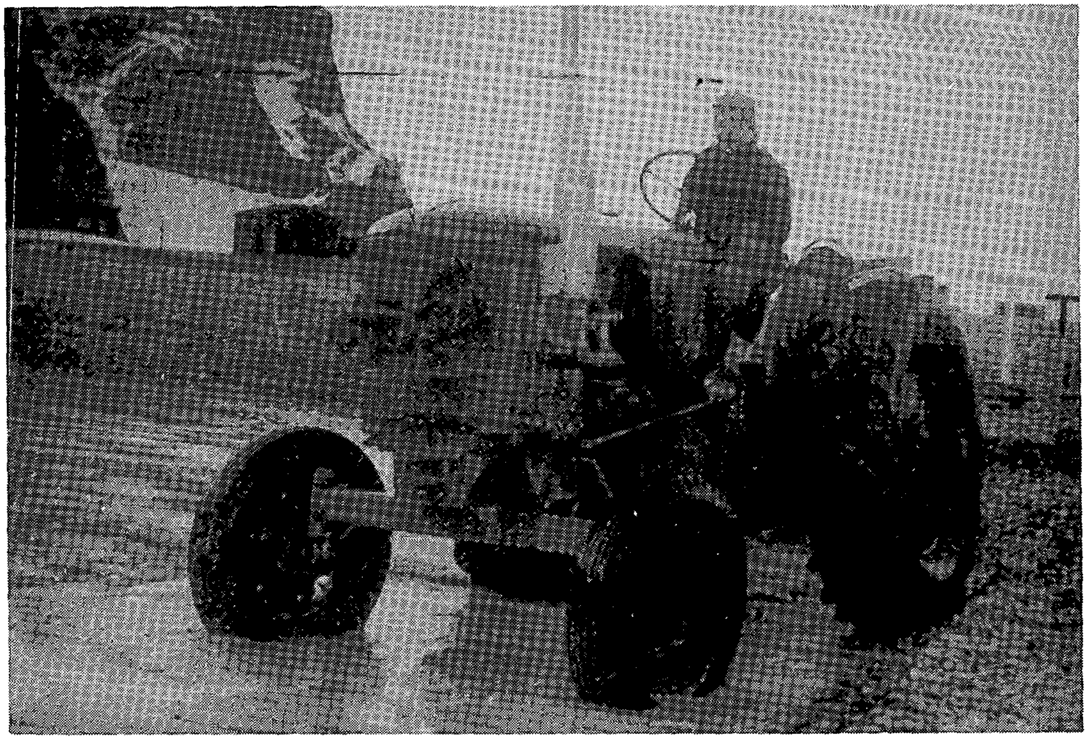


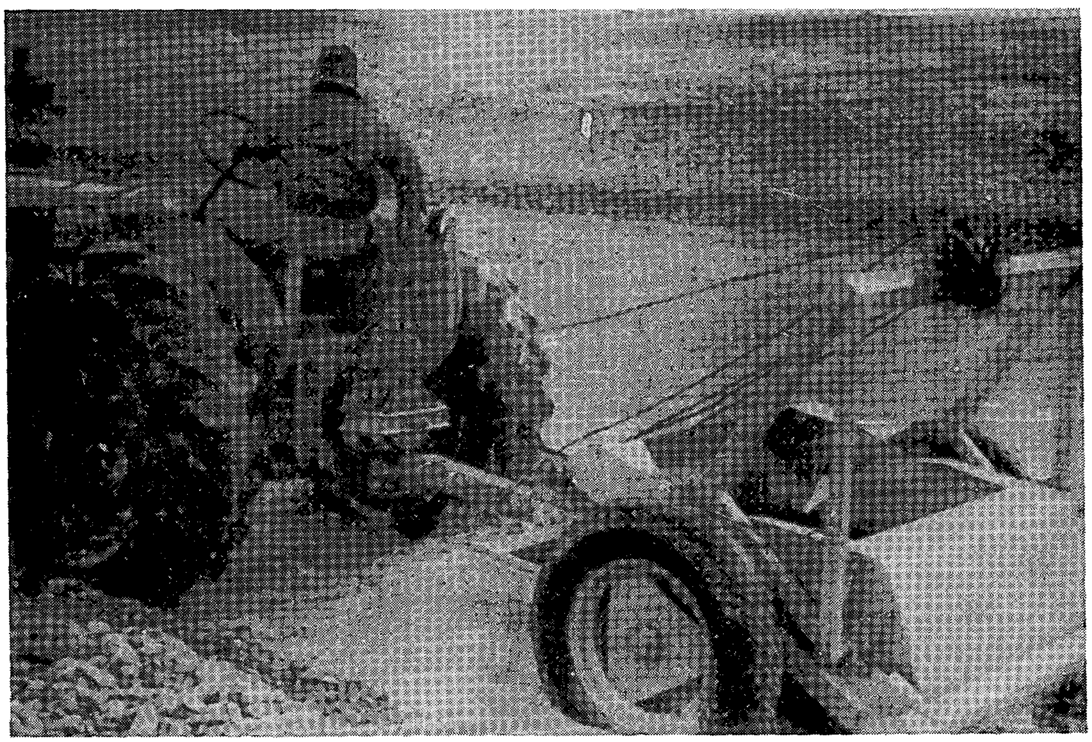
Hills limiting isthm



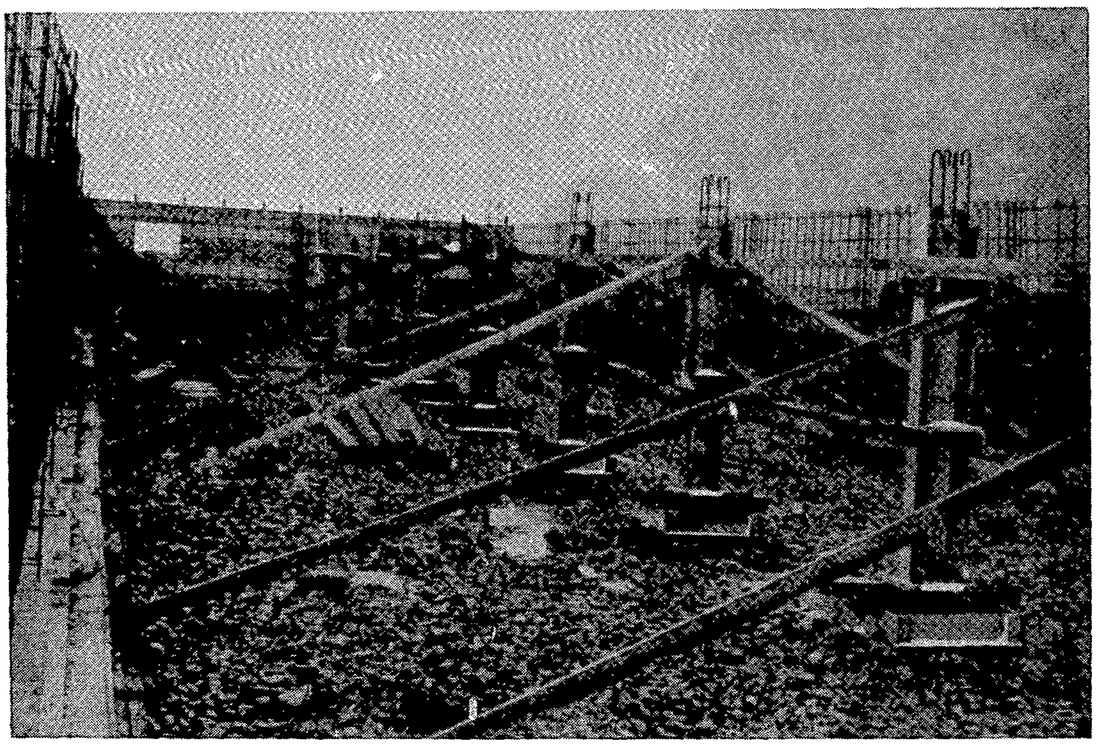


Hills limmiting isthm

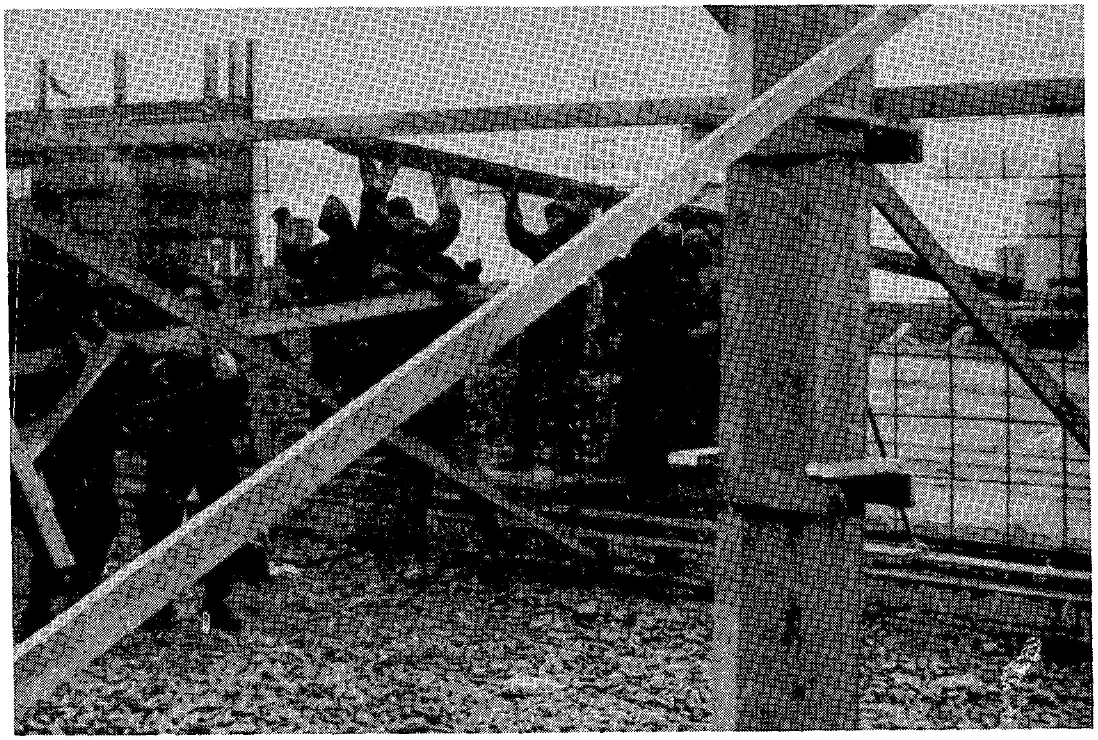




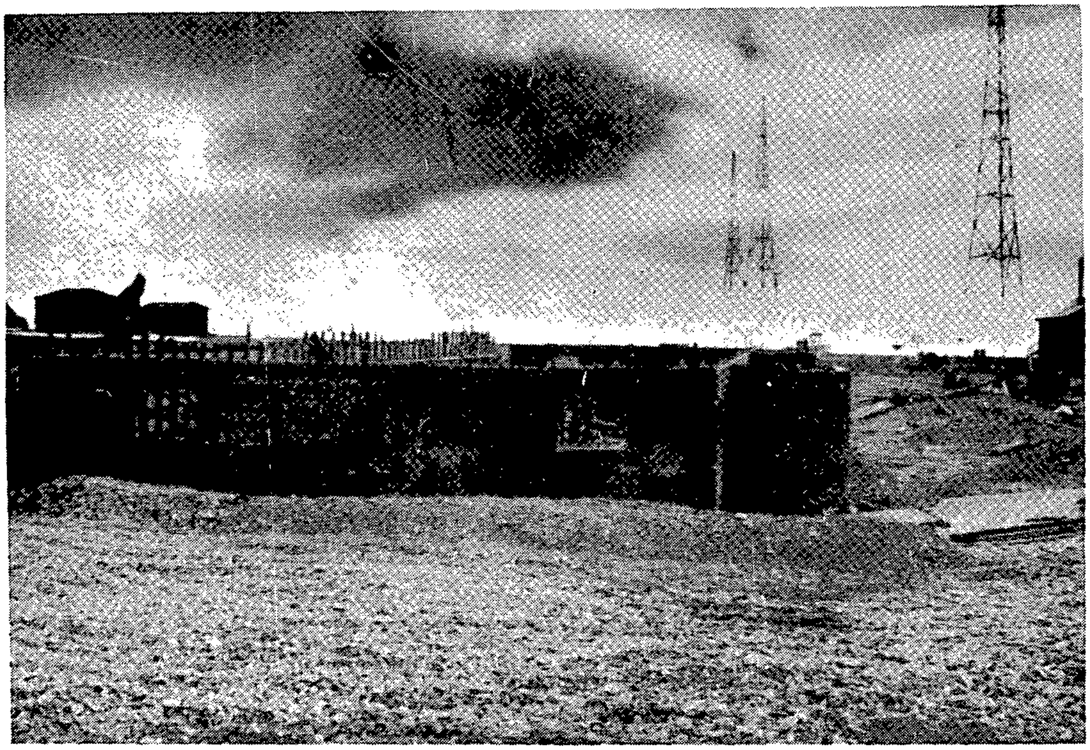
Tractor and mechanical shovel used to remove pebbles

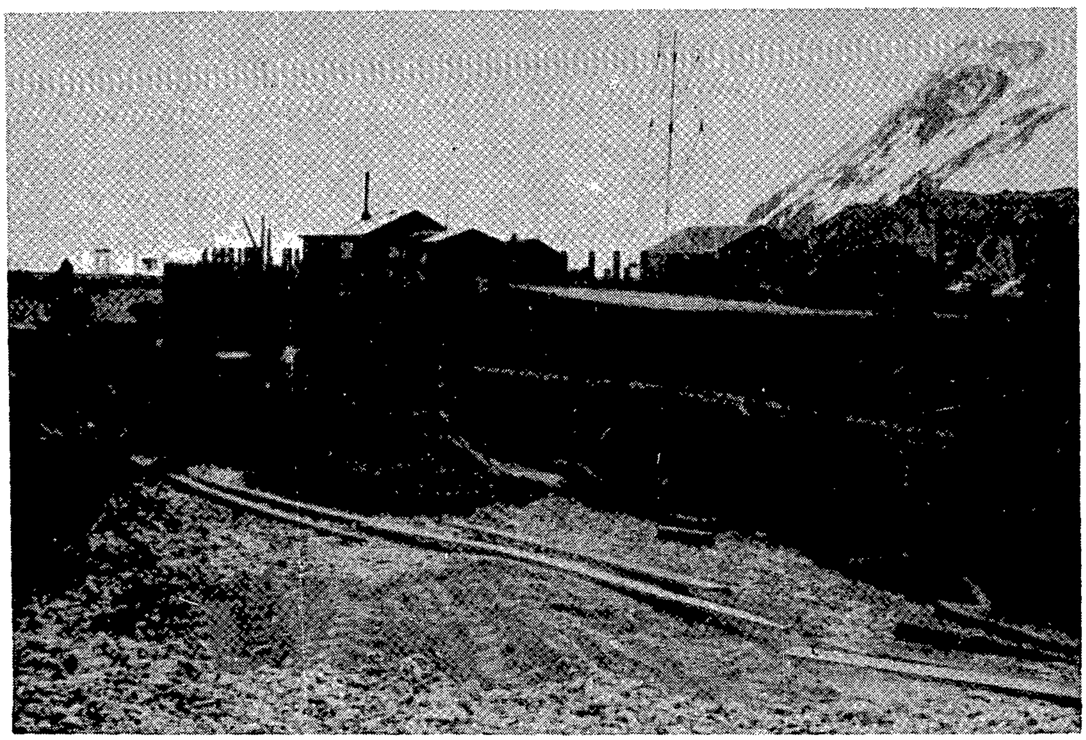


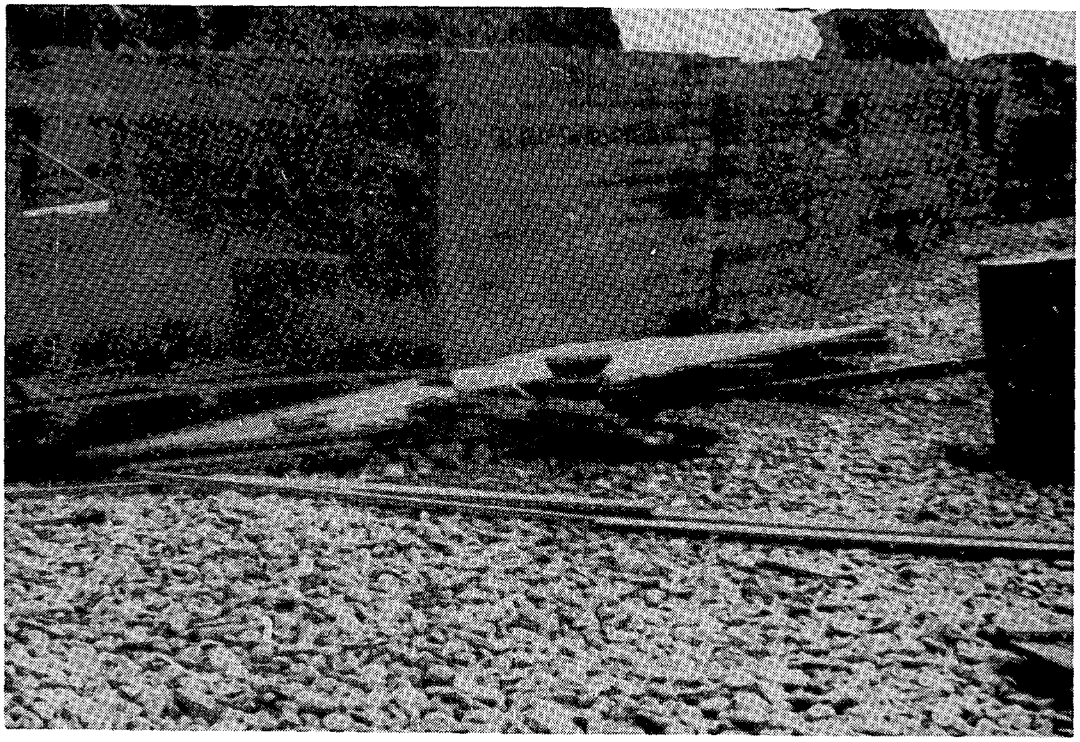
Cellar construction-interior view



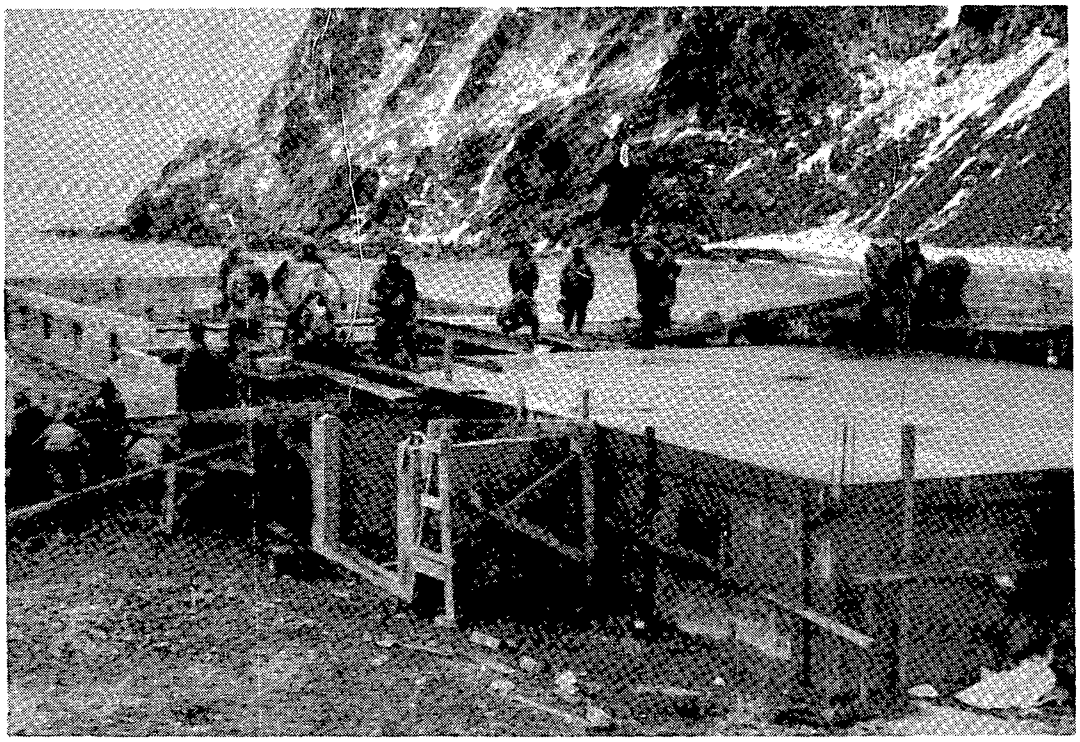
Cellar construction-exterior view

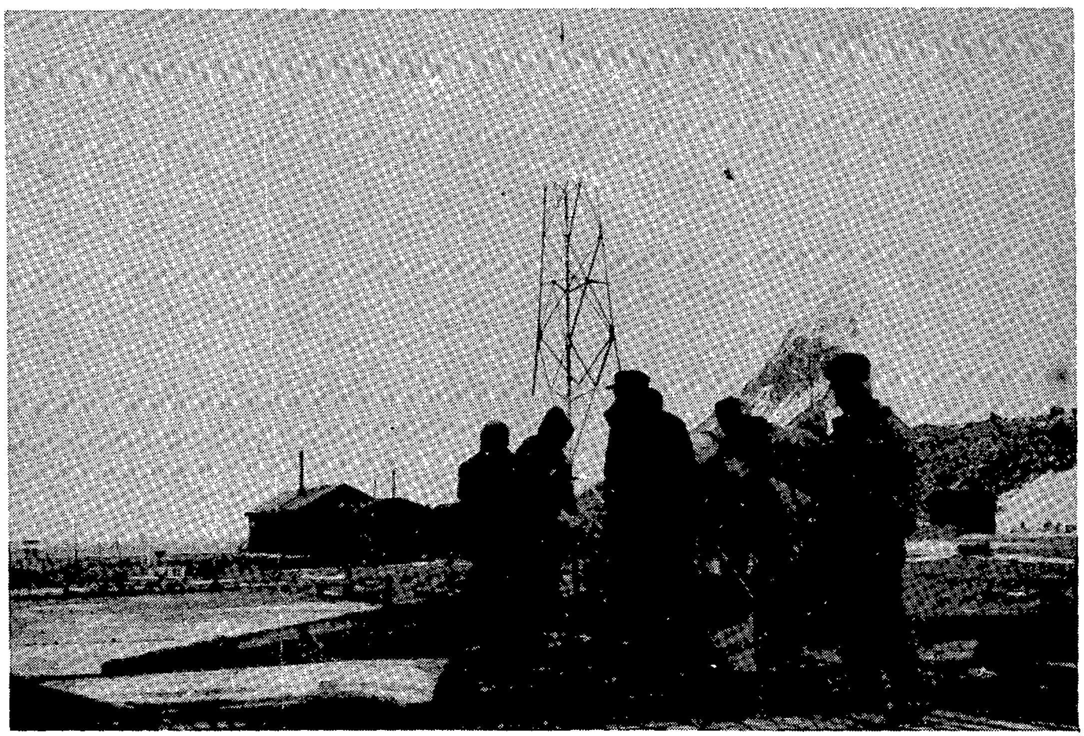




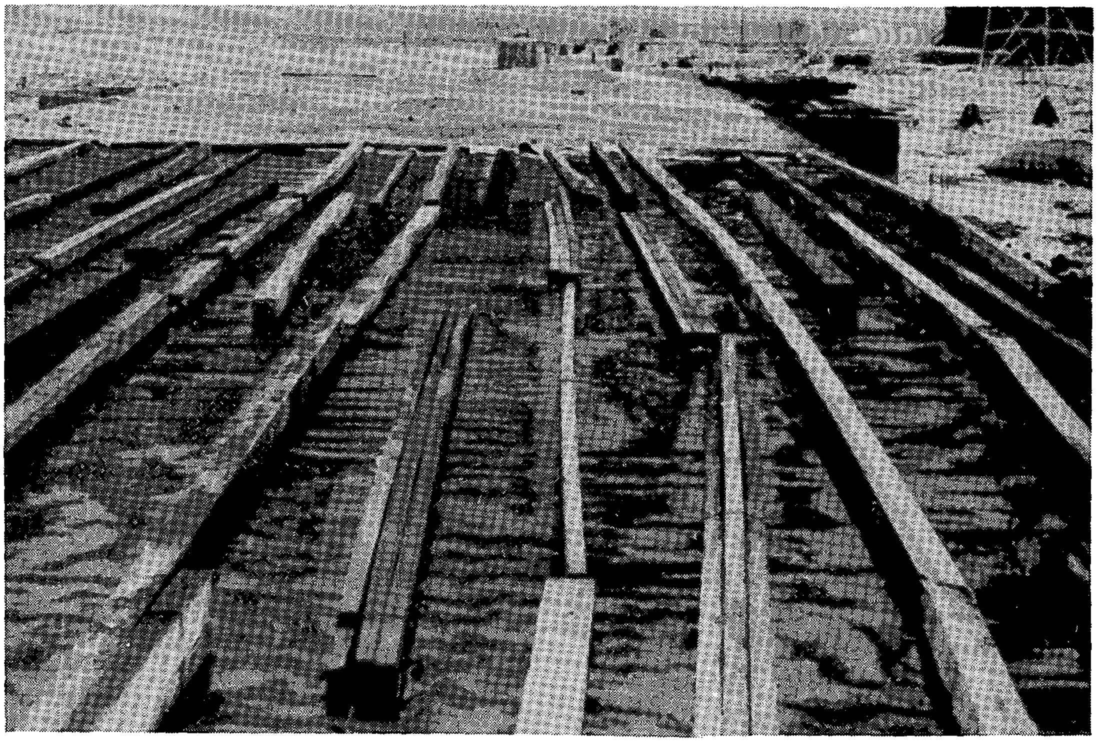


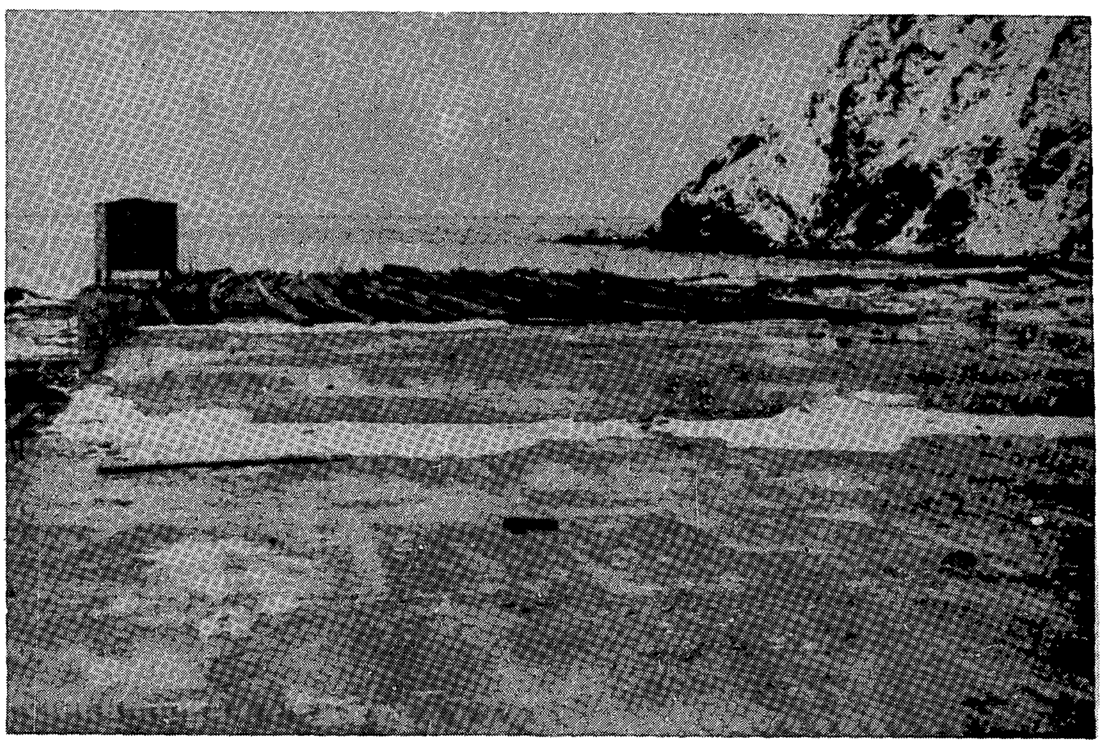
Cellar-lateral views





Cellar-upper view





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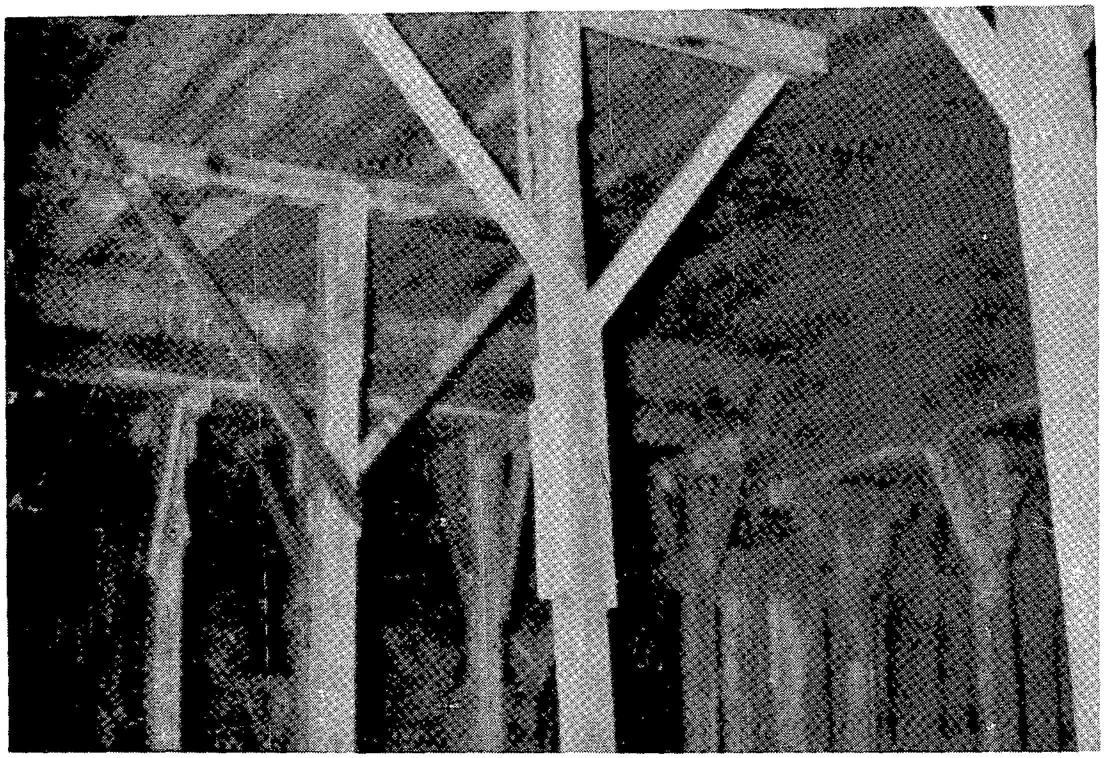
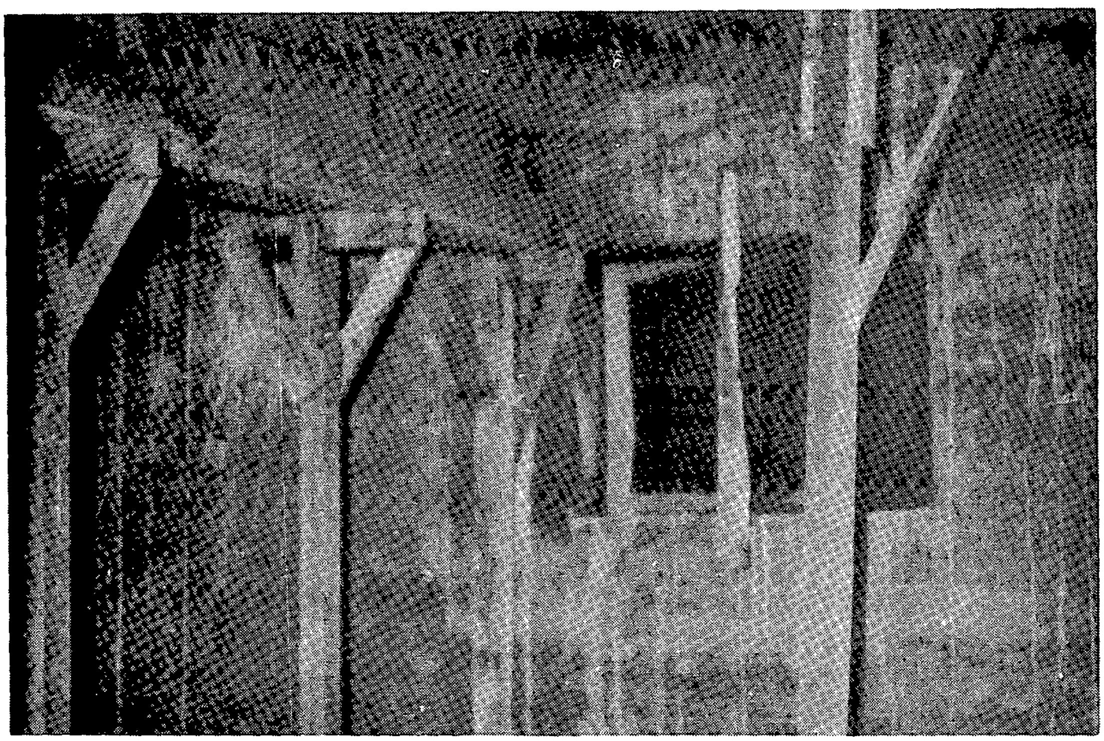
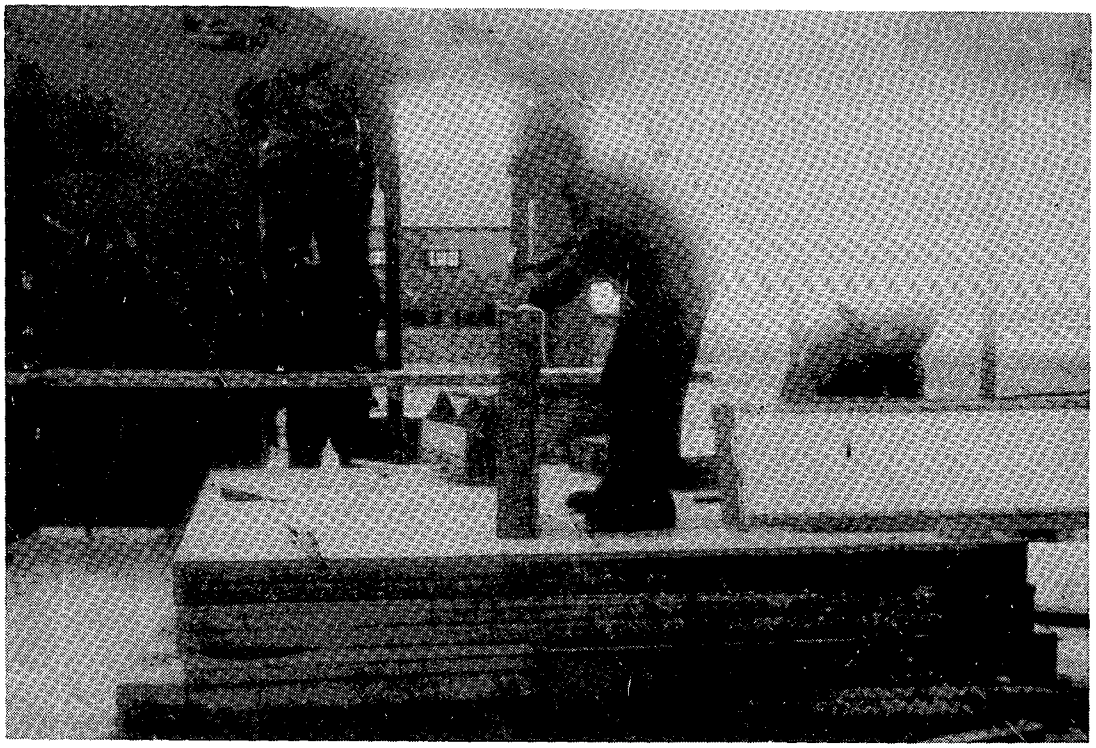
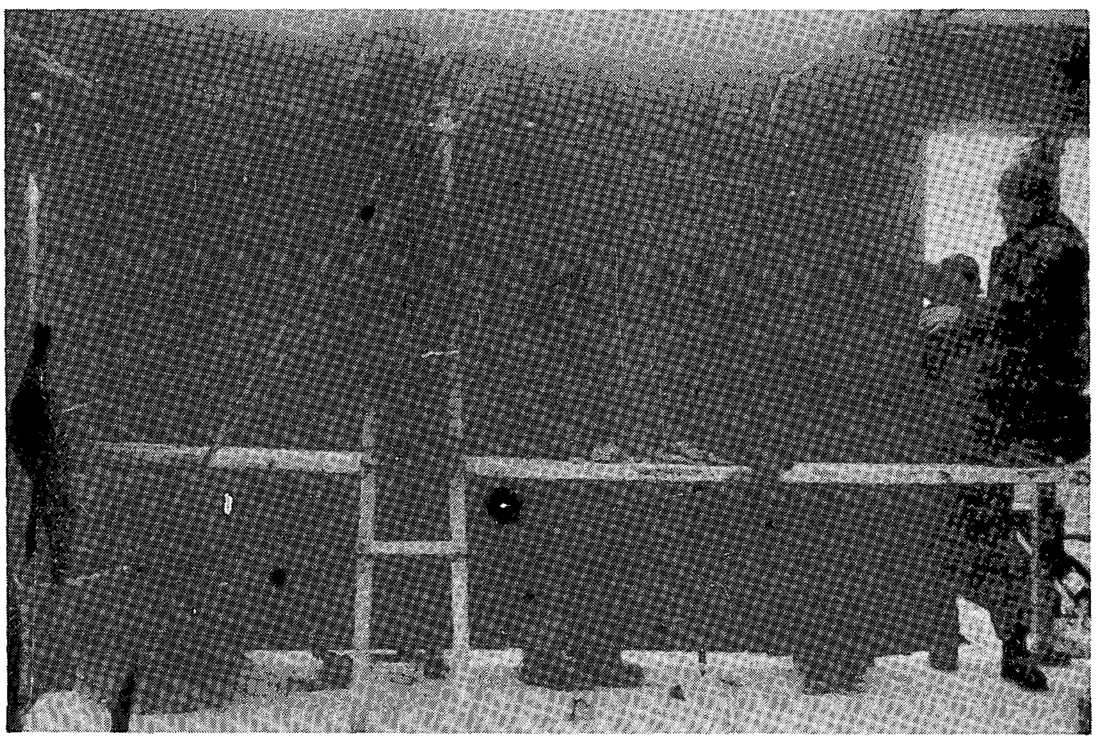


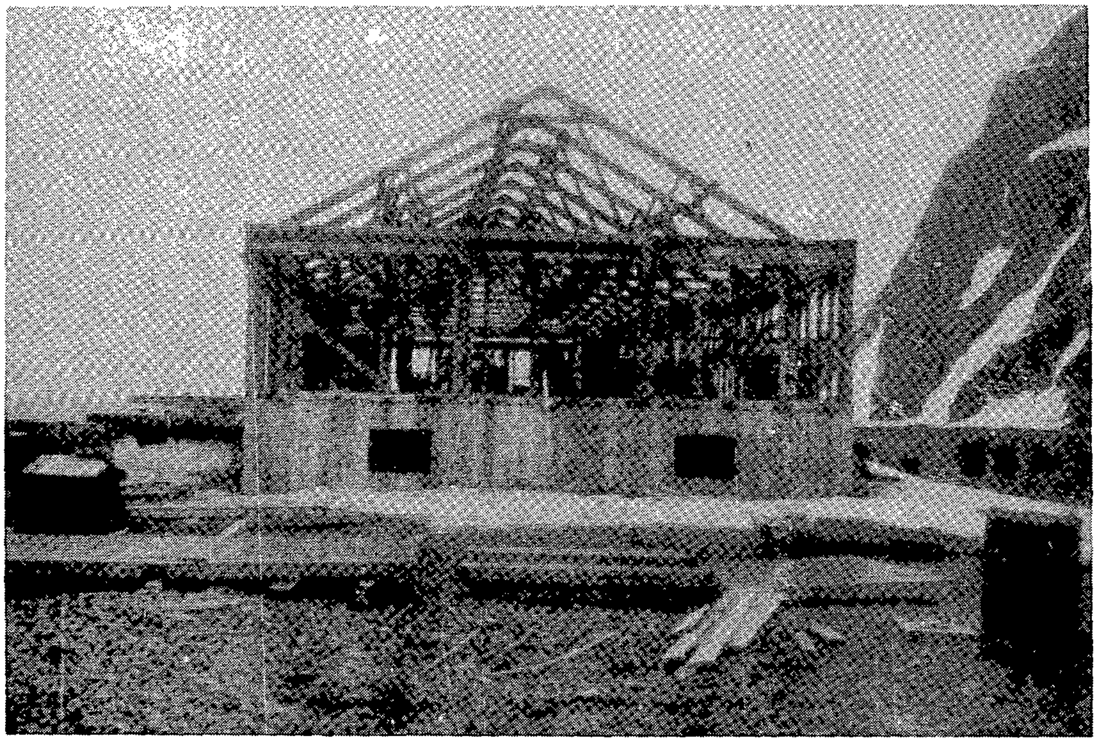


Cellar-interior view





Assemblage-interior or upper plant



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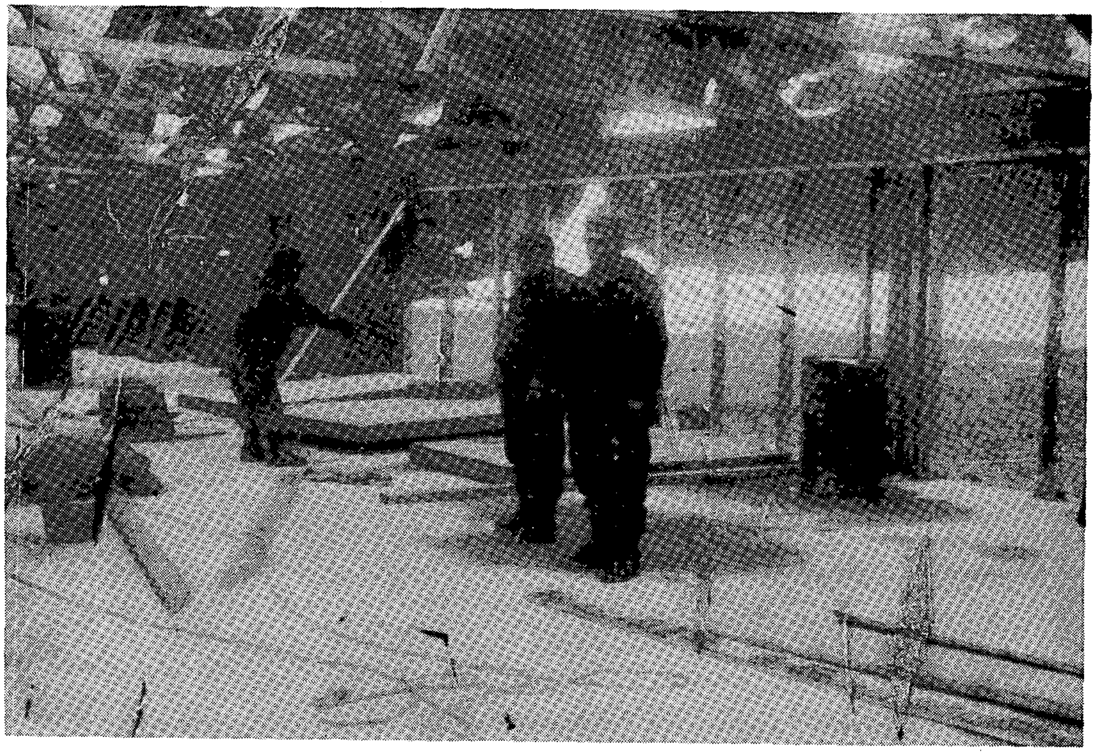
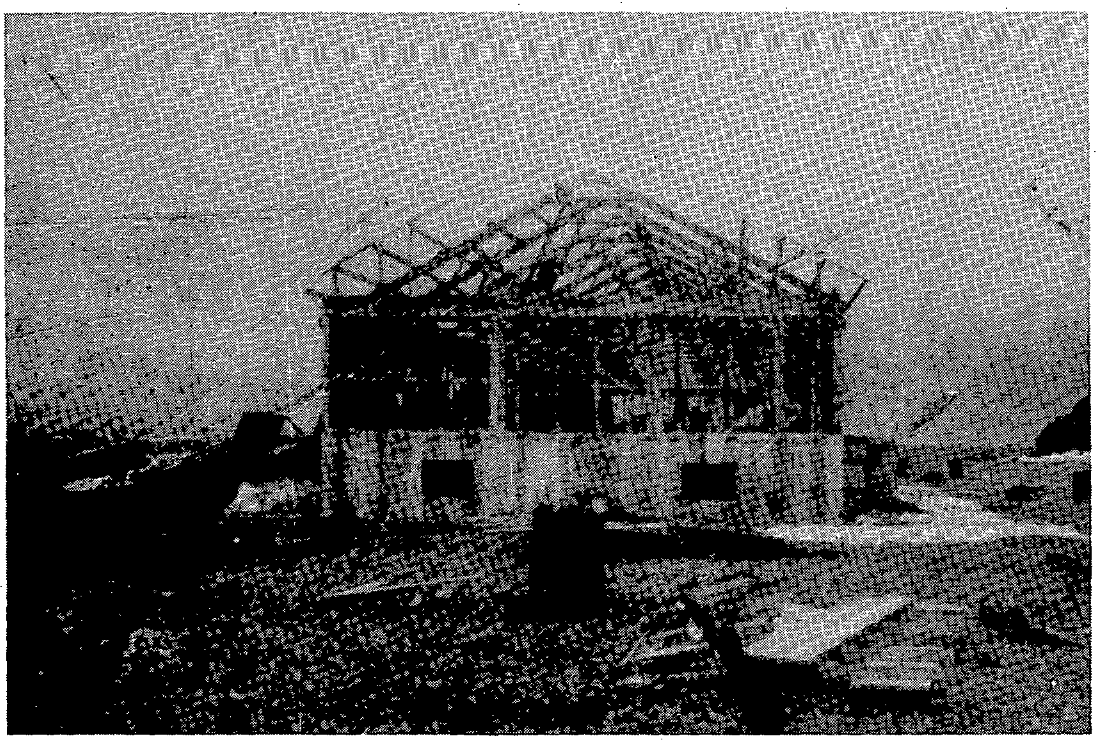
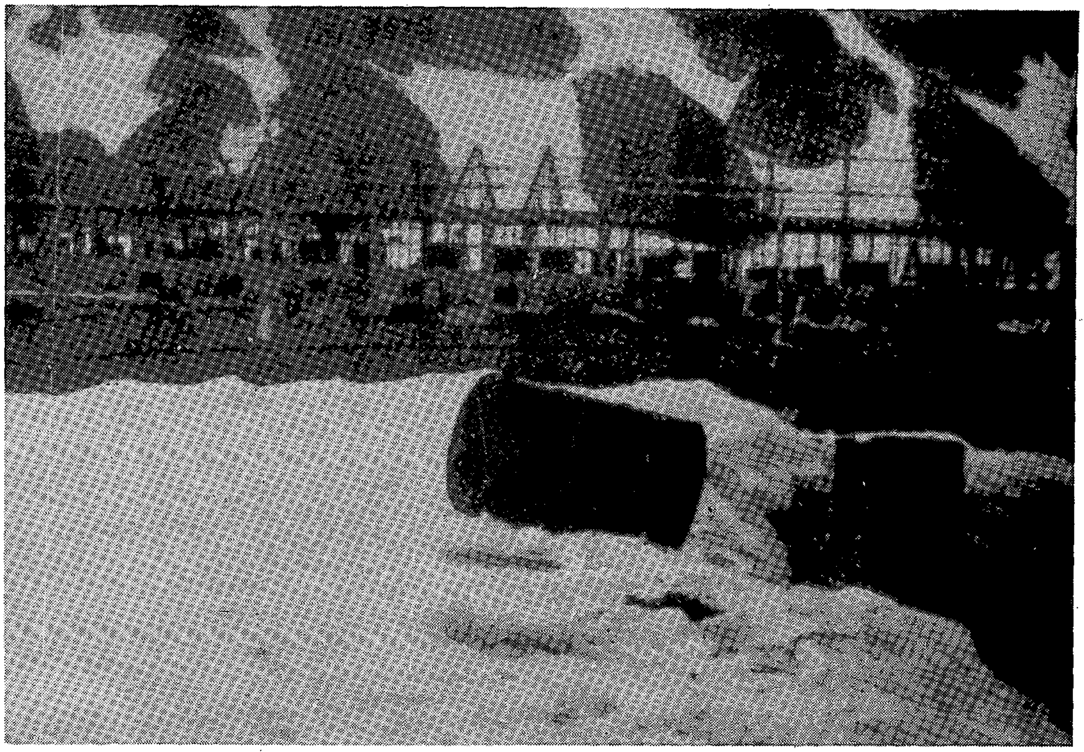
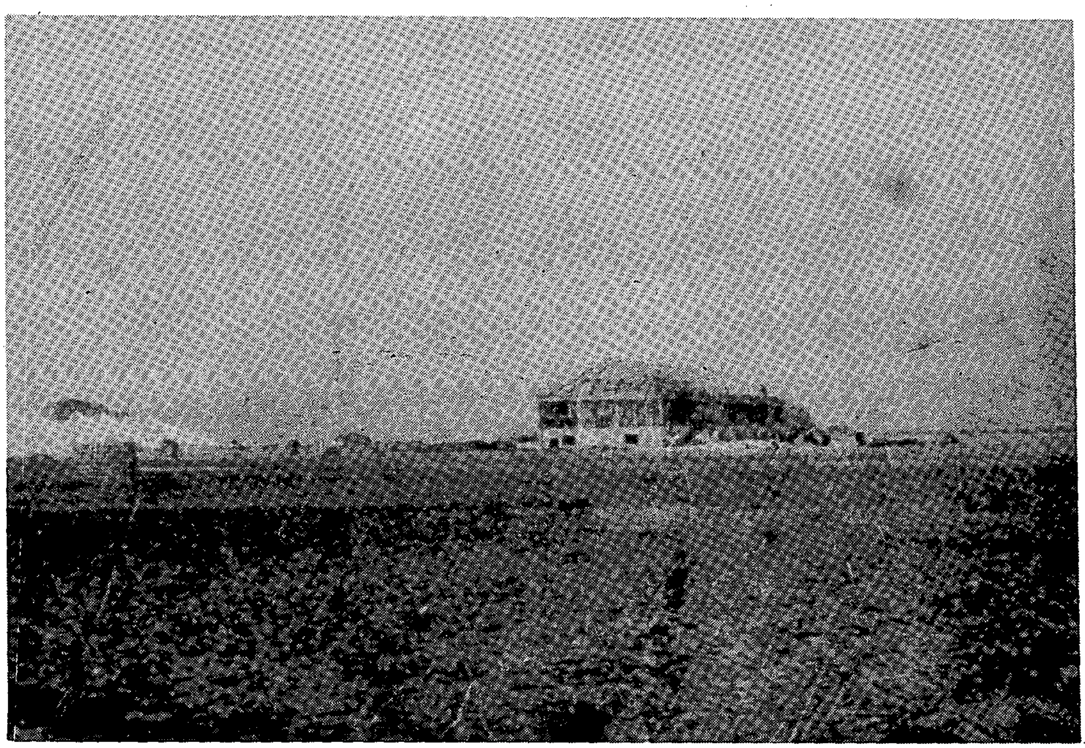


Assemblage-upper plant



St. ucture-upper plant





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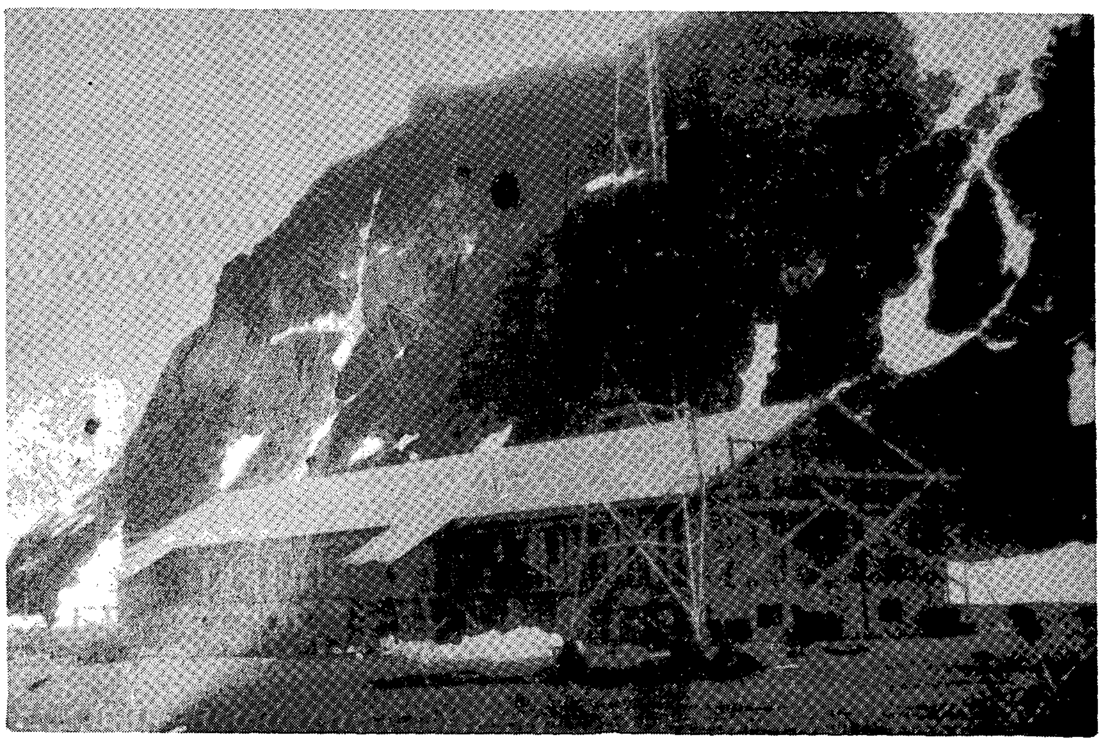
Construction of outer roof



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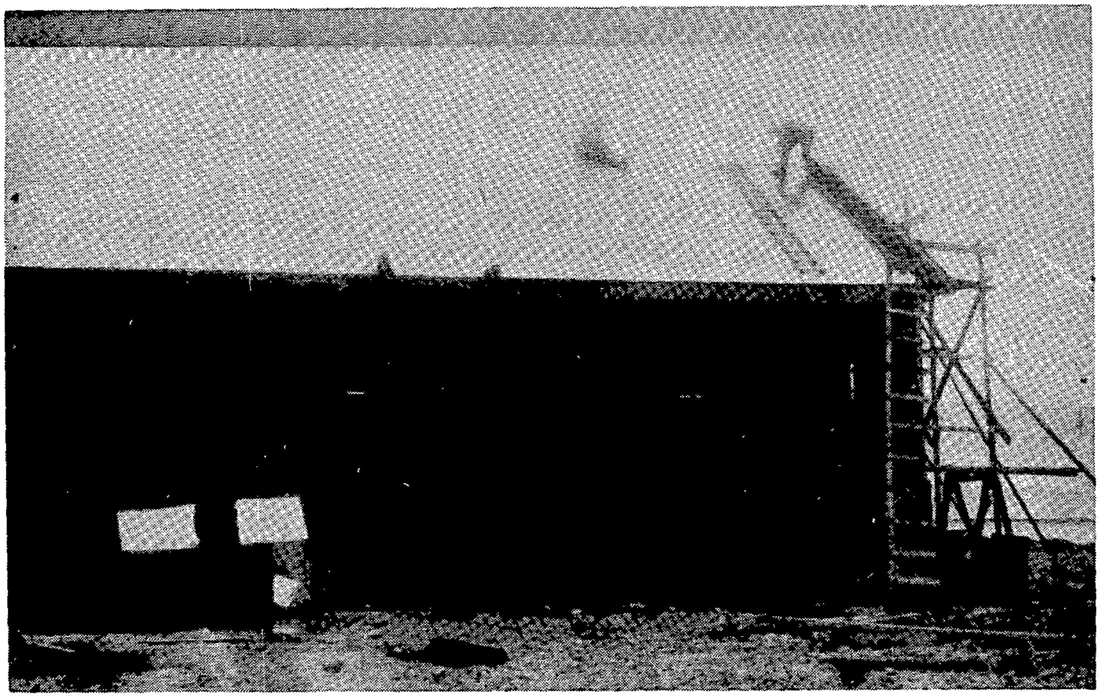

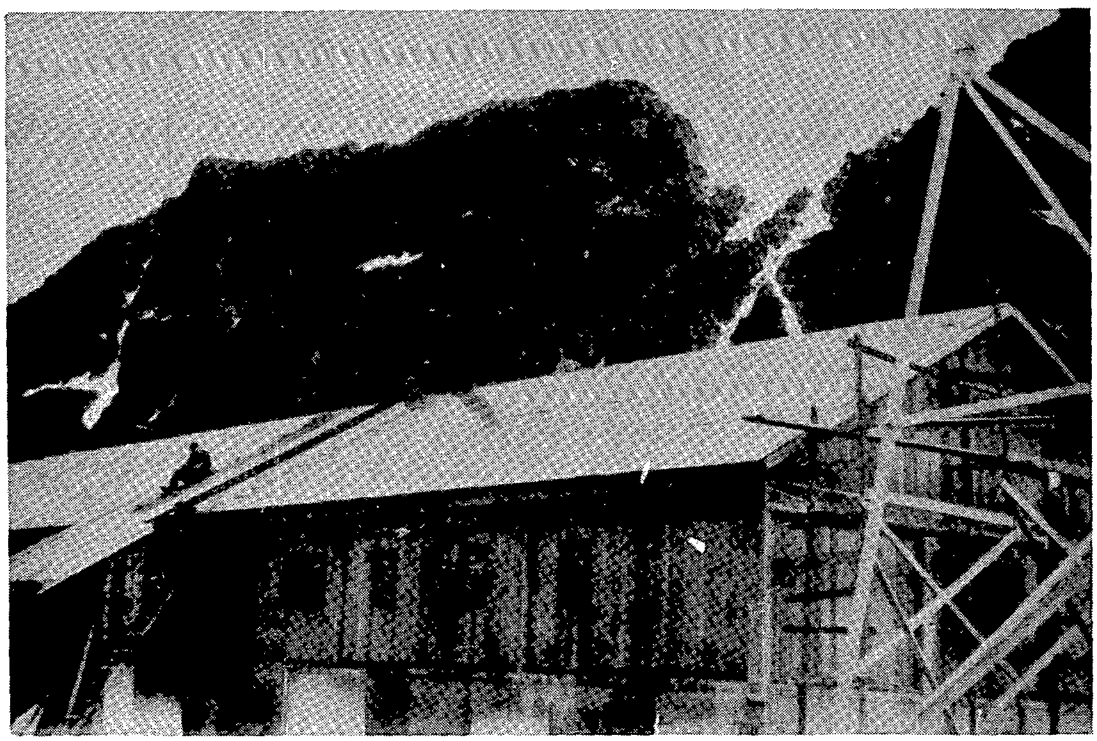

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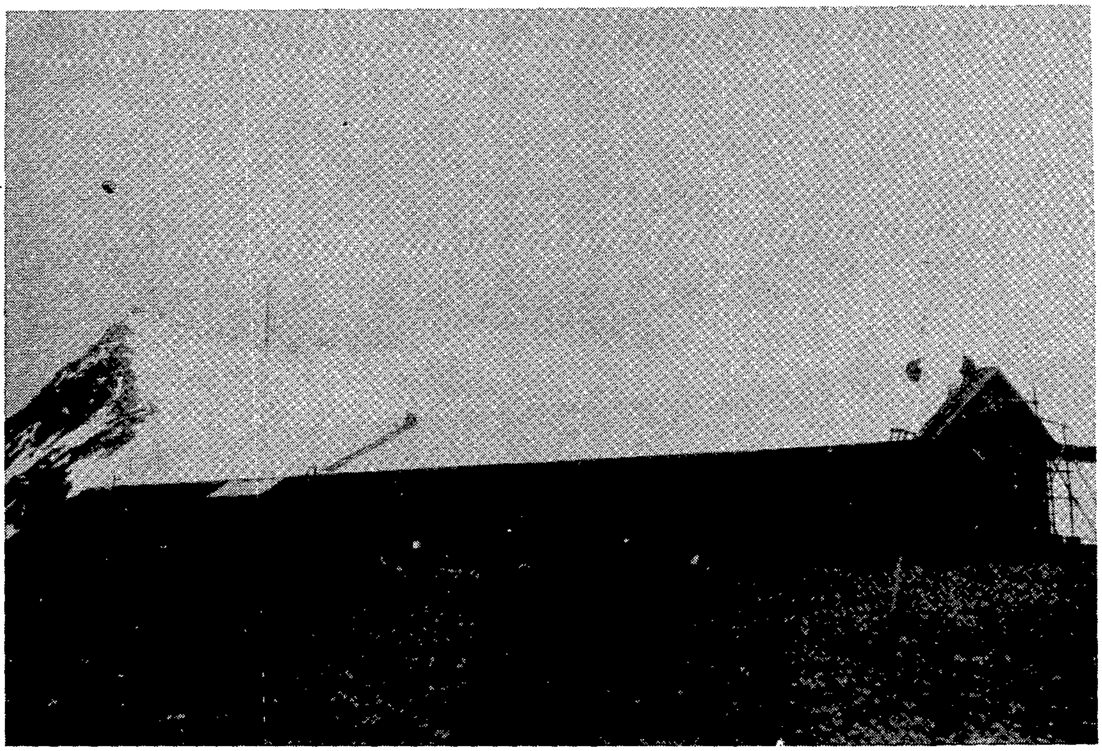
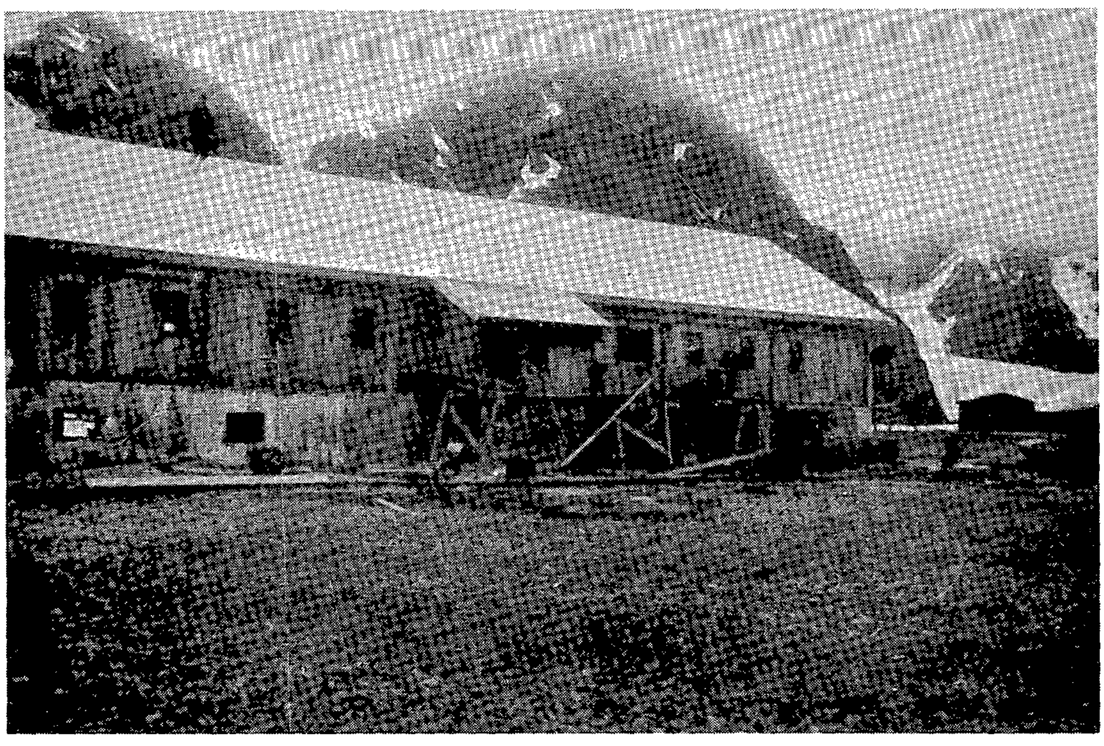
Lateral view of upper plant





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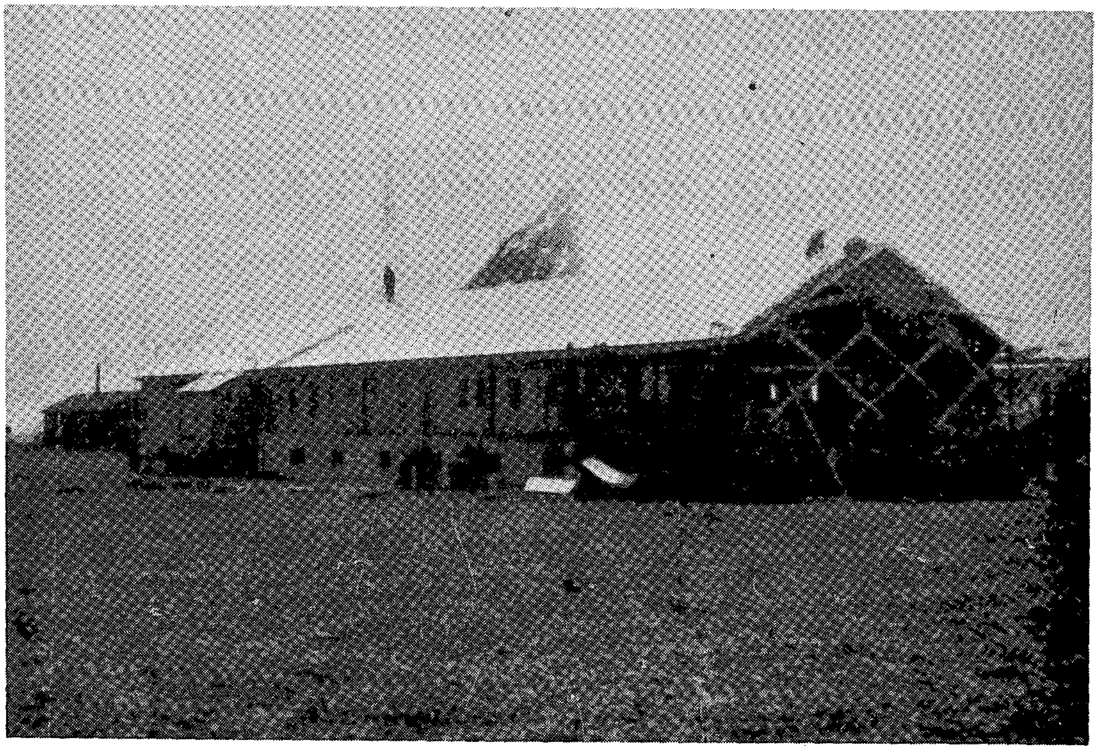
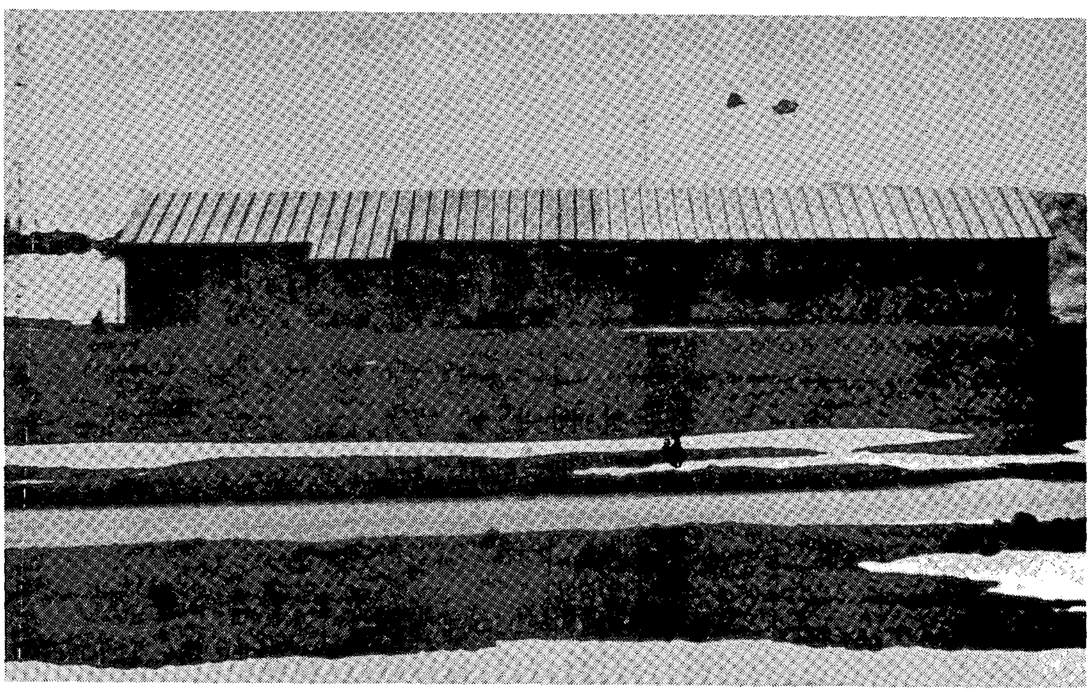
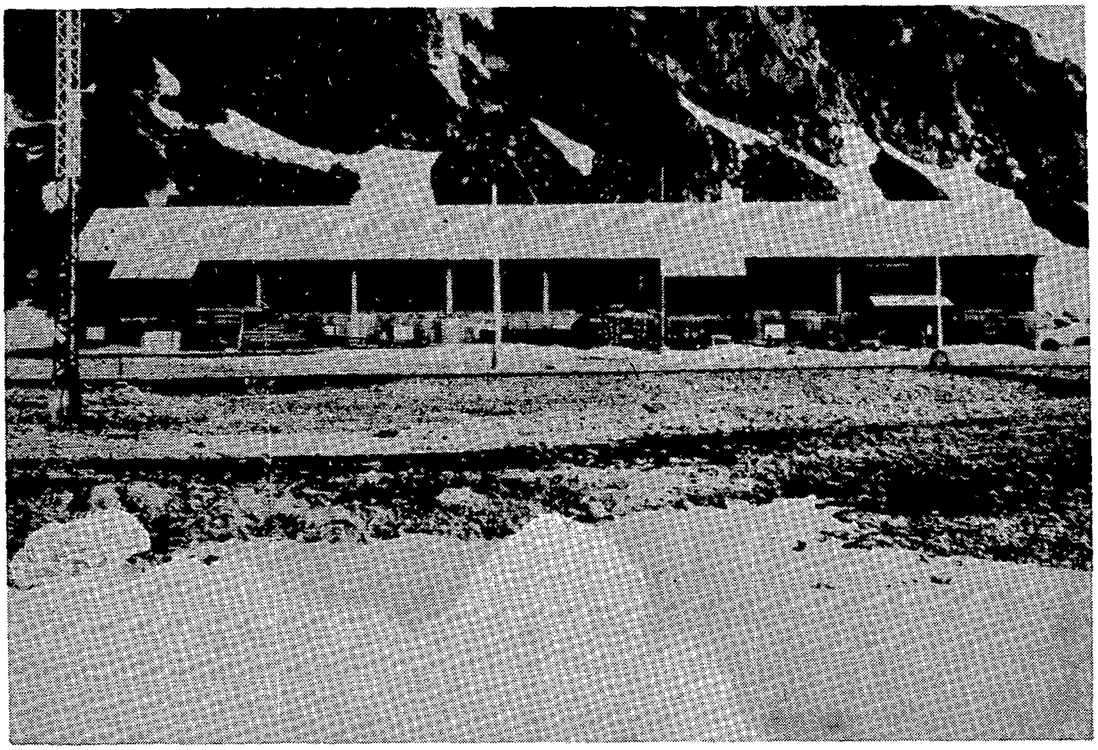
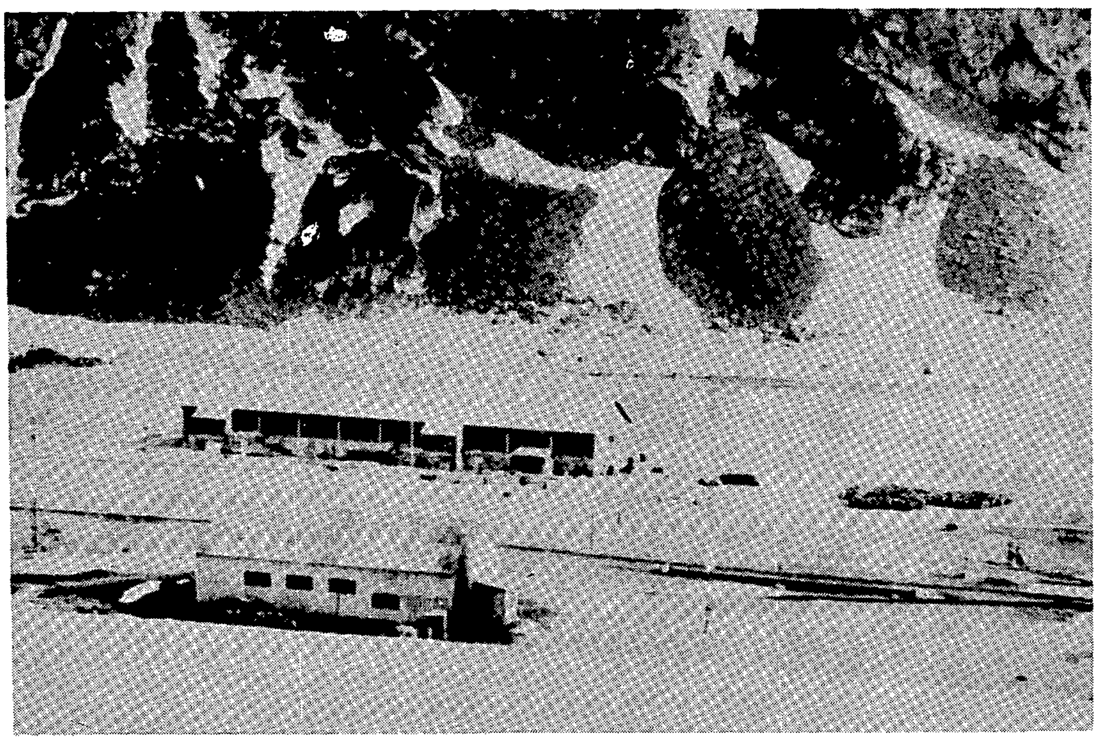




General view of structure





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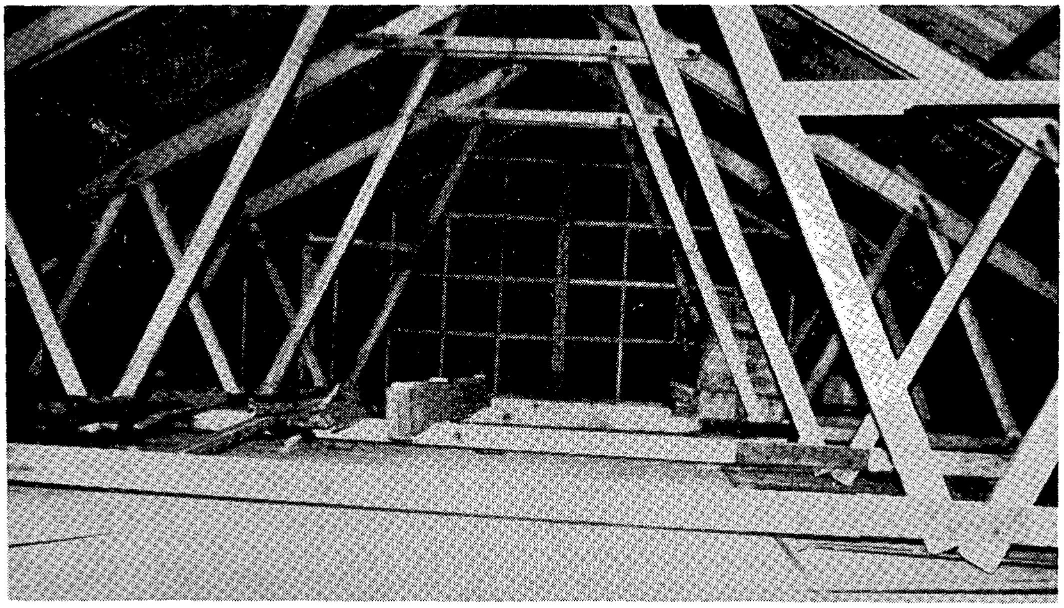
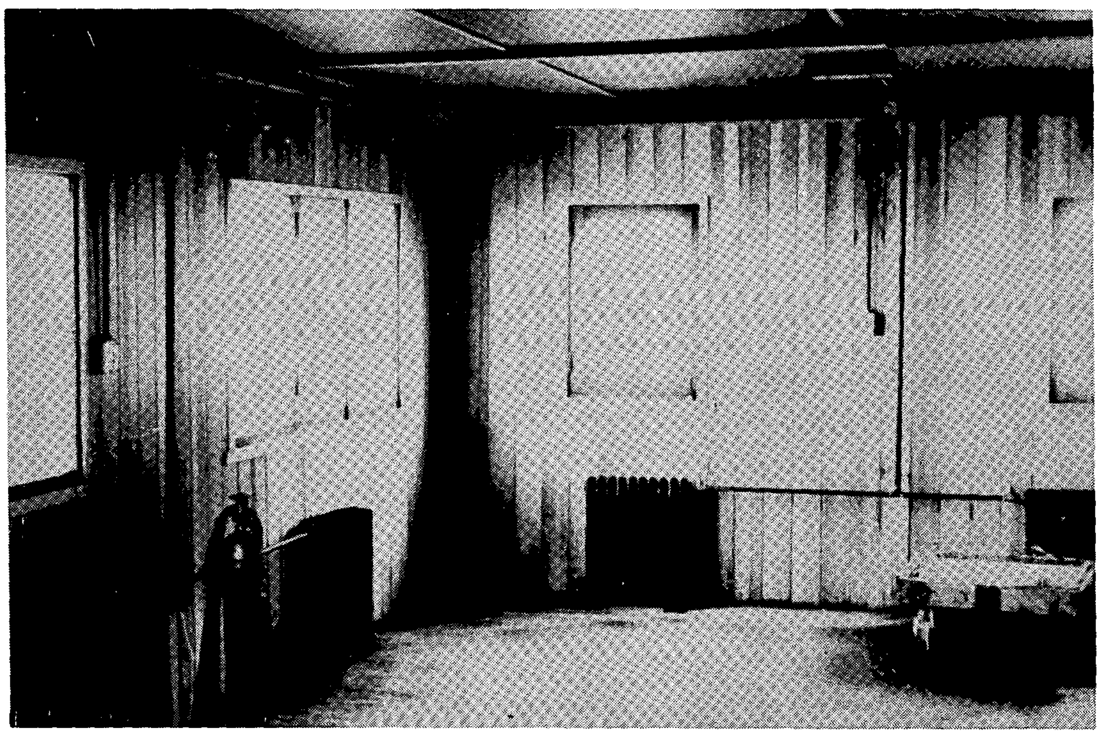
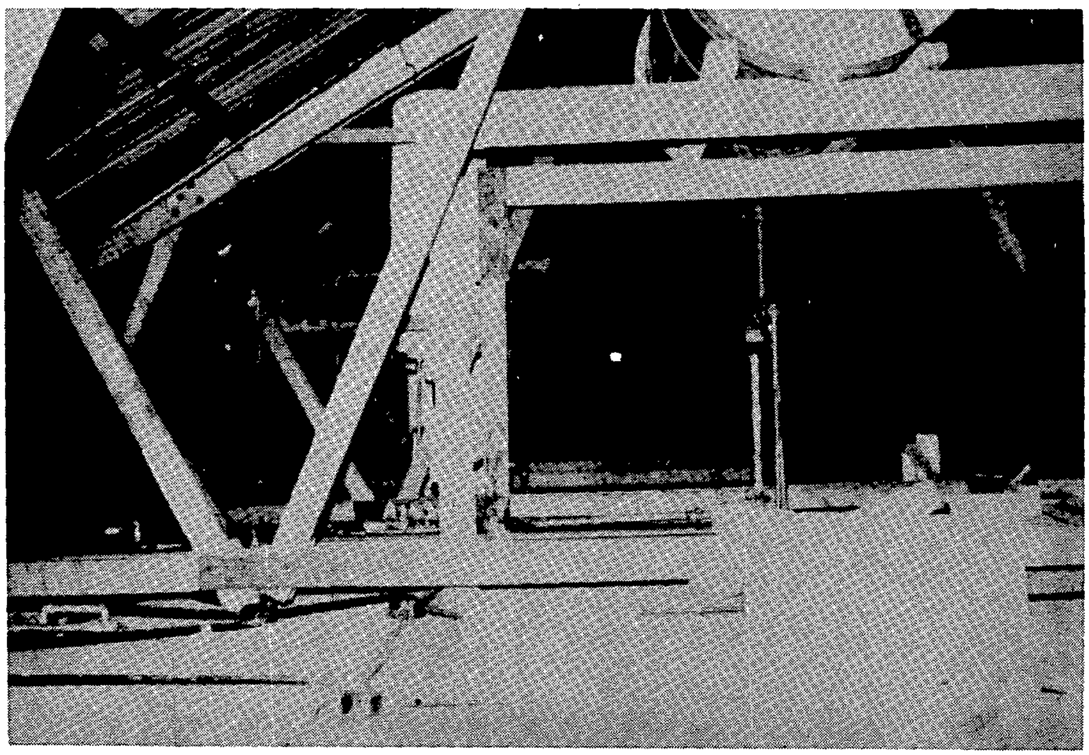


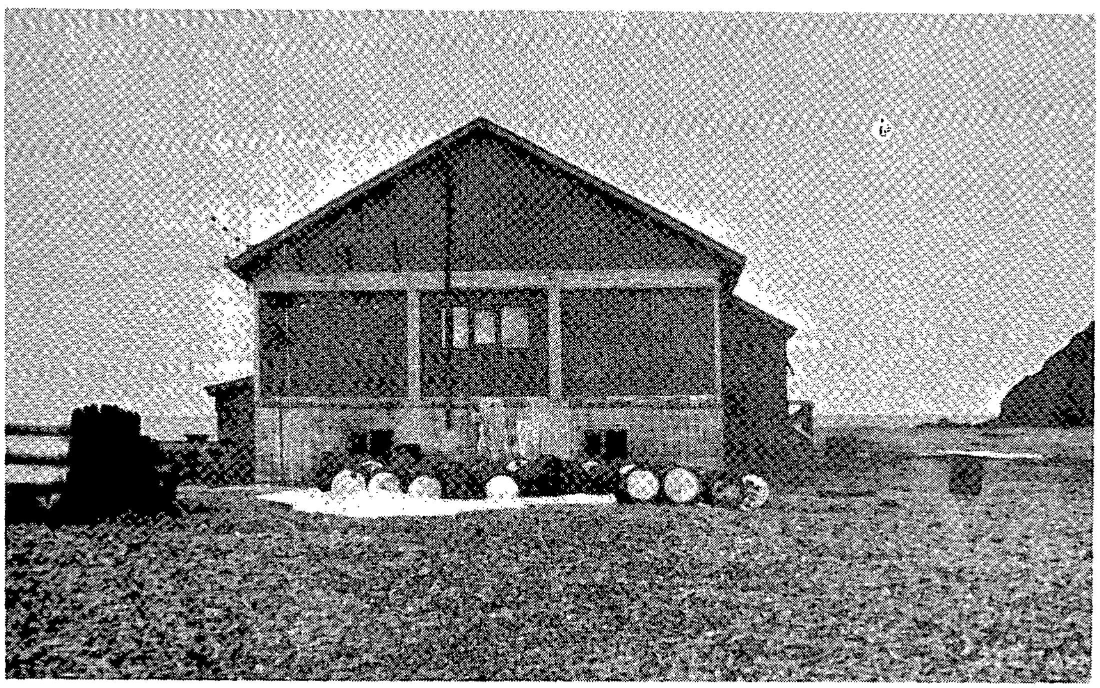
Garret



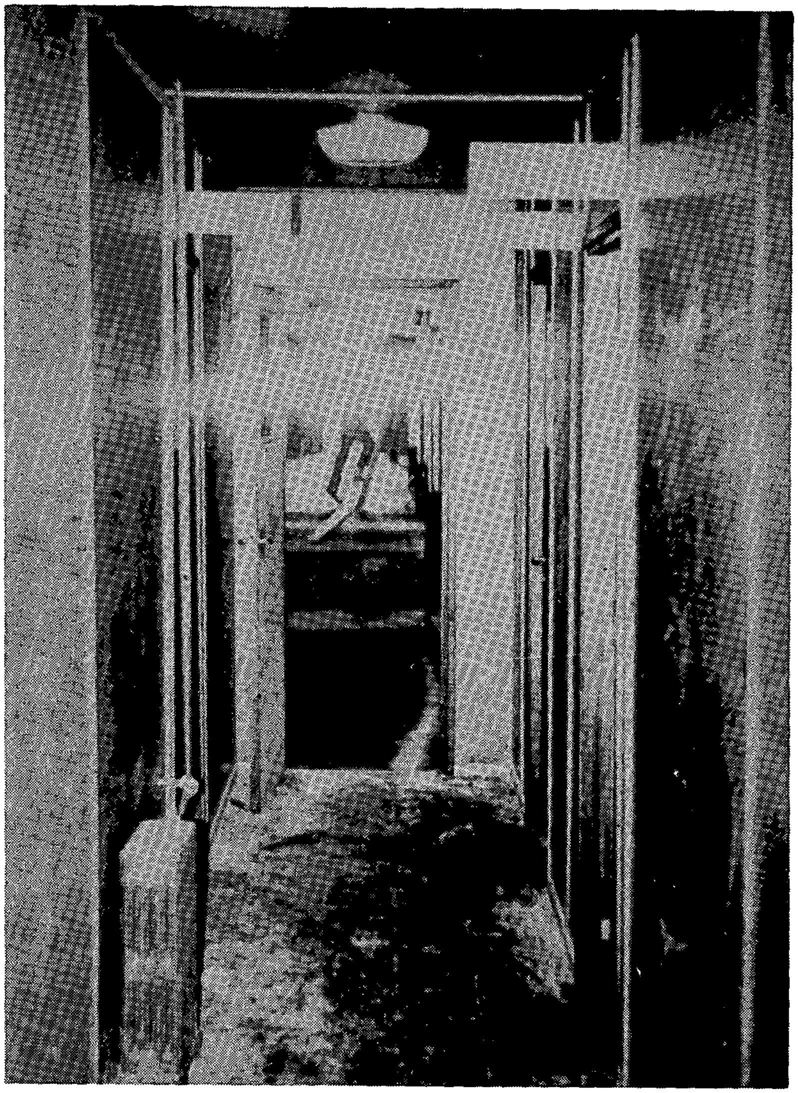
Chamber for Petty Officers



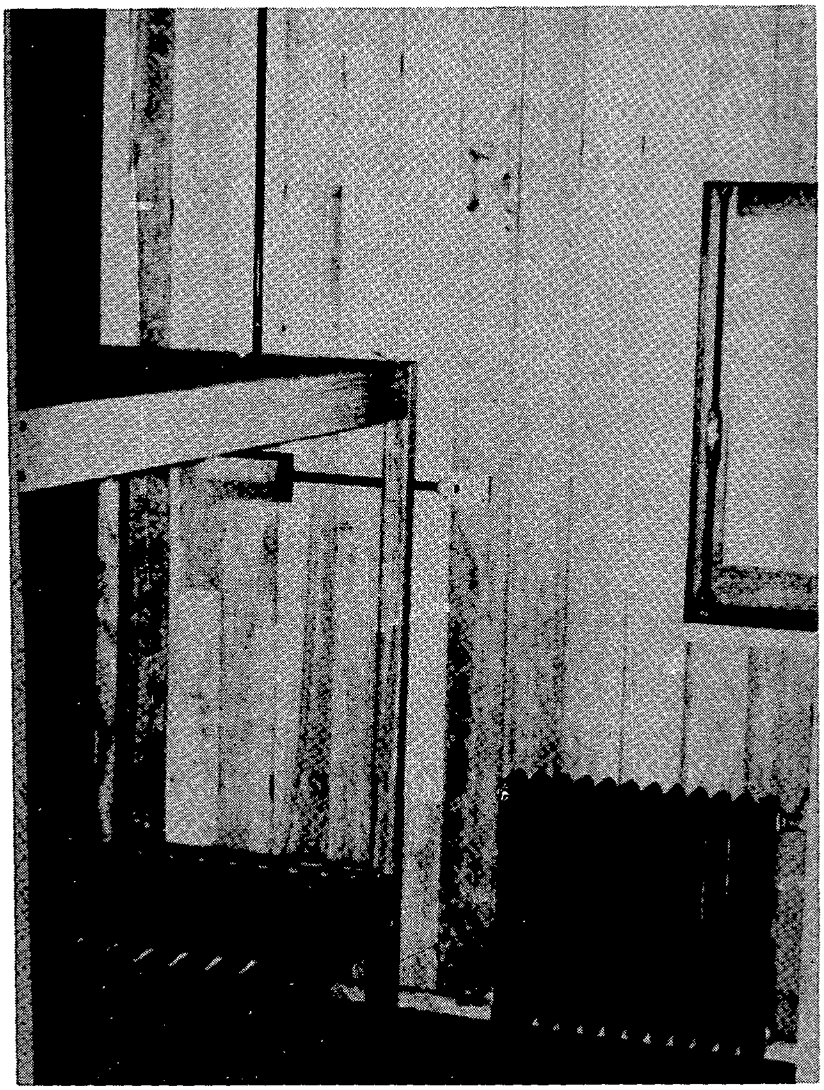
Garret



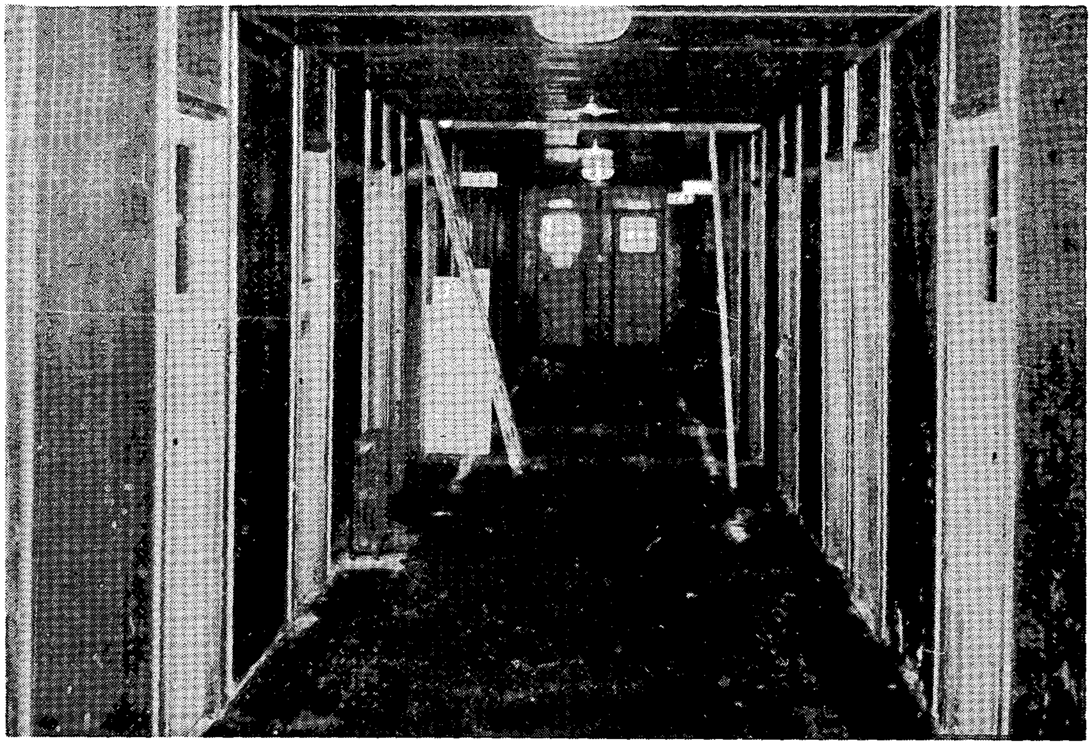
Lateral view of structure



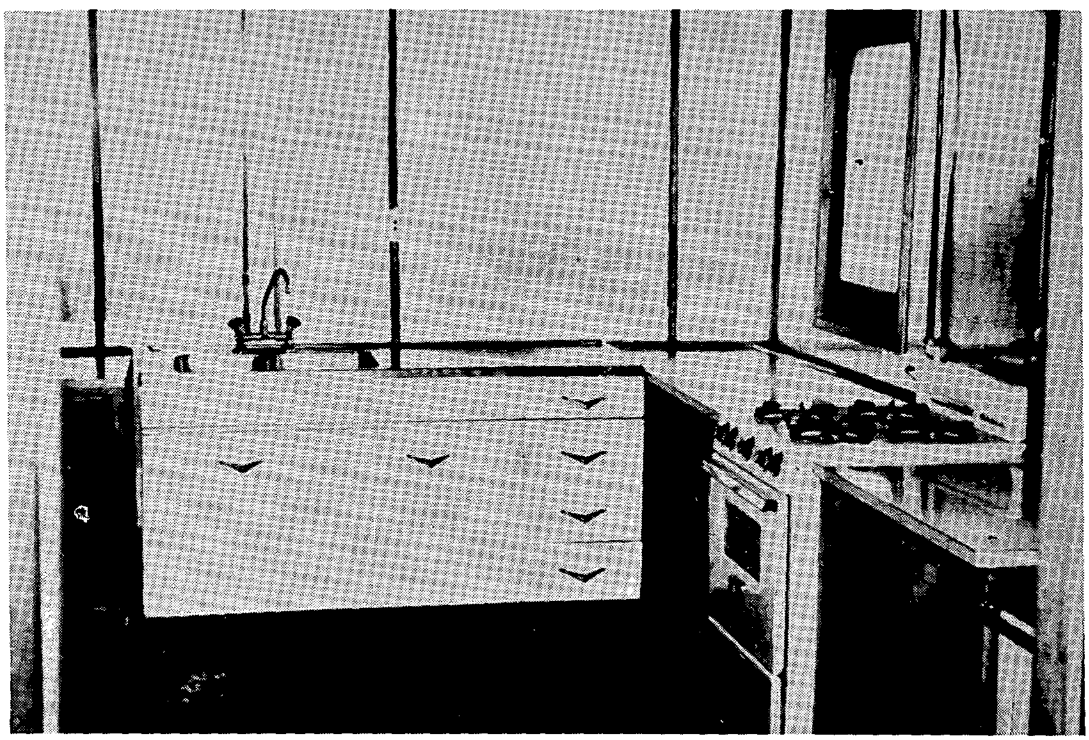
Corridor Nr. 2



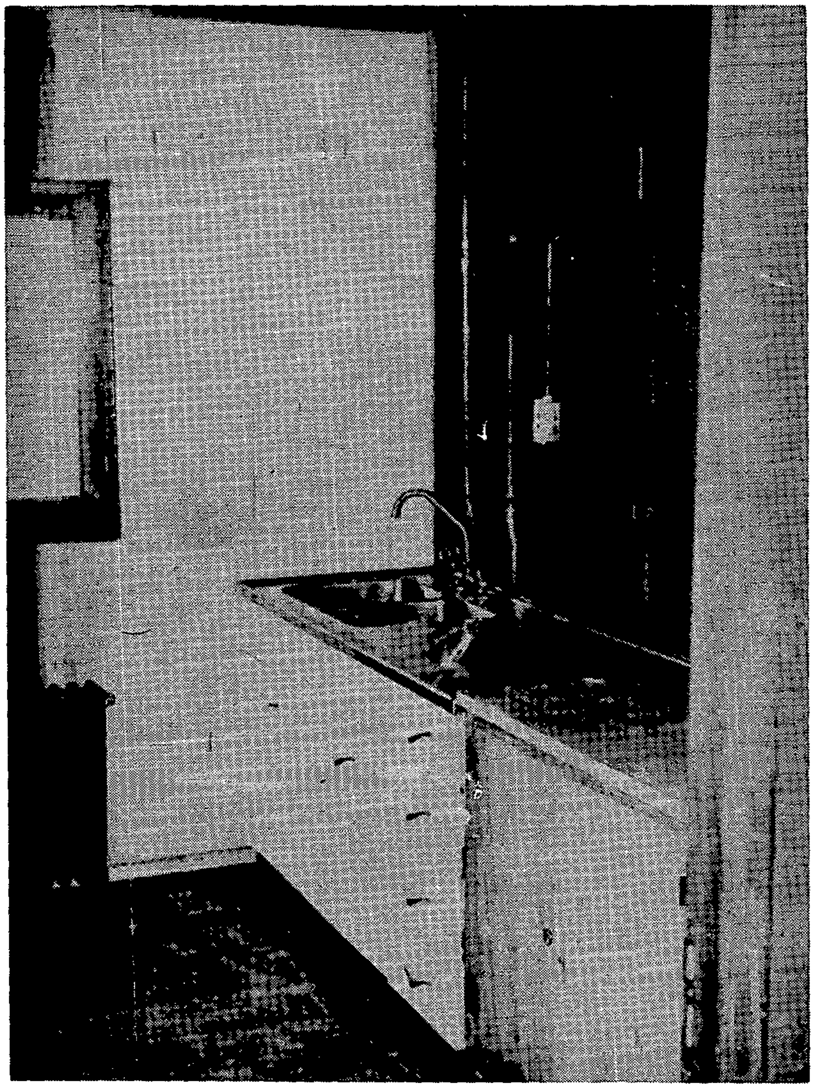
Cabin



Corridor Nr. 1



Kitchen



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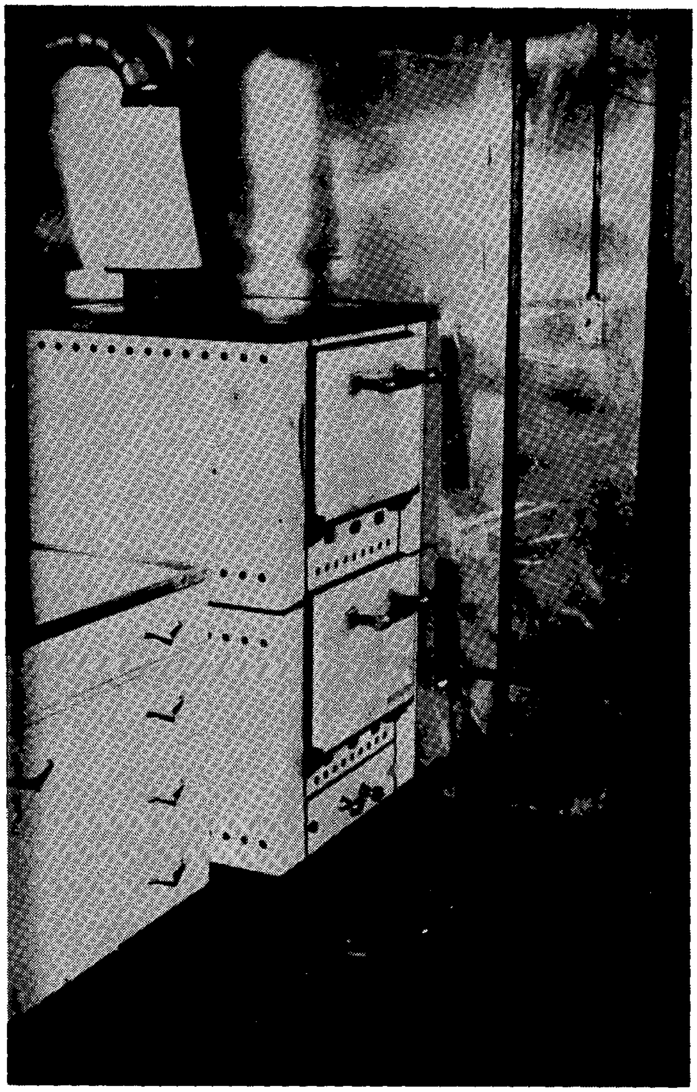

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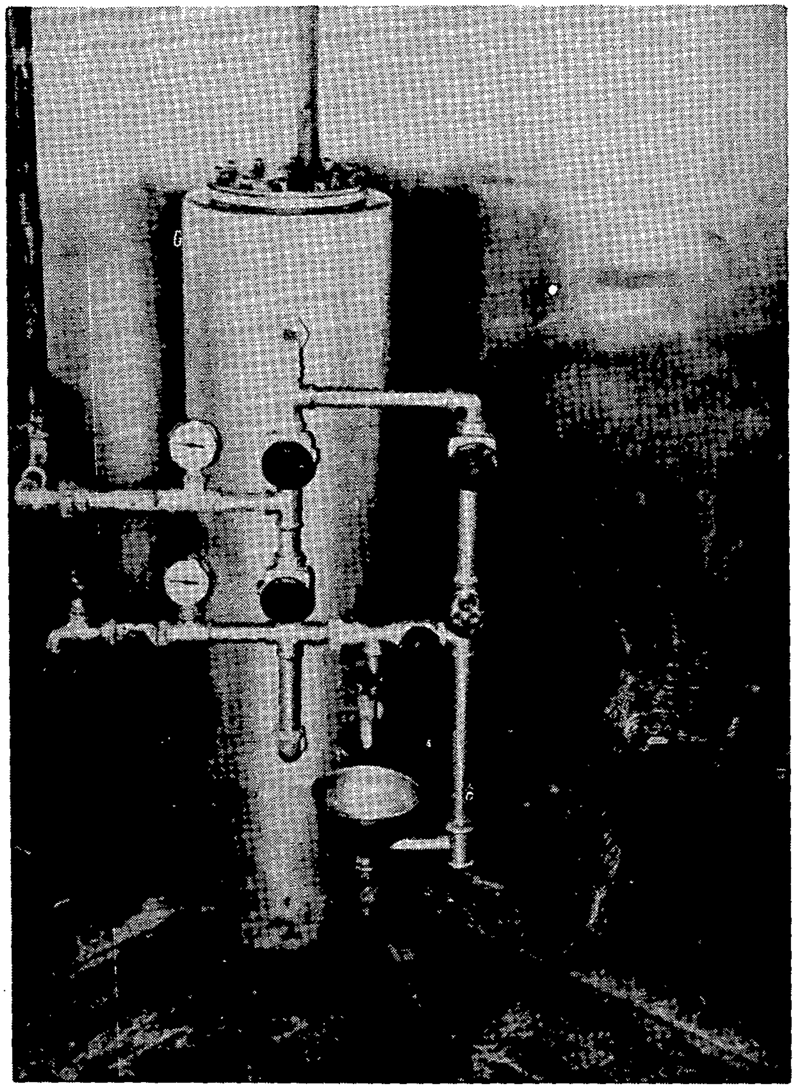
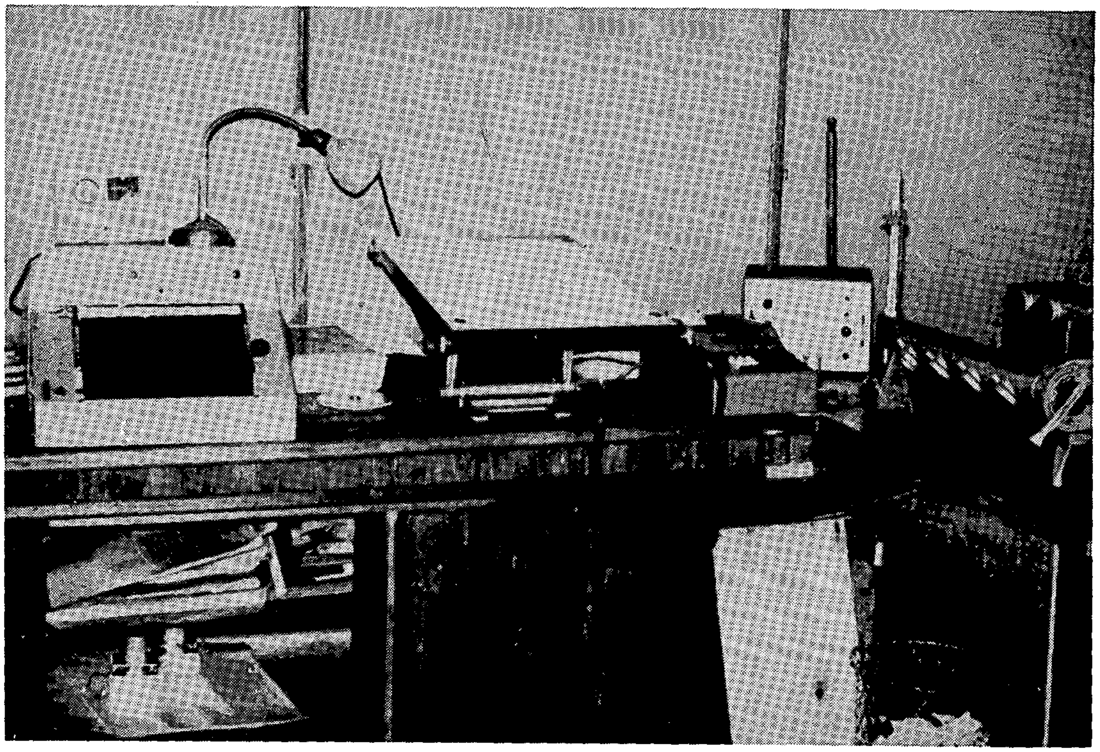
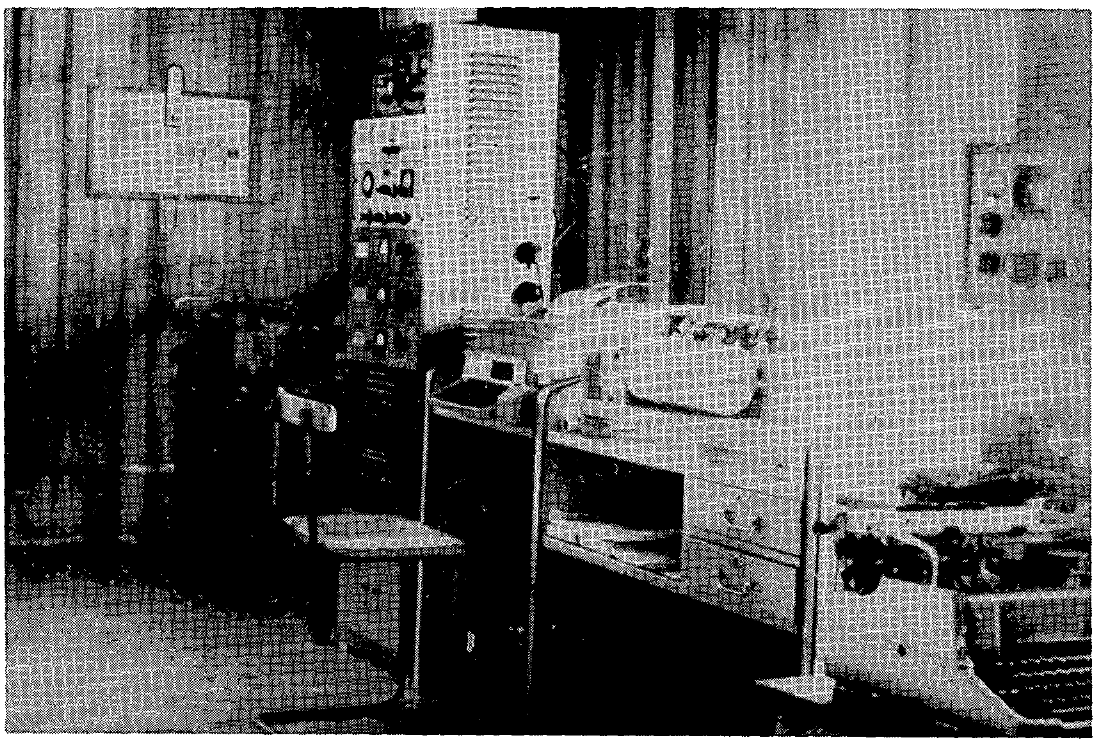
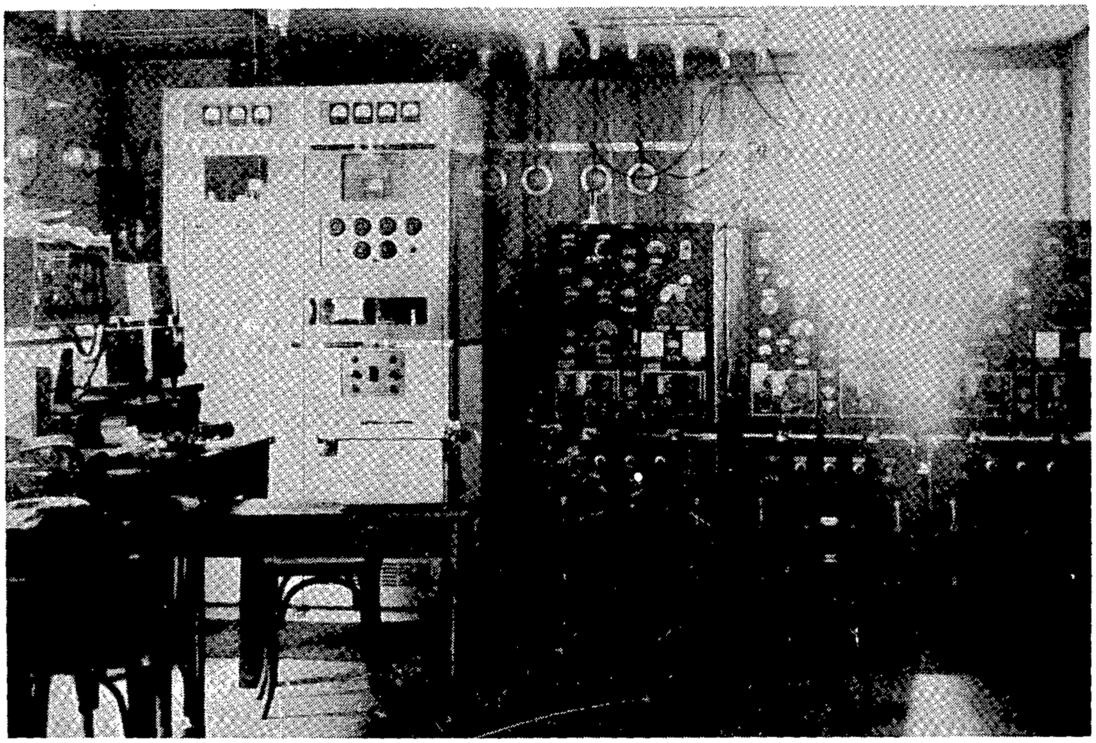


Water filter

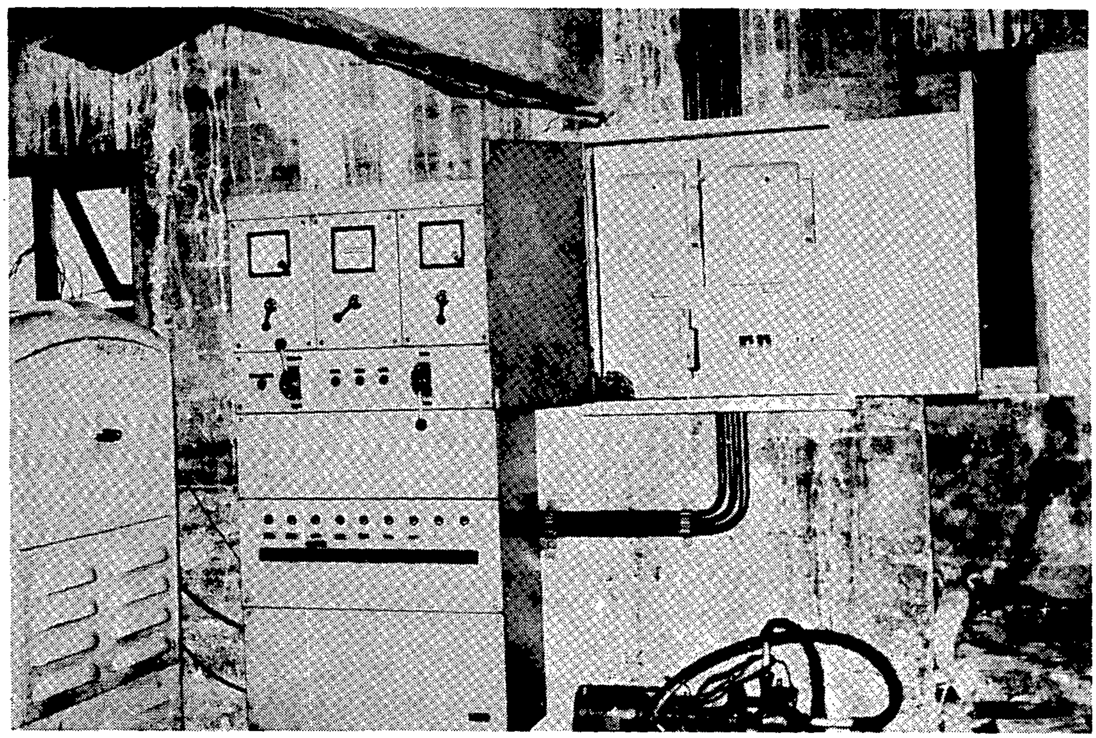




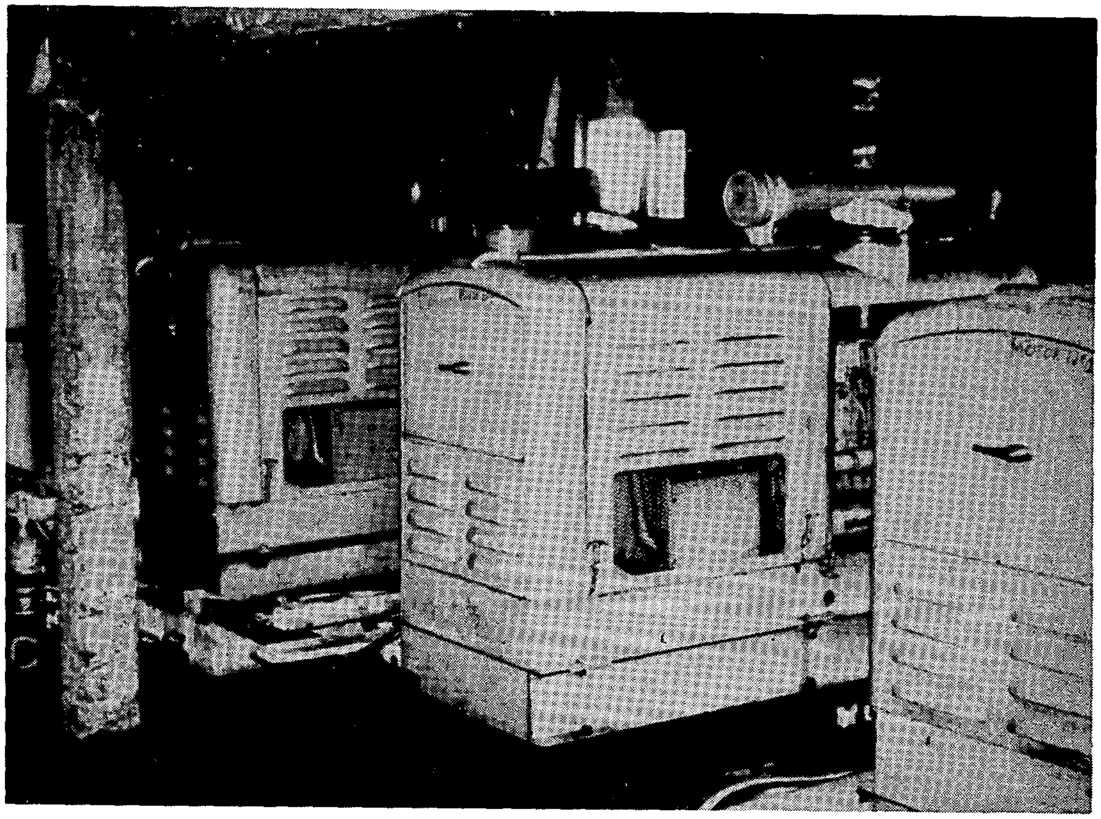
Meteorological Office



Radio cabinet



Electric distribution panel



Electric generators

DISMOUNTABLE ANTARTIC REFUGE TRANSPORTABLE BY AIR

Manrique Jose Duran and Personnel of Antarctic Division, Argentina

Summary

Detailed construction characteristics of a Hut to be installed on distant and isolated zones, made so that all his elements can be loaded on DHC-2 beaver type airplane.

The panels are modulated to let the but be erected in the required dimensions, up to a maximum of 8 men. The heaviest item weights not more than 100 Kgms.

Also technical construction details, refered specially to the fitting of the panels, that make it completely hermeticm are shown on drawings.

Mobile Refuge Adopted for the Antarctic Zone

For the antarctic campaign 1967/68, the Air Force ordered the construction of refuges capable of being transported by aircraft DHC-2 "Beaver" type, capable of meeting all the necessary security conditions and having the minimum comfort characteristics necessary for groups of up to four men to occupy them for long periods of time.

1. Project date

a) The pre-established areas for the installation allow the possibility of coping with hard ground (moraine type), ice or "firn".

b) The impossibility of counting with appropriate work instruments for the installation "in situ" must be considered.

c) The system must be developed with relation to the mounting and dismounting of the set, avoiding the fixing of its parts, which will only be jointed by means of set-screws.

d) Impossibility of counting with qualified bandwork in the rigging up.

e) Maximum possible reduction of the hours/man necessary for the installation.

f) Adaptation of the elements bearing in mind the fact that the handling will only be effected by hand and the transportation in aircraft DHC-2 "Beaver" type.

2. Technical Summary

Strong structure.

a) Wall boards.

b) Floor boards.

c) Roof boards.

The following were considered unfavourable conditions.

1°) RT (ground resistance) = negative for a concentrated load, it was only uniformly distributed considered.

2°) Wind pressure, approximately 250 Kg/m^2.

3°) Over the roof surface, a uniformly distributed load equal to 0.50 m of snow.

Strong Structure

Due to its physical-technical qualities, first class cedar from Misiones was adopted. It was even put through a waterproof process of industrial kind. Mortise-and-tenon joint was used, and where this was not feasible, halved joint,

Identification

Identification is generalized in the following way.

a) Corner boards floor
roof

b) Center boards floor
roof

c) Partition board, a1, a2, a3 type.

The mounting was effected by means of metal carpenter's squares and of set screws which prevent all possibilities of definite fixing.

Covering

a) Exterior: The covering of all partition walls was effected with first-class, 1.2 mm thick aluminum sheets attached to the panel by means of galvanized machine screws to prevent corrosion.

b) Interior: Wood of a quite soft type (northern pine) was used because of its technical qualities and its easy maintenance and it was processed with fire proof type painting.

c) Thermical Insulation: Due to their qualities in general the following were adopted.

- Expanded chloride polyvinyl "TERGOPOR".

- Air camera system.

- Ventilation: Ventilation tubes were used mixed with hand type regulation.

- Lighting: Within the strong structure and in order not to modify its shape, small portions of plastic transparent sheets by way of double wall were fitted.

- Typing straps and accessories. The typing was effected by means of four steel tighteners of high tractive resistance with provisions for different types of anchoring (ice or rock) and their respective regulators.

3. Mounting

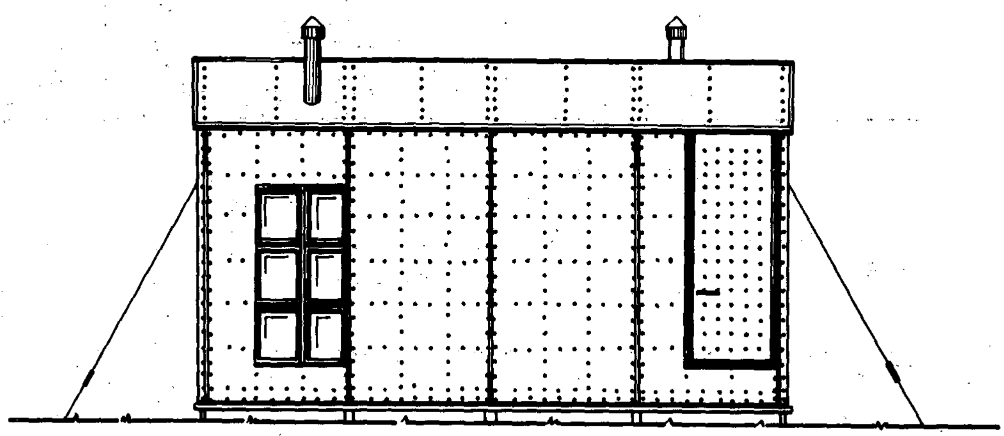
1º) Disposition and joining of the floor boards.

2º) Once this is done, an inferior sill is fixed, which will serve as link between the partition boards and the floor boards. Then the lateral partition boards are placed, sliding wedges in their joints which will keep them tight. In the superior part of the partition walls a superior sill will act as linking element. This sill is composed of an iron 0.50 x 0.6 mm slab. The truss sets and the sides of the brackets rest on the sill, serving as a direct link between the superior partition wall sill and the inferiorpart of the truss-sets.

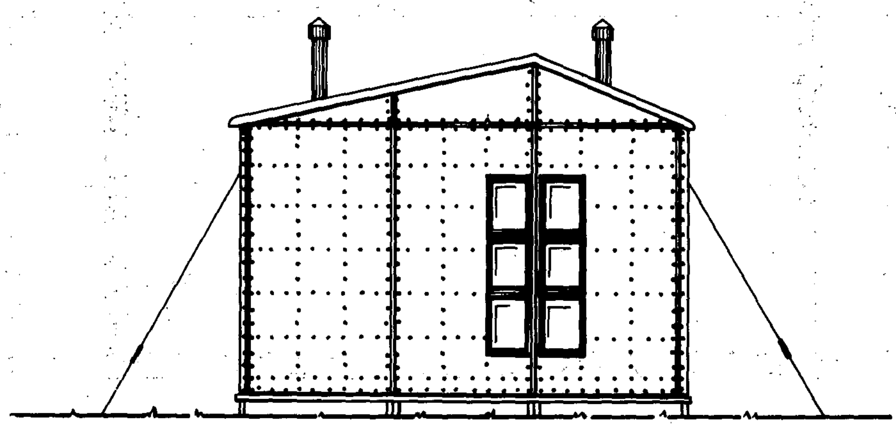
3º) Roof boards or panels. Once the superior sill of lateral boards is perimetrically closed, the roof boards are placed terminated by corner and center boards, which are joined to the truss sets by means of steel plates identical to those used in the joining of wall boards.

4º) By way of definite closure and sealing aluminum shaped mouldings were used.

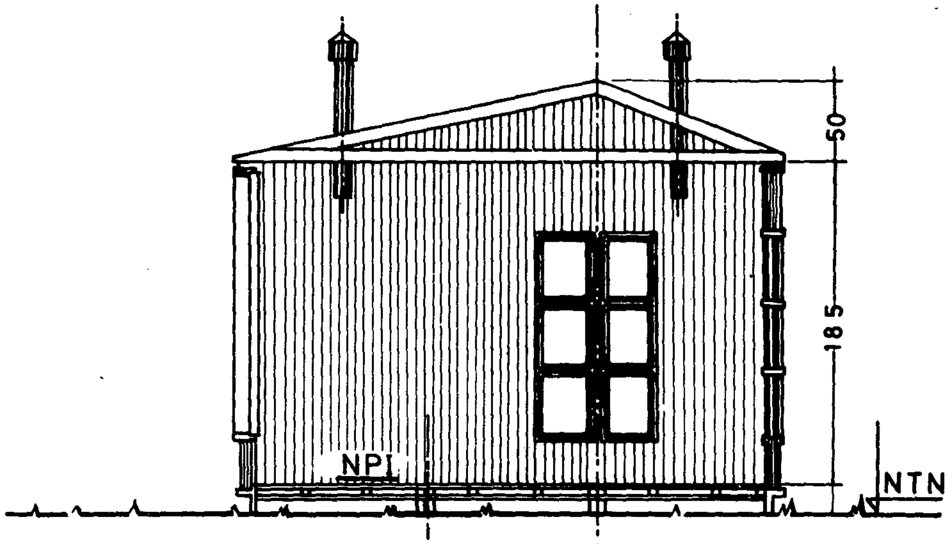
Once the mounting is finished the tightening of the tying straps must be effected by means of its complementary elements (stakes, cables and tighteners).



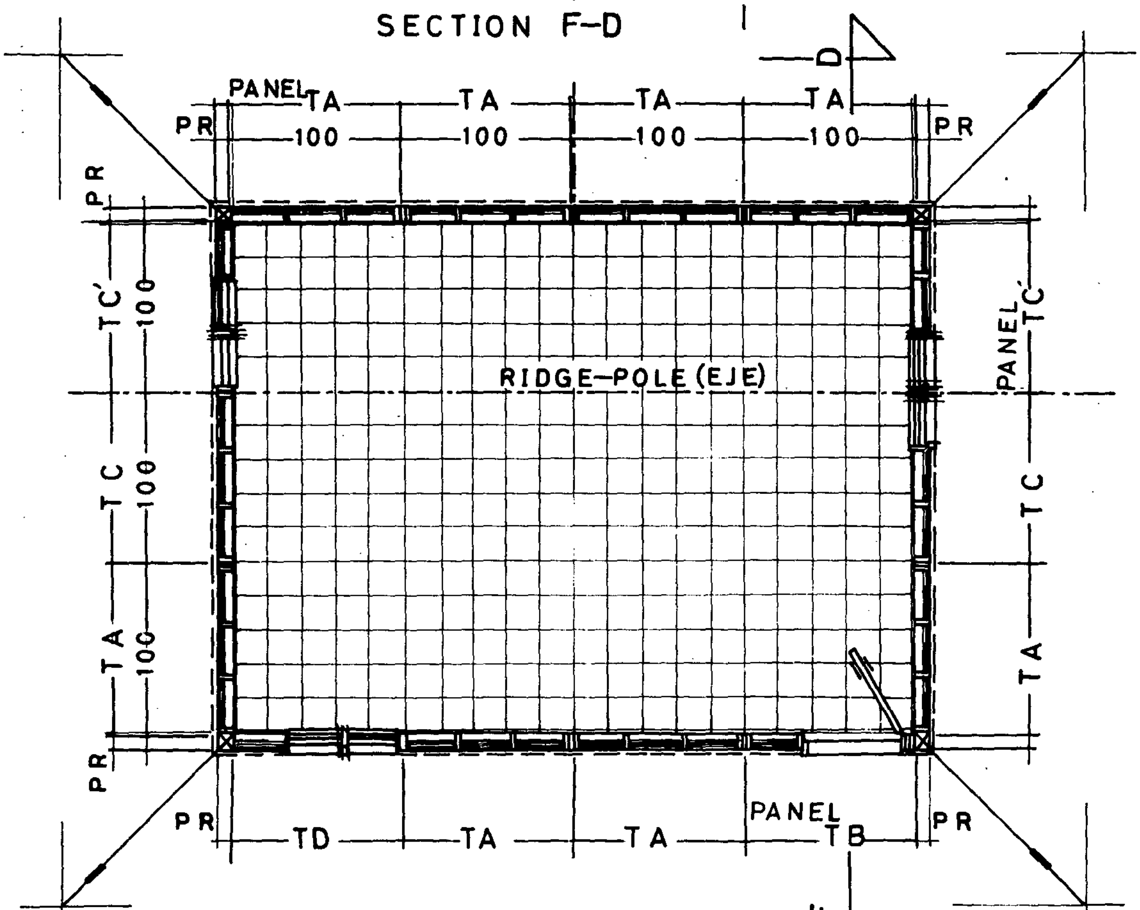
MAIN FACADE



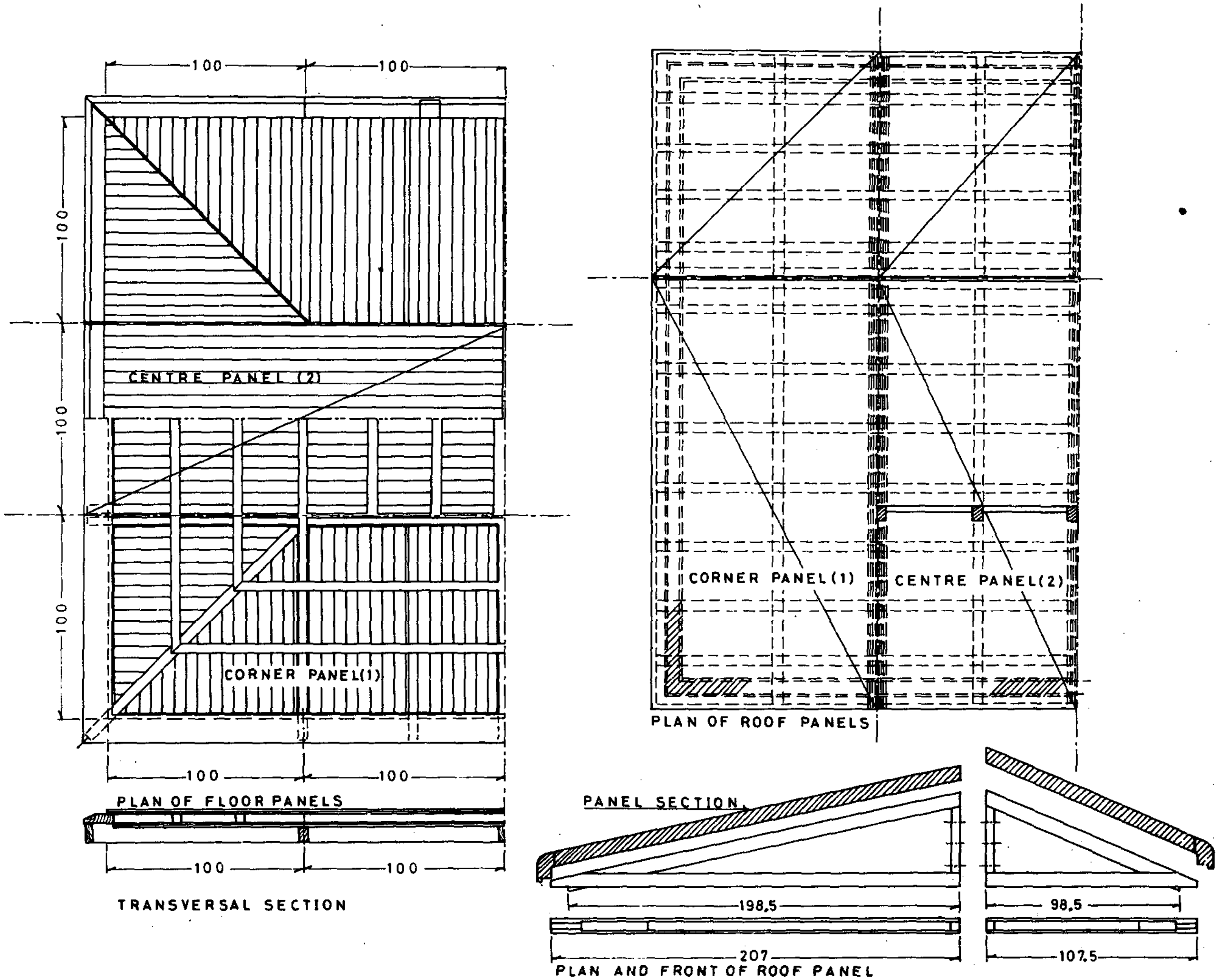
LATERAL FACADE



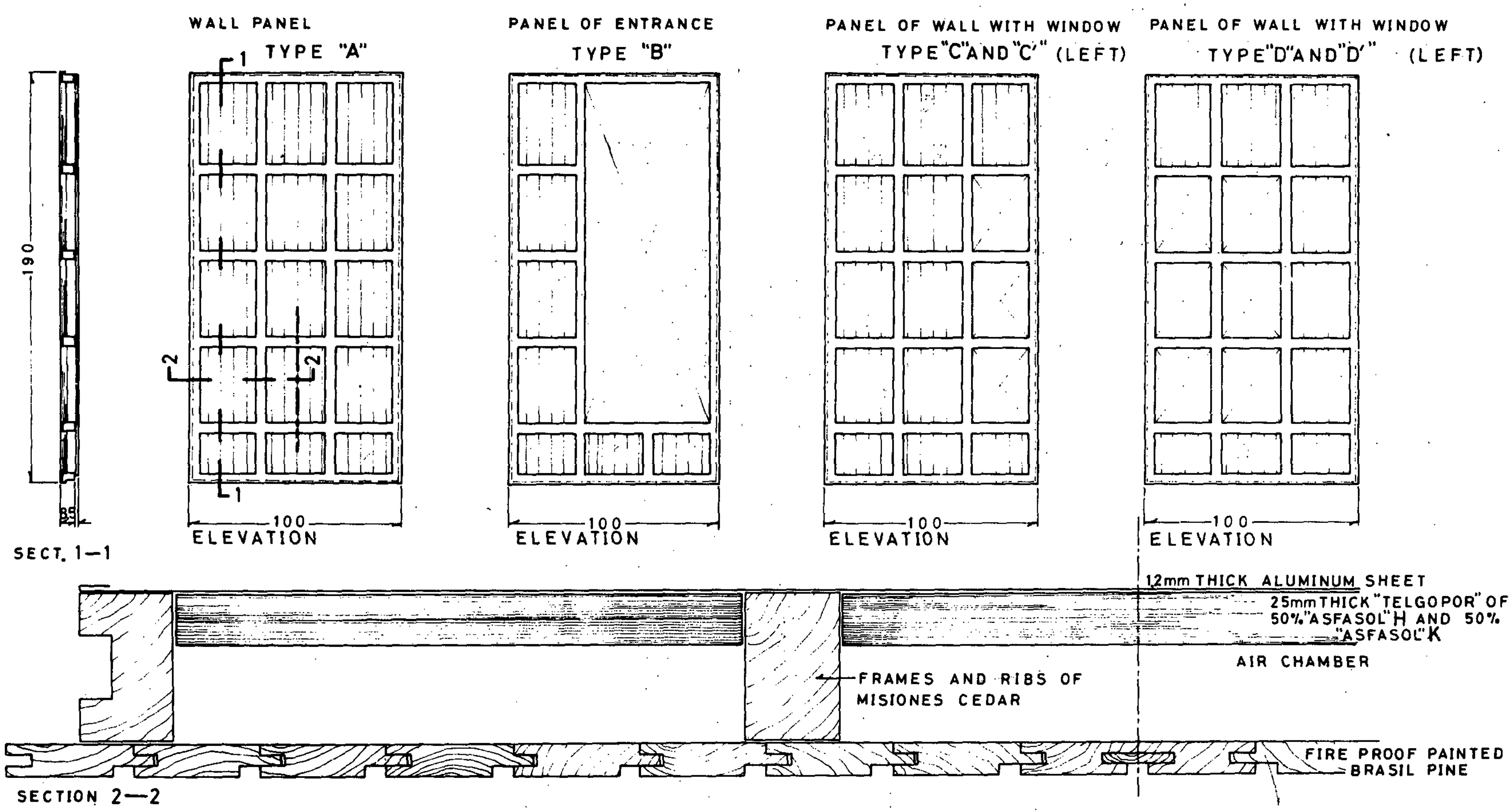
SECTION F–D



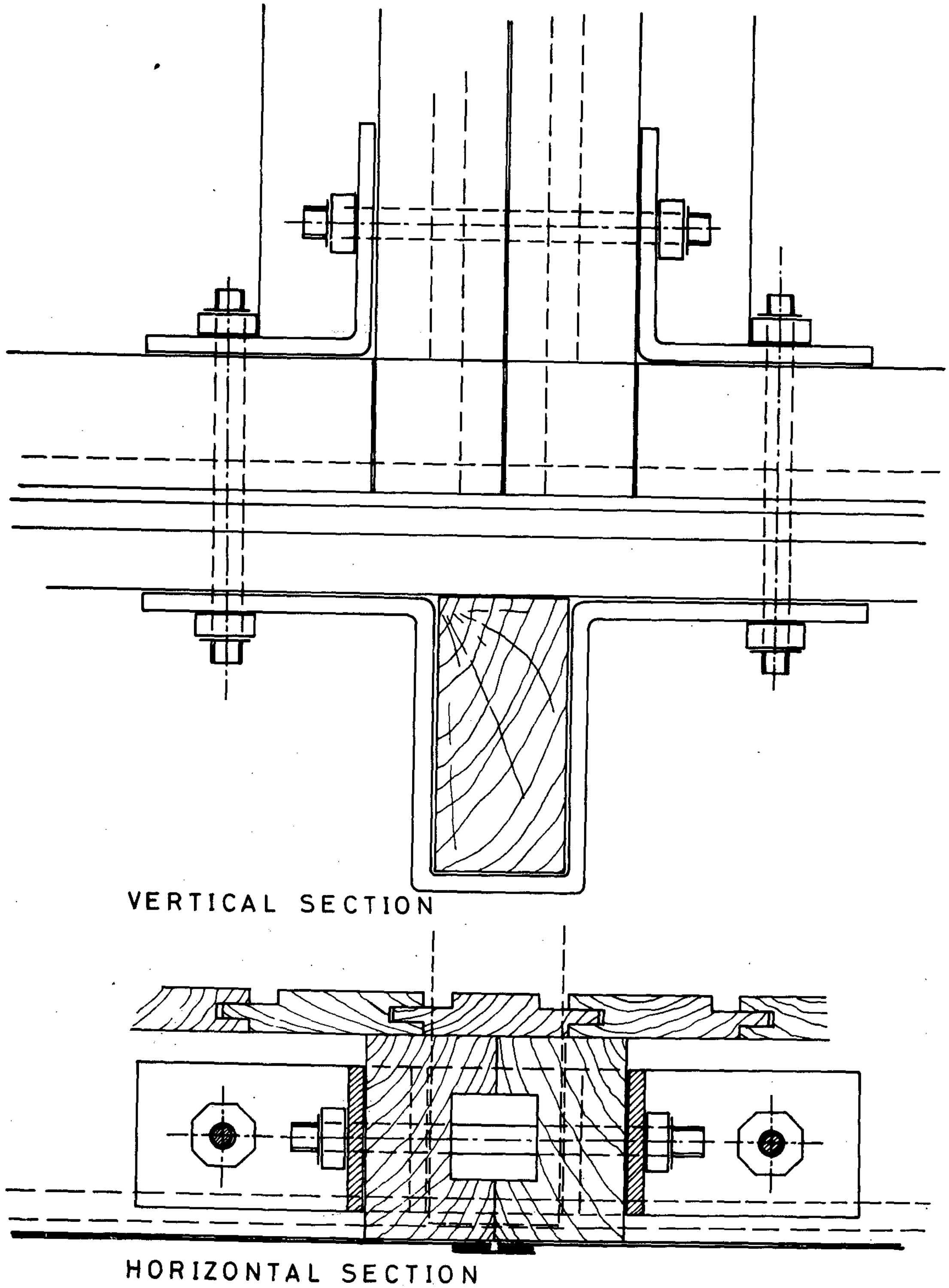
PLAN



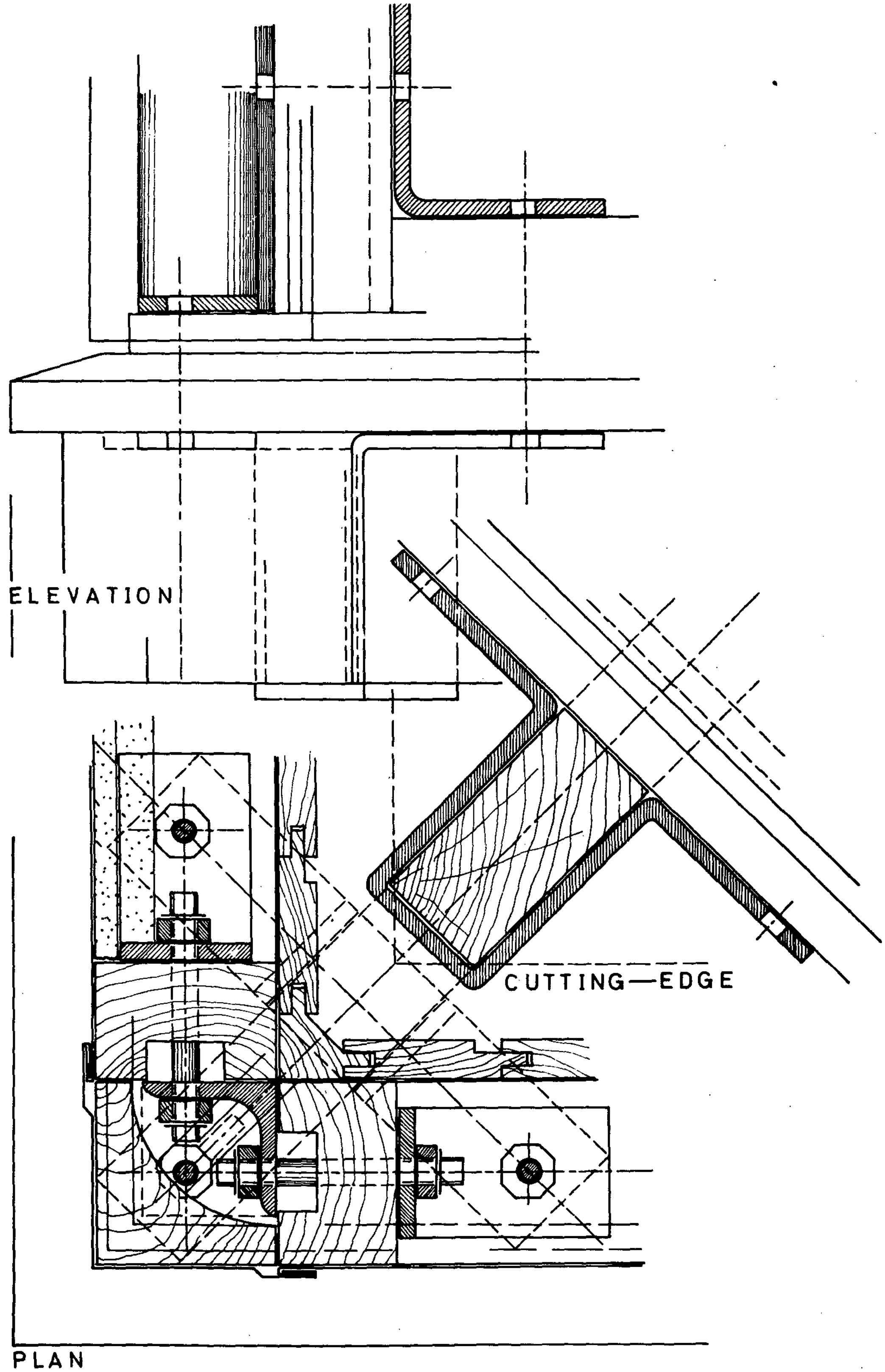
MODULACION OF FLOOR AND ROOF PANELS



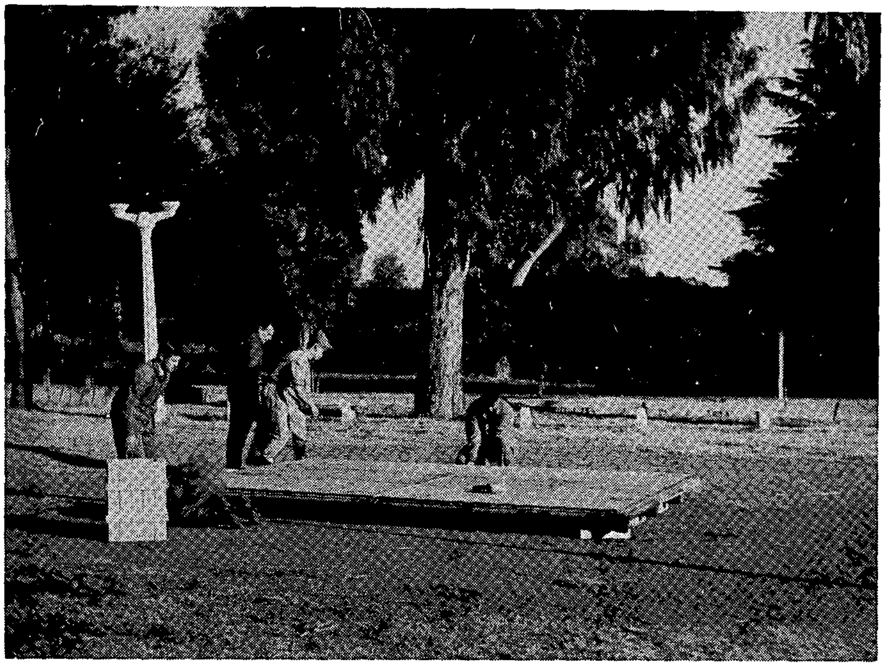
MODULATION OF WALL PANELS



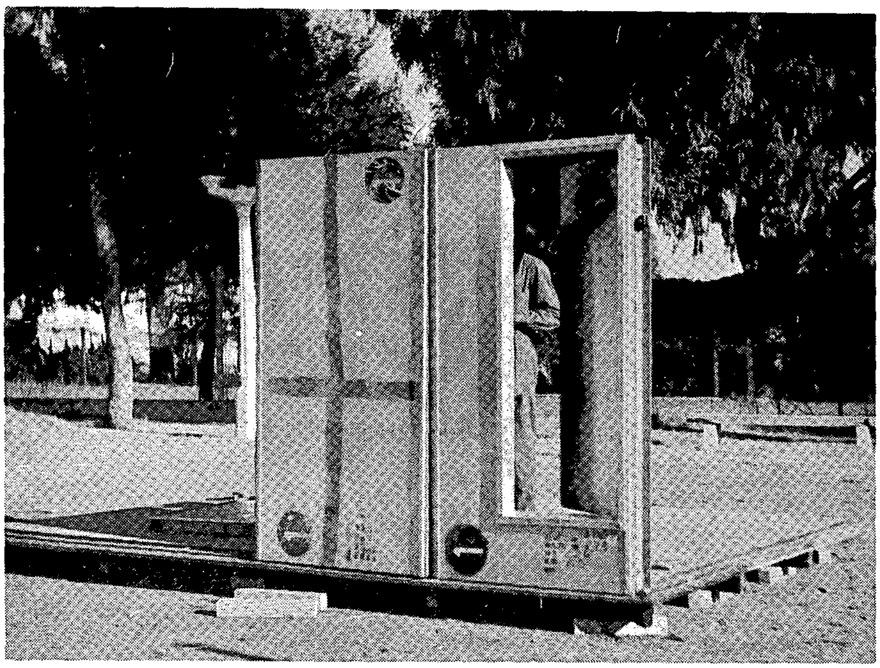
JOINT OF WALL PANELS



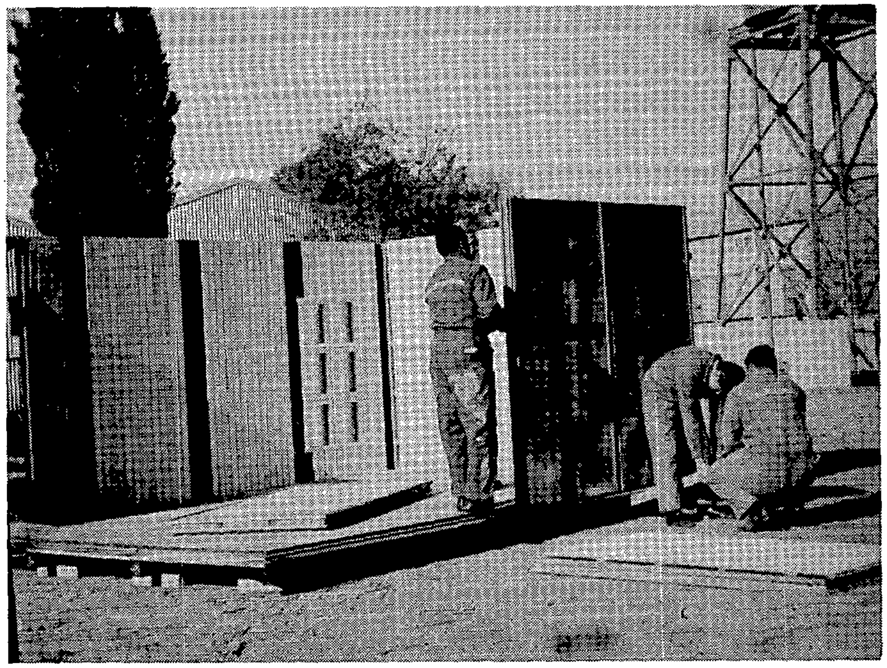
DETAILS OF CORNER

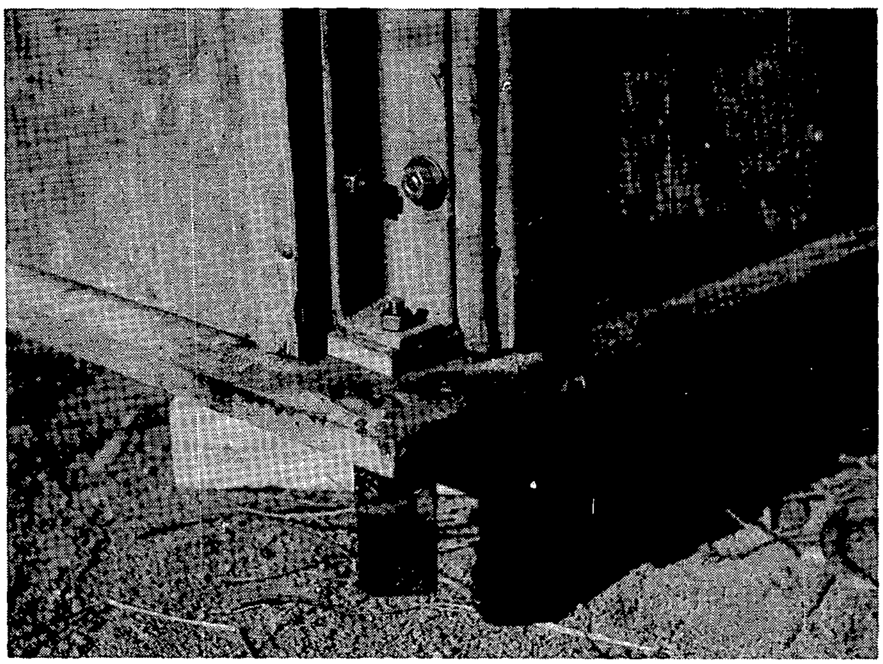


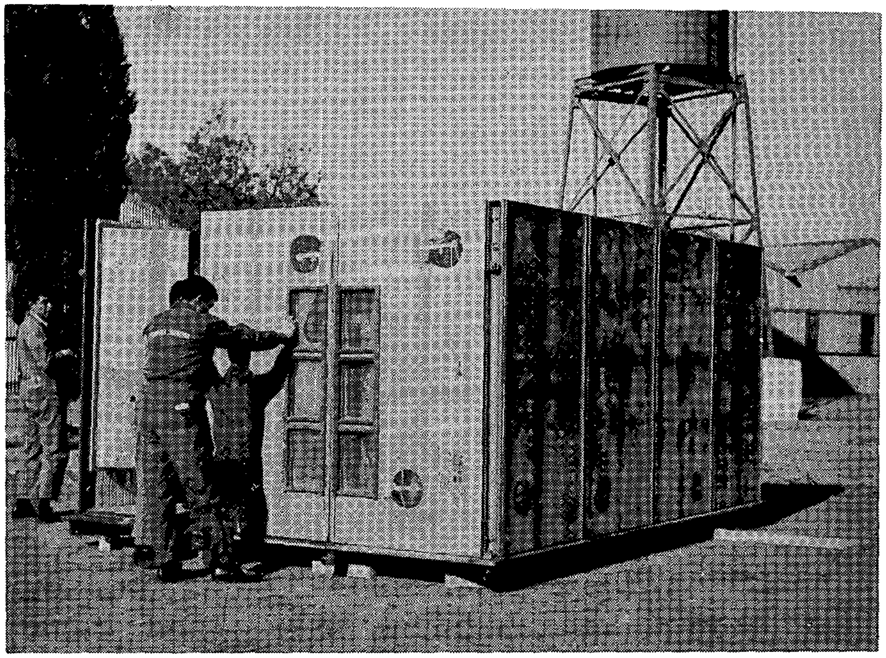
Floor joining



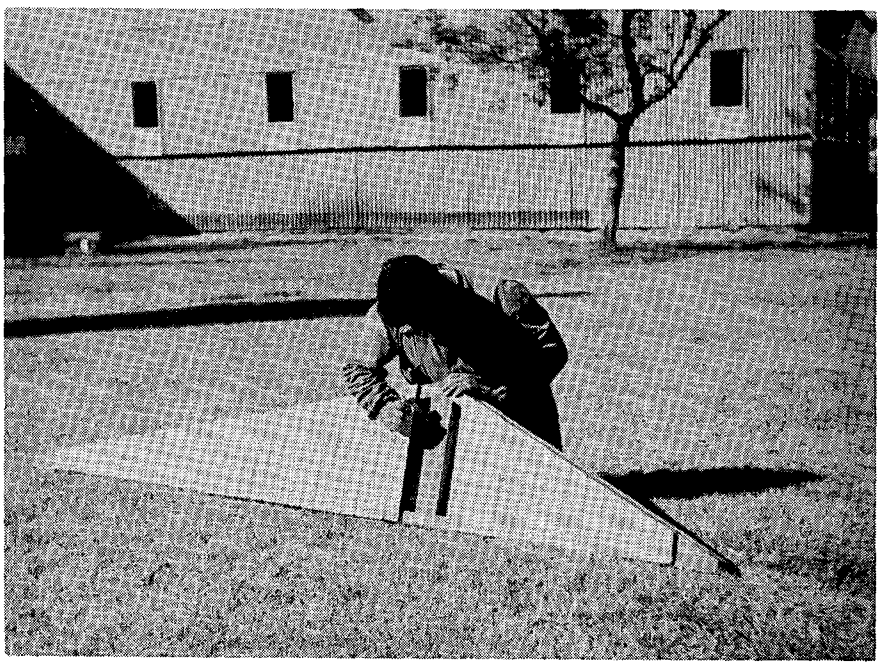
Placement of the first lateral boards


Completing lateral boards

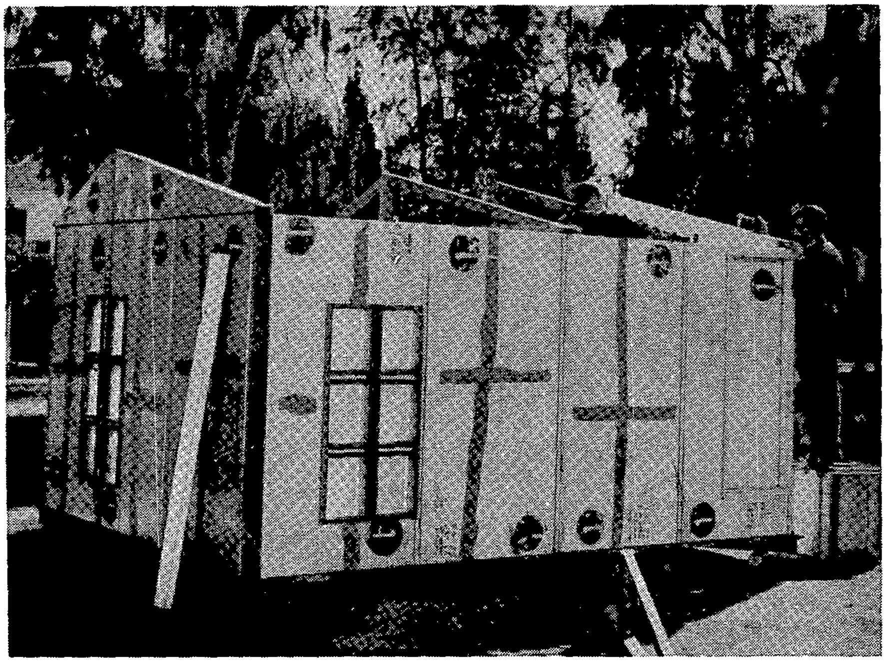

Iron corner with linking device



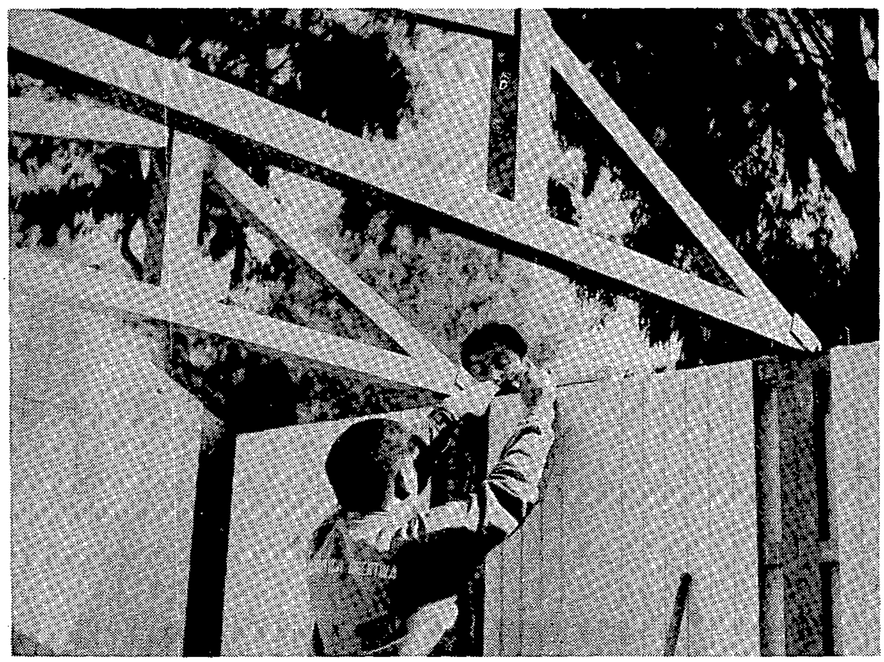
Finishing lateral walls



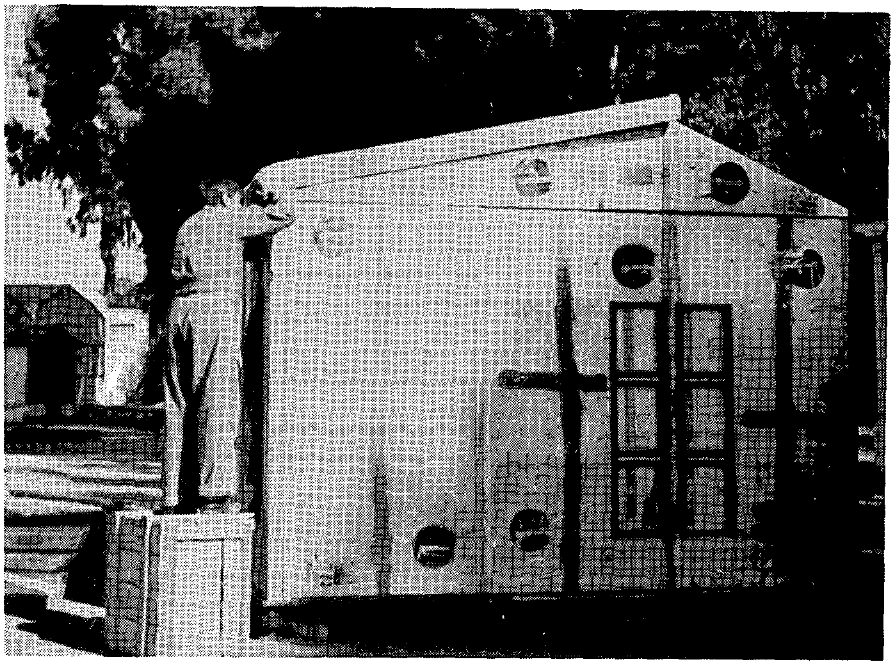
Mounting exterior ridge poles



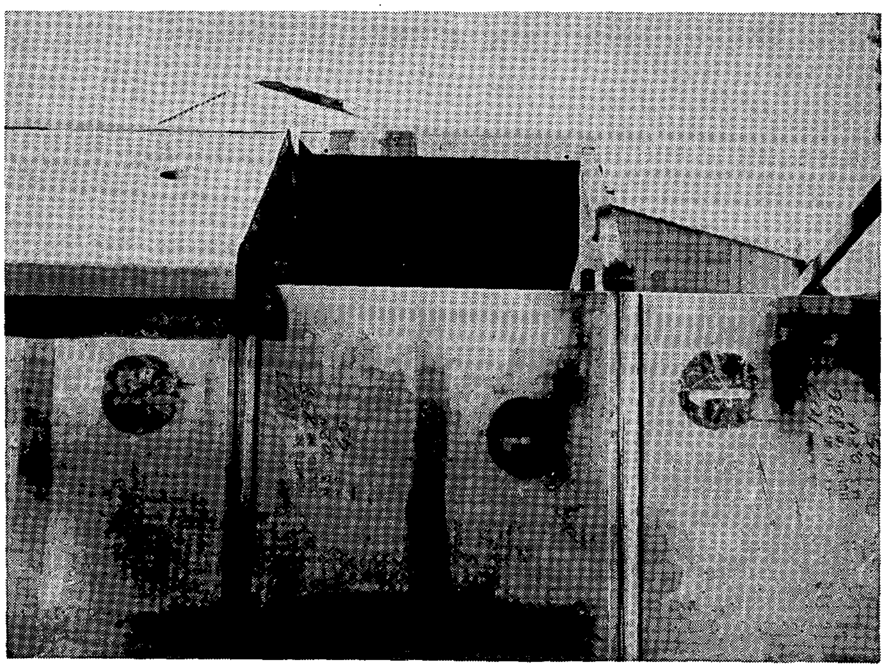
Tightening the structure



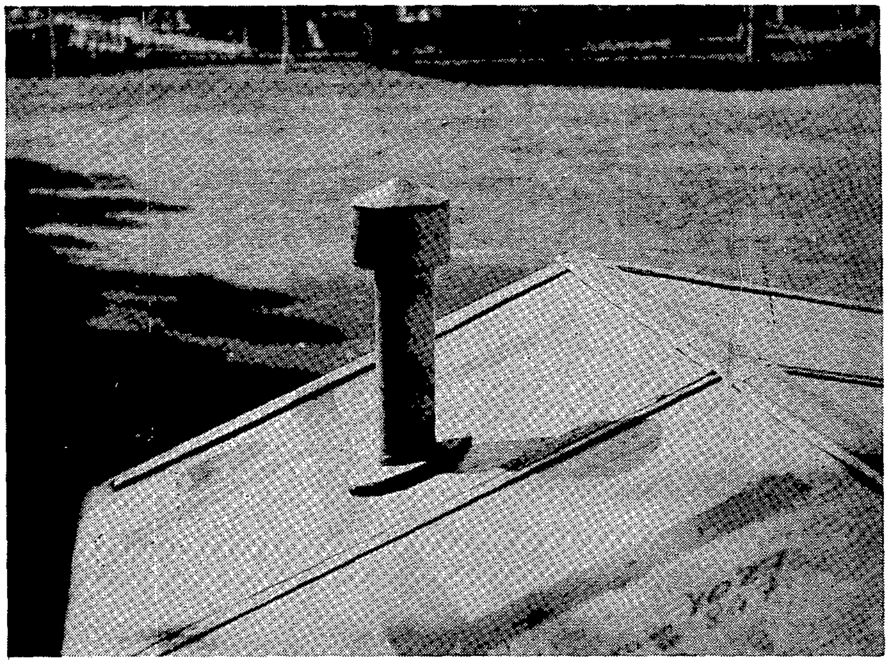
Placing central ridge poles



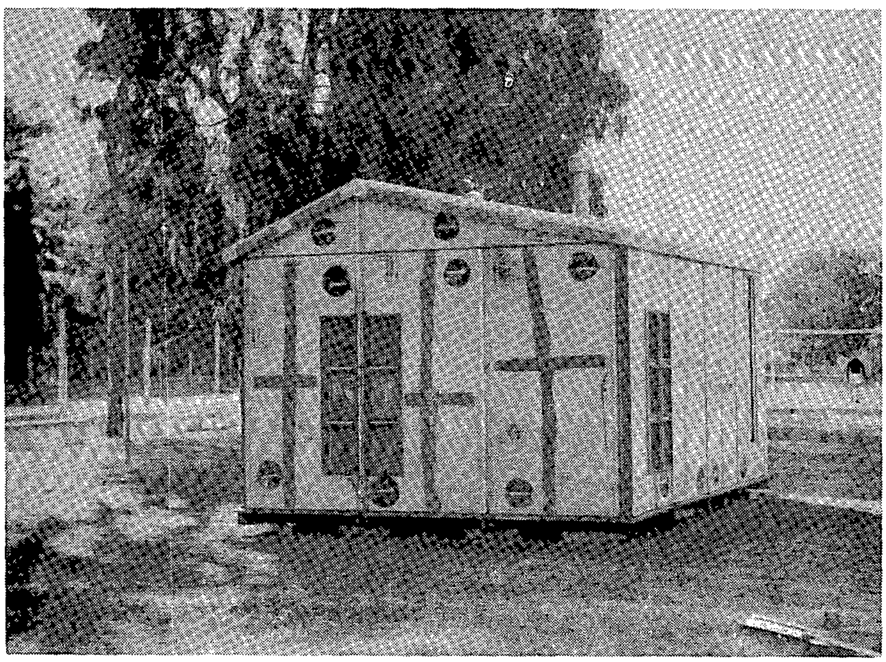
Placing the roof panels



Details of the position of the roof panels



Air-hole or air-horn



Completed house refuge

PLANT INSTALLATION WITH AIR-COOLED ENGINES, AND USE OF THE HFAT

Antarctic Division, Argentina

Summary

This is a report about Diesel air refrigerated engines, used on the Antarctic. The importance is based on the advantages offered by the use of this type of machines because liquid refrigeration is eliminated having in mind the problem of obtaining water and the composition of the refrigerant to avoid freezing.

We also detail the use of the refrigerated air out-put flux, which reaches temperatures of approximately 80° C and is guided through appropriated conducts so it can heat rooms and mechanical elements.

Use at "Teniente Matienzo" Air Force Base, of Electricity Generating Groups Equipped with Air-Cooled Diesel Engines

It is necessary to refer to Mr. Sumio Maita's article, 1962 Edition of the Antartic Logistics Symposium.

In this article, considerations are made on the technical advantages which the use of the Diesel engine has over that of the gasoline engine.. These advantages may be summarized in the following way:

1°) Less specific fuel consumption.

2°) Greater fuel transport and storage facilities, due to the fact that Diesel fuel is not as damaged by the transport and storage handling as the other gasolines.

3°) Less possibilities of fire due to the fuel characteristics.

4°) The fact that the exhaust gases from the Diesel engine do not practically contain carbon monoxide, makes it possible to prevent one of the most serious problems that the maintenance personnel have had to cope with: ambient air contamination (plant engines case).

The above mentioned article, in its paragraph 5.2, refers to the fact that the possible use of an air-cooled Diesel engine is considered very advantageous.

The Air Force Antartic Division put the matter into consideration for its 64/65 Antartic Campaign, and received the advise and help, on the matter, of the local industry represented by an important company which produces this type of engine in the country, thus deciding to use this type of engine in the electricity generating groups of "Teniente Matienzo" Air Base during that campaign (and up to the present time).

We shall add some considerations to the mentioned concepts in relation to the air-cooling of the Diesel engines.

The elimination of the water circulation and of its elements, that is, of the water jacket in the cylinders and cylider heads, of the pump, of the pipes and its rubber interconnexions, as well as the radiator, and of all the parts subject to disturbances during performance, not only simplifies considerably the engine, but also highly increases the service security. It simplifies the engine because this one is composed of elements subject to wear and tear, and it increases the service security because water is not the ideal refrigerating agent at all, for the following reasons: it freezes at 0° C; in the best conditions it evaporates at 100° C; it runs through all the non hermetic places; it is not always available at the working place, and finally it forms calcareous sediments.

From this point of view the advantages of the air cooling could be summarized as follows:

1°) Neither the cylinders nor the cylinder heads may crack under the freezing action, even if the engine is let outdoors.

2°) It is not necessary to empty the radiator in the afternoon, nor is it necessary to add hot water in the morning.

3°) There are no scales or obstructions in the pipes and in the radiator, and as a result, there is no water evaporation.

4°) Water does not penetrate in the cylinder nor in the crankcase, and therefore there are no ram strokes followed by serious accidents and damages in the bearings. There are a series of important advantages in the air-cooled engine. It has been proved that the cooling, essential to all the internal combustion engines, within the necessary limits may be better maintained under the direct action of the air than under that of the water. The highest temperature which an air-cooled engine, specially the cylinder heads and the cylinders, reach immediately after starting and later, under charge, offers the following advantages:

1°) Easier starting

2°) The air-cooled engine immediately reaches the prescribed temperature due to the absence of the great volumes of water to heat after starting the water-cooled engine.

3°) Less fuel consumption.

4°) Less oil consumption due to its longer duration.

5°) Less cylinder wear.

The advantages of points 4° and 5° arise from the high temperature of the cylinder walls, which prevents the sulphur contained in the fuel to condense forming sulphuric acid, provoking oil decomposition and a high cylinder wear.

As water evaporates at 100° C, in order to obtain the same results mentioned in points 4° and 5°, in water-cooled engines, it would be necessary to provoke the water circulation through pressure, thus increasing the risks of disturbances.

Another advantage of the air-cooled engines arises from the constructive point of view. They have not only individual cylinder heads, but also individual cylinders, easy to dismount and therefore all repairs may be effected in lesser time than that employed in the common water-cooled engines.

The technical considerations of the electricity generating groups employed are as follows:

Type	A4L 514
Quantity of cylinders	4
Interior diameter of cylinders	110
Stroke	140 mm
Piston displacement	5320 cm^3
System and cycle	Diesel 4 Strokes
Number of revolutions	1500
Compression ratio	1:19
PIN Power A for heavy duty at 1500 rpm	50 HPh
PIN Power "B" (intermittent) at 1500 rpm	55 HPh
Consumption of fuel at full charge	185 gr/HPh
Fuel consumption at 3/4 charge	185 gr/HPh
1/2 charge	220 gr/HPh
Maximum torque	31 mkg 1200 rpm
Refrigeration	(by air) turbofan

Injection pump	"Bosch"
Fuel feeding pump	"Bosch"
Nozzle holder	"Bosch"
Starting system	Electrical
Starting motor	24 V
Dynamo	24 V

Generator of three-phase alternating current, self regulated and self-excited, with a normal effective power of 40 KVA, with cosine fi 0.8= 32KW, 400/231 Volts, 50 cycles, fit for providing three-phase current of 380 Volts, and between each phase and neutral 280 monophasic volts.

Technical characteristics:

Apparent power	40 KVA
Real power with cosine fi 0.8	32 KW
Tension	3 x 220 / 380 V
Winding	Threephasic
Frequency	50 cycles/sec
Speed	1500 rpm
Admissible overcharge during one hour	10%
Tension ratio between empty and fullcharge and viceversa, more or less	4%
Insulation	Class "B" impregnated in epoxy resin
Construction	Protected from dribble and splash, self ventilated and with rotor with bearings
Coupling	Coaxial, by means of semi-elastic balanced flange.
Flow of refrigerating air	60 m^3 / PHh

Detail of the refrigerating system:

The cooling system is operated by means of an axial flow fan attached sideways to the row of cylinders by means of trapezoidal straps which are kept conveniently tied by means of spring loaded tension pulleys.

This fan is calculated to allow a flow of air through the engine of 50-60 m^3 CHP/h which prevents with security its excessive heating even at medium temperatures of more than 60° C.

Under normal functioning conditions, the flow of refrigerating air will have the following temperature values:

Ambient temperature entering through the fan	Outlet temperature
0° C to 10° C	70° C
10° C to 20° C	80° C

This circumstance makes it possible to use the outlet flow of the engine, in order to heat other places or avoid the obstruction of the air passage, which could derive in an increase of the engine temperature.

Practical examples of use at "Teniente Matienzo" Air Base are the following:

1°) Ambient heating in dwelling-house over a surface of 9 by 15 mts.

2°) Precinct heating for clothes drying.

3°) Heating of vehicles engines, auxiliary equipments, etc.

Obviously this system may have multiple uses according to the necessities of each Base.

Briefly, as a result of the experiments performed throughout three years of service, at Antartic Bases, whose power consumption does not exceed the 60-70 KW, the use of air-refrigerated Diesel engines as the one described in this report, is considered extremely advantageous.

OUTLINE DESIGN OF AN ANTARCTIC STATION TO MINIMIZE DRIFT ACCUMULATION

D. F. Styles* and W.H. Melbourne**

Abstract

Scientific stations built on ice-free rock in Antarctica may be submerged in permanent accumulations of wind-blown snow drift. Wilkes is described as a typical example. It is postulated that any structure placed in the path of a snowladen wind will cause loss of wind velocity with consequent deposition of snow; the variables involved are discussed and a theory is developed for controlling the location and, to a certain extent, the growth of the deposit. The results of wind tunnel tests made to determine some of the parameters are given and from these certain outline design features of the station are derived. Interim results are given of actual depositions at the station built to this design to replace Wilkes.

1. Introduction and Background

Most stations in Antarctica are based on rock because it offers a more stable foundation than ice and because, in the case of coastal stations, it is usually more accessible from the sea from which the bulk of the fuel and heavy supplies are delivered. In some areas, however, stations placed on rock have become submerged in permanent snowdrift. These are the areas in which drift deposition around buildings, vehicles and stores has exceeded the losses by wind erosion, evaporation and melting.

In such cases a new surface of snow has appeared where there was once rock, and the warm buildings have been encased in shells of ice in the névé with only their roofs exposed by the wind. Meltwater pools have formed under the buildings and have risen with increase in temperature; the stations have been difficult to operate and have required a lot of manpower for maintenance; the fire danger has become unacceptable; in at least one case access from the sea has become more difficult; and at times equipment has been buried during blizzards and lost.

It was realised that most of these problems would be common also to inland rock stations and to stations based on ice, even though some means were introducted to prevent the latter sinking, and that therefore any remedies which might be found might have a wide application.

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** Monash University, Melbourne, Australia.

The station at Wilkes was very vulnerable to drift accumulation as it was built with its major axis across the prevailing wind in the gap between two ridges. Methods suggested for melting the immense accumulation of névé and ice there did not seem to be very attractive, for they would have to be repeated after every blizzard or two to be fully effective.

In Europe and North America most drift problems can be solved if snow traps are provided of sufficient capacity to hold the maximum amount of snow which is likely to accumulate in one season. These are commonly snow fences, hedge rows, rows of trees, or extensive cuttings (for roads and railways). Their effectiveness depends on the snow completely melting away each time before it accumulates in such a quantity as to fill the trap.

Such solutions might be valid for certain limited areas in Antarctica, such as on the rock at Mawson, and in the Vestfold Hills, but not for the greater part, which includes Wilkes. At Wilkes, wind fences offered no solution, for the very large mounds of drift they would cause to be deposited would never melt in the cold Antarctic summer, so that they would soon be buried in mounds of their own creation. Other means of either reducing the local drift accumulation or removing drift regularly are required, if station buildings are to be kept clear of permanent drift and névé.

The most logical thing to do seemed to be to try and use the wind which brought the drift to carry it away again. There was already some hope that this deceptively simple approach might be made to work if the mechanics of it could be properly understood, for it had been observed over the years that obstructions placed in the path of winds carrying drift could cause scouring as well as depostion. This effect, so clearly demonstrated in the case of parked aircraft and tractors, had been used from the beginning to determine the orientation of access doors to buildings and the orientation of parked tractor trains, and later for the design of sledges, and more particularly since 1960 when buildings had first been placed on stilts at Australian Antarctic stations to obtain a level sub-frame of bearers above sloping contours.

Relying on these experiences, the Antrarctic Division proposed, in July 1964, the design of an elevated station in which drift deposition near the buildings would be minimized, and a scouring or pick-up action encouraged to limit the growth of the deposits. Experts including glaciologists, physicists, aerodynamicists and engineers from the Antarctic Division, the Works Department, the Aeronautical Research Laboratories of the Department of Supply (all Australian Government instrumentalities), and Melbourne and Monash Universities, were convened as committees in the latter part of 1964 to determine the design parameters.

Construction of the new station near Wilkes began in January 1965 during the brief visit of the relief ship. It has been continued, mainly in summer visits, and is now nearing completion. Some interim results of the drift accumulation have already been observed.

Although they are encouraging, in that no permanent drift has accumulated under or near the buildings which have already been erected for more than a year, it is a little early to be too confident.

Details of the main design features follow in the later paragraphs of this paper and the appendices. The replacement station is 1.25 miles south across the bay from Wilkes and 5 miles from it by snow trail round the bay. It is referred to as "Repstat" until it is occupied and named as a station.

2. Description of the Problem at Wilkes

Wilkes station consists of a complex of approximately 30 buildings, linked by covered passageways placed across a rocky depression between two ridges. This construction blocked the prevailing wind sweeping down the valley and caused an accumulation of drift on both upwind and downwind sides of the main group of buildings.

The original station was constructed in late 1956 and early 1957, and for the first two or three years of occupation the problem was apparently not very serious. Photographs taken in 1959 and 1960 show that ablation in summer was sufficient to reduce the drift and expose most of the rocky valley.

As time went on, however, it was found that the mass balance fluctuated from year to year and by 1963 the station was submerged to roof-level even in midsummer. By this time the drift on the upwind side of the station was at least half a mile long and merged with the permanent drift below the terminal moraine of the Antarctic ice sheet some two miles away. That on the downwind side was still extensive but more limited.

The drift in contact with the warm station melted and formed pools under the buildings which refroze when external temperatures fell, so that the buildings were soon sitting in boxes of ice rather than snow, with only the roofs occasionally exposed. At times oil was spilled accidently by men refuelling heaters or working on diesel engines in the powerhouses or garage, or on the stove in the kitchen. This oil floated on top of the water under the buildings and rose with it, when the temperature rose, impregnating the excessively dry warm timbers of the substructures, floors and lower walls of the buildings and passageways before it was noticed and pumped out. This created a very dangerous fire risk in the heated buildings.

Drift had to be cleared from external doors after every storm. Plant, equipment and stores kept outside had to be placed on ridges, for if left anywhere else they would be quickly submerged and lost.

The massive drift on the upwind (eastern) side of the station covered the only practicable landing beach, several hundred yards of access roads between there and the station, and the fuel depots, with a bank of drift up to fifteen feet deep in midsummer. A great deal of labour was used to excavate a ramp to the beach (with the aid of explosives and tractors) each year just before the relief ship arrived, so that supplies could be landed. Whenever the wind rose during relief operations, as it often did, the ramp partially filled with drift and time was lost clearing it again.

The bank of drift also made it nearly impossible to give proper maintenance to the walls of the station. In the dry atmosphere the timbers shrank and the walls leaked whenever the temperature rose.

These were some of the factors which made it difficult to continue operating at Wilkes.

3. Site and Environment

Except in the immediate vicinity of Wilkes, the Antarctic coast for several hundred miles in either direction has no areas of exposed rock large enough to contain a station and accessible to ships. Nearly all the coast in this region terminates in ice cliffs, ice shelves or bay-ice, and most of it isprotected by massive concentrations of pack-ice and iceberg tongues. This narrowed the choice of site for a new station considerably. In any case there was a natural predisposition to continue the scientific programmes which had been conducted in that locality since the International Geophysical Year. Law Dome behind Wilkes was of particular interest to glaciologists as a kind of Antarctica in microcosm.

After inspecting all the rock outcrops of interest around Wilkes by helicopter and examining five of them in detail, the one chosen for Repstat was at 66°16'50" S, 110°32'20" E, on Bailey Peninsula just across Newcombe Bay south of Wilkes, where it had been observed over several years to be free of permanent drift accumulation.

The meteorological records of several years at Wilkes showed that the air temperature on the coast ranged from -37.2° C in winter to an extreme maximum of +7.8°C in summer, with a mean of -9.6°C.

Winds ranged up to 120 knots with an average of 10.8, and a mean daily wind run of 255 miles. These were cyclonic winds, as the dome protects Wilkes from the katabatic wind. The prevailing directions were from 90° to 105°T. Blizzards were frequent and lasted up to five days.

The quantity of drift transported across the coast in a year by these winds was known to be considerable, but had not been determined for Wilkes. Theories had been proposed by Shiotani and Arai in 1953, by Loewe in 1956(1) and by Dyunin in 1954[2] and 1959[3]. Loewe's theory gave an estimate of 13 million pounds of drift transported across each foot of coast per year at Port Martin. The quantitative predictions could not be checked by observation because of the inherent difficulties in measuring drift.

The more elegant measurements and theories put forward by Budd and others in 1966 (4) were of course not available at the time. Whatever the exact amount, the figure was known to be so large that even a small percentage dropout would create a very large bank of drift.

4. The Variables

In this paper the term "accumulation" is used to indicate net gain of deposition over ablation, where ablation includes pick-up, evaporation and melting.

The amount of drift carried by the wind depends on wind velocity, height above the surface, the drift particle shape and density, the ambient temperature and air density and viscosity. Only the first two can be controlled. If the velocity of a wind fully laden with drift is decreased, some of the drift must be precipitated. If it is raised again to the original velocity not all the drift which was precipitated is picked up again because a large vertical momentum exchange is required to lift the particles from the surface. Where groundlevel flow separation occurs downwind from an obstacle, the low velocities associated with it will almost certainly cause excessive drift accumulation.

If the separated airflow region in the lee of an obstacle can be isolated from the ground level surface, then the velocities near the ground can be kept as high as possible and drift accumulation will be kept as low as possible.

5. Means of Limiting the Growth of Drift near Buildings

It was soon realised that the important thing was to keep the slot open between the bank of drift and the building. This could be done, firstly, by ensuring that there was adequate ground clearance under the buildings and, secondly, that the size and shape of the profile of the buildings were chosen to maintain a high relative wind velocity under and downwind from the buildings to ensure that scouring, or pick-up, would remove snow which accumulates in relatively calm conditions. Just what height for a given profile and just what ratio of local to freestream velocity (V/V_o) would suffice for the conditions obtaining at Wilkes could only be determined by experiment.

Thirdly, it was decided to place all buildings on a ridge to ensure that freeflow velocities would be the highest available.

An early decision to limit the dimension in the direction of the prevailing easterly wind by designing the station as one or two long narrow lines of buildings placed across the wind gave more latitude in these parameters of height and velocity, as also did the decision to improve the builiding profiles with fairings designed to streamline them.

The fairings were extended to link the elevated buildings and serve as connecting passageways for men and reticulated services such as power, communications, heating ducts, and water.

It was further expected that narrow lines of elevated buildings in a north/south direction would allow maximum penetration of solar heat to assist ablation of any residual snow under them and that the fire risk would be reduced by having the line across the prevailing wind.

Additional protection against fire was given by providing a space between buildings, for it was hoped that there would be no drift to confine a fire. The spacing chosen was determined for the materials used in a series of experiments conducted at the Commonwealth Experimental Building Station in Sydney.

Elevated stagings of open-mesh steel were erected in the fire gaps between some buildings to serve as unloading platforms for stores going in to the raised buildings.

These measures did, of course, complicate the structural design of the buildings. It was necessary to pay particular attention to the turning moments of the elevated line of buildings and to integrate the design of sub-frame members and anchors to secure the line of buildings against the tendency to turn over in the 150 m.p.h. winds which can be expected in that environment. It was also necessary to ensure that the additional heat loss due to exposure of the buildings to the wind could be met economically.

Other papers offered in this series cover the structural design(5), the heating considerations (6) and the fire protection experiments(7).

6. Wind Tunnel Tests (8, 9)

The main object of the wind tunnel tests was to find a building configuration of height above ground and profile, and a horizontal layout which would maintain the horizontal wind velocities as high as possible, particularly in the first few feet above ground level. If the ratio of local to freestream wind velocity, V/Vo, were allowed to fall too low in critical areas under and near the buildings, it could be predicted that drift would inevitably be deposited and form a parmanent attachment to the buildings when the slot between the lower surface of the buildings and the snow was closed by growth of the drift.

As a corollary, these experiments could be extended to indicate whether a second line of buildings 300 feet downwind from the first would reduce the velocity ratio to the critical point. If it did, the whole station would have to be planned in a single line 700 feet long extending over the crest of a relatively steep rock ridge.

Tests in the wind tunnel could give only relative velocities at different points for various building elevations. It was necessary to introduce some control model into the locality to find out what was the critical velocity below which the drift accumulation would close the slot permanently in that environment. (The environment includes the uncontrollable variables of ambient temperature, air density and viscosity, and particle shape and density referred to above.)

Fortunately, the Antarctic Division's observations of the raised meteorological balloon hut built at Wilkes in 1963, and the bulk fuel tanks built on raised platforms in the period 1961-63, were available as control models. The balloon hut was found to have caused marginal drift conditions. Drift had not appeared in any great quantity until near the end of the first winter, had then just failed to attach to the building, and had persisted without much loss of volume throughout the following summer. This, then, was taken to be the criterion.

A model of the Wilkes balloon hut was made on a scale of 1:48 and examined at the Aeronautical Research Laboratories in Melbourne, Australia, in a small wind tunnel of 21 inch by 21 inch working cross section. Velocity ratios were measured by vertically banked pitot tubes, and air flow and separations were visualized with the aid of wool tufts and smoke.

When the model was placed at the height and angle above the floor of the wind tunnel corresponding with the height and angle above the surface of the actual balloon hut at Wilkes, the critical velocity ratio V/Vo was found to 0.6. Figures 1, 2 and 3 show respectively the model, the balloon hut and its drift, and the measured velocity profiles.

The behaviour of a two-dimensional model of a building of cross-sectional dimensions 25 ft by 9 ft, provided with a semicircular fairing, was observed in the same way and the effect of varying the height and removing the fairing was noted.

A map of the site prepared from aerial photographs, and two alternative layouts proposed for the main buildings, is given in Figure 4. A model was made on a scale of 1:144 and placed in the 9 ft by 7 ft low-speed wind tunnel in November and December 1964 while the first two buildings were being designed and built. A photograph of it in Figure 5 shows the initial layout of buildings in two lines about 330 feet apart.

Velocity profiles were measured along the four representative transvers lines shown in Figure 6 and for the different configurations listed in Table 1. The measurements are given in the graphs recorded in Figures 7 to 10.

From these measurements it can be seen that the velocity V in the lee of the second line of buildings falls so far short of the desirable 0.6Vo, even when the height of all the buildings is raised an extra 2 feet, as to create a very distinct risk that drift would accumulate and the new half-million dollar station would probably soon be submerged, as was Wilkes.

Table 1. Table of Configuration Details

Config. 1	Rectangular unfaired passageways. Heights of builidings as shown in layout, Figure 6. Wind direction east. Buildings supported at corners only.
Config. 2A	Round fairings on windward side of passageways (see inset 2, Figure 6). Building heights as shown in layout, Figure 6, wind direction east; buildings supported at corners only.
Config. 2B	As for 2A, except that wind was SE.
Config. 2C	As for 2A, except that wind from NE.
Config. 2D	As for 2A, except that building 2 is raised two feet (these heights are in brackets, Figure 6).
Config. 2E	As for 2A, with the addition of scale-scaffolding, as shown in Figure 6.
Config. 3A	As for 2A, with the addition of scale-scaffolding as shown in inset 1, 2 and 3 of Figure 6.
Config. 3B	As for 3A, except that building 1 is lowered by 2 ft 6 in, as shown in inset 1, Figure 6.
Config. 3C	As for 3A, except that wind direction is changed from E to 15° S of E. From this direction the wind is at right-angles to building 1, and the rows of scaffolding are orientated with the stream.
Config. 3D	As for 3A, with addition of snow mound, as shown in Figure 6.

The plan for the second line of buildings was therefore dropped and all main buildings were placed in a single line. This meant that, towards the southern end where the slope rose rather steeply, it was necessary to remove the top five feet of the rock ridge with explosive to accommodate them without giving a dangerous elevation to one end of a building.

Other conclusions brawn from the tests were that ground clearances of more than 8 feet should be provided as far as possible and that in no case should they be less than 5 feet after allowing a margin for the losses of effective height due to the presence of the sub-frame scaffolding. The slot could close if clearances were less.

The addition of a rounded profile as a fairing on the windward side of the buildings greatly increased the velocity recovery downstream and was worth adopting as a design feature. Modification of the fairing to a more streamlined shape was not worth the trouble, nor was the addition of a trailing edge fairing to the buildings.

Steel wires were added to the model to simulate the sub-frame scaffolding on which the buildings were mounted, and it was found that they reduced the velocities downstream from buildings with up to 8 feet clearance by up to 20 to 30%.

The model tests indicated that the effect of placing 2 ft-high boulders in front of the buildings was comparatively small where the clearance was 10 feet (see Figure 7), but would be larger if the clearance were less. However, the very adverse effect of adding a mound to represent a build-up of drift downstream, but close to the buildings, can be seen in Figure 10.

The effect of rotating the model in the wind tunnel through 45° either way to represent winds blowing from the north-east and south-east, instead of from the east, was found to be not very significant.

Further wind tunnel tests were made in December 1965 to help determine the optimum locations for the powerhouse and vehicle workshop which, it was hoped, could be placed directly on the rock to simplify foundations and access for heavy plant. The results are given in Figures 11 and 12.

Following the conclusion of the tests, a drift-risk area was defined within which no substantial building or like obstruction should be placed. Sites were chosen for minor buildings, a radome and the bulk-fuel tank farm.

7. Observed Results

Results obtained so far are promising but not very conclusive. Only six of the main-line buildings, 190 feet of the profiled passageway and the powerhouse and workshop have been up for more than a few months: the remaining eleven buildings were erected in January and February 1968.

Permanent drift-markers have recently been installed in five significant lines as shown on the final site plan (Figure 13), but drift has been accurately measured over more than a full twelve months' weather cycle on two of these lines, A and B. Results are plotted in Figures 14 and 16 and shown photographically in Figures 15 and 17.

From these it will be noted that, in the last two years, the maximum accumulation has not caused any attachment of drift to the buildings along these two lines. Nor has there been any attachment of drift to any of the other buildings as will be seen in the general view shown in Figure 18. However, the high build-up of drift in the lee of the mess building in September 1967 (Figures 16 and 17) introduces a note of caution. On the other hand, the high build-up of drift under the balloon hut at Wilkes did not grow in times of high accumulation to form any attachment to that building. September 1967 was a time of heavy snow falls. It is quite possible that heavier precipitation might occur at some time and close the slots where ground clearance is small; subsequent winds, evaporation and melting might then reopen them after such rare occasions. A general picture taken in March 1968 (Figure 19) shows that the residual drifts at the end of summer are quite small.

Observations will have to be taken over some years to determine the matter conclusively. Whatever the long-term results may be, the combined effects of wind, evaporation and melting to date have been sufficient to keep the slots open beneath the buildings.

The location of the powerhouse and workshop on the sites selected by the wind tunnel tests also appears to have been successful. Accumulation certainly did not affect the buildings upwind from them, and wind and other ablation kept the drifts within limits as shown in the photograph (Figure 20). There were no residual drifts in this area by March 1968.

The whole site is quite vulnerable to drift accumulation. A large rock downwind from the ablutions block caused such an immense mound of drift that it had to be removed so that the access road from the landing beach could more easily be kept open. Boulders and concrete used to help anchor the buildings cause mounds of drift across the roadway in the lee of the main-line during winter.

Future plans therefore include levelling all upplanned obstructions in an area several hundred feet upwind and downwind from the main line of buildings. This will be known as the drift-risk area and will be kept entirely clear of obstructions.

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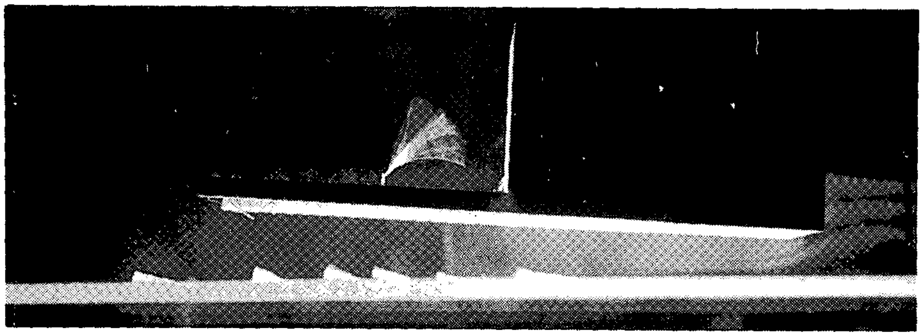
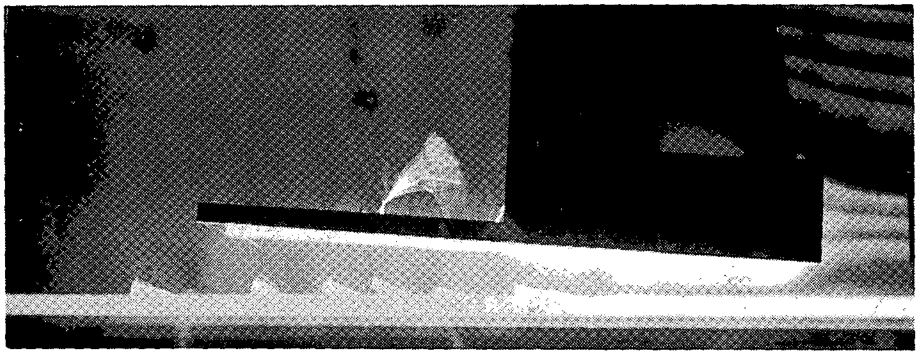
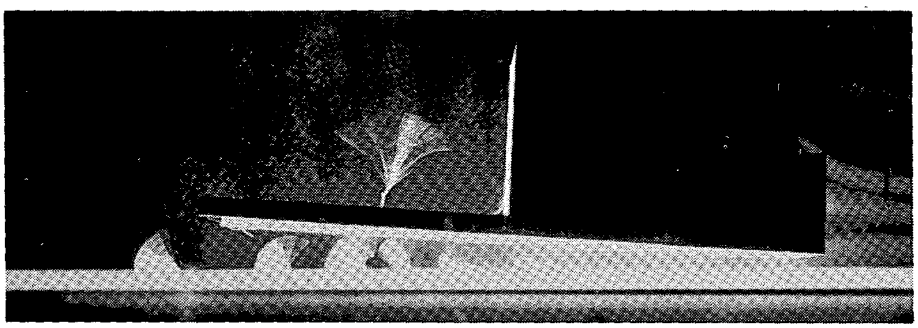


4 ft clearance



3 ft clearance

2 ft clearance



ARL photo

1 ft 6 in. clearance

Fig. 1. Model of Wikes Balloon Building in the small wind tunnel. Tufts indicate flow direction and separations.

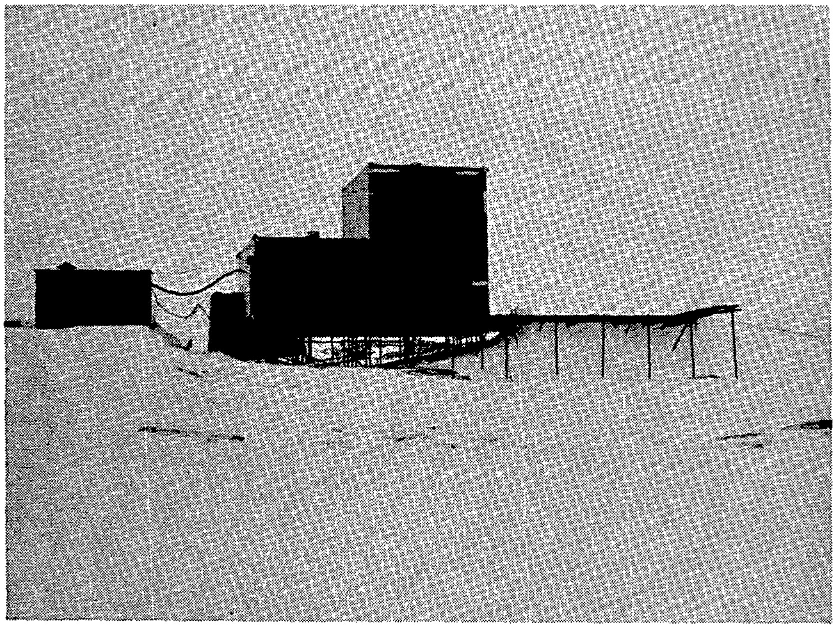


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Fig. 2. Wilkes Balloon Building and its drift.

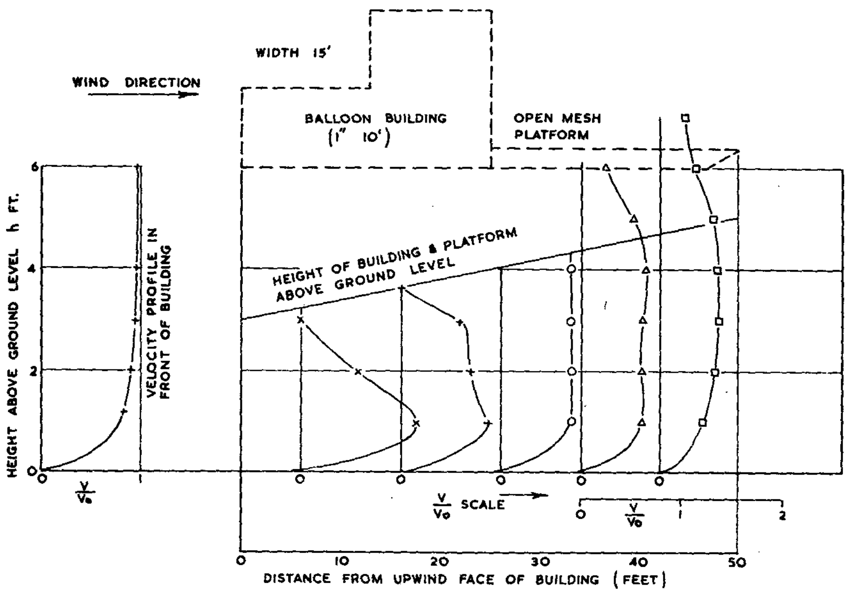


Fig. 3. Wilkes Balloon Hut model velocity profiles measured in the small wind tunnel.

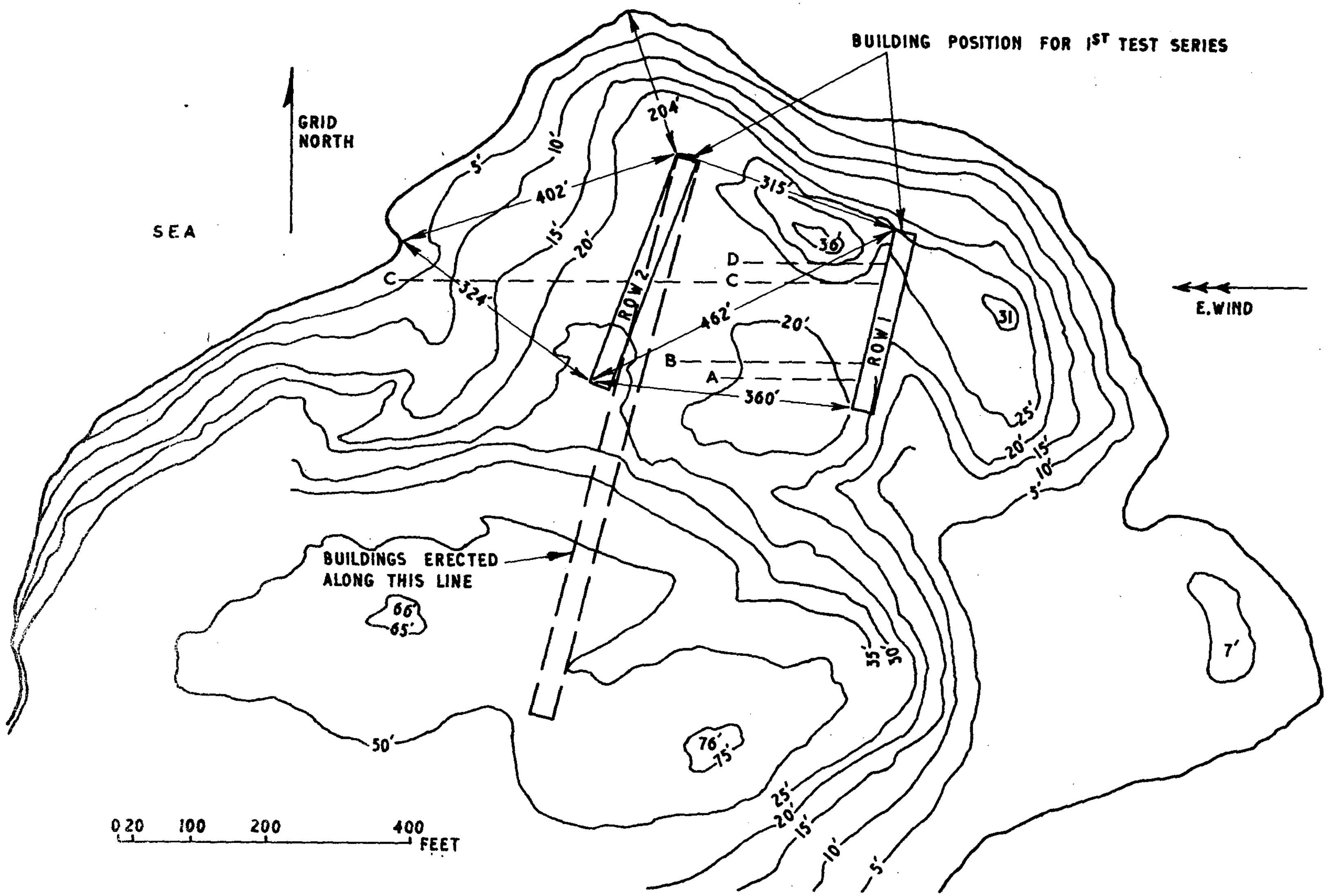
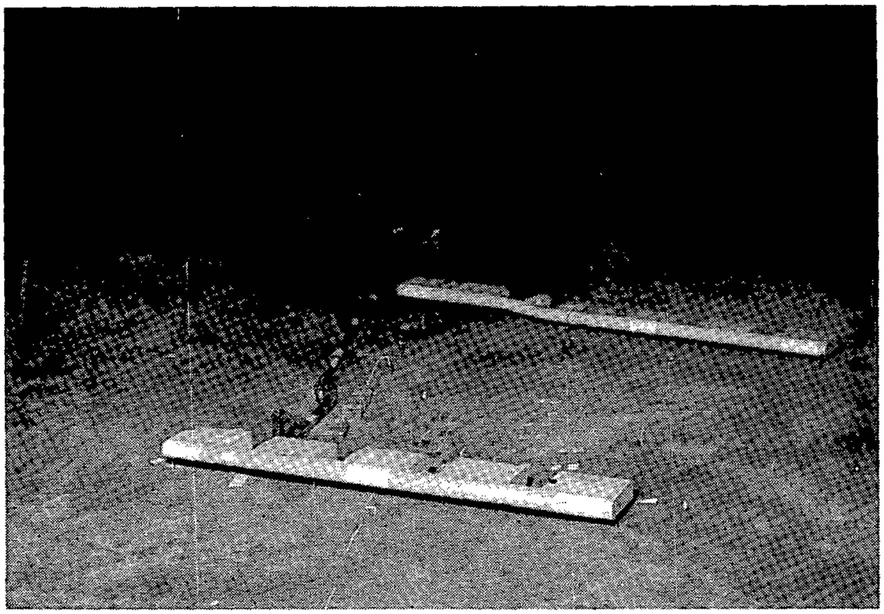


Fig. 4. Map of Repstat site prepared from aerial photographs showing two alternative layouts for main buildings.



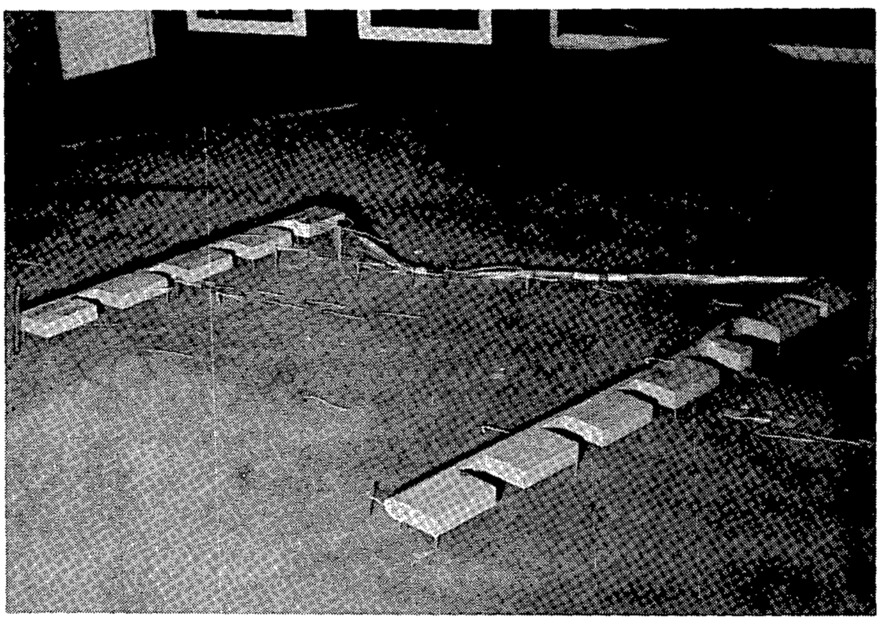


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Fig. 5 Model of the new station (1:144 sc scale) mounted in the large wind tunnel.

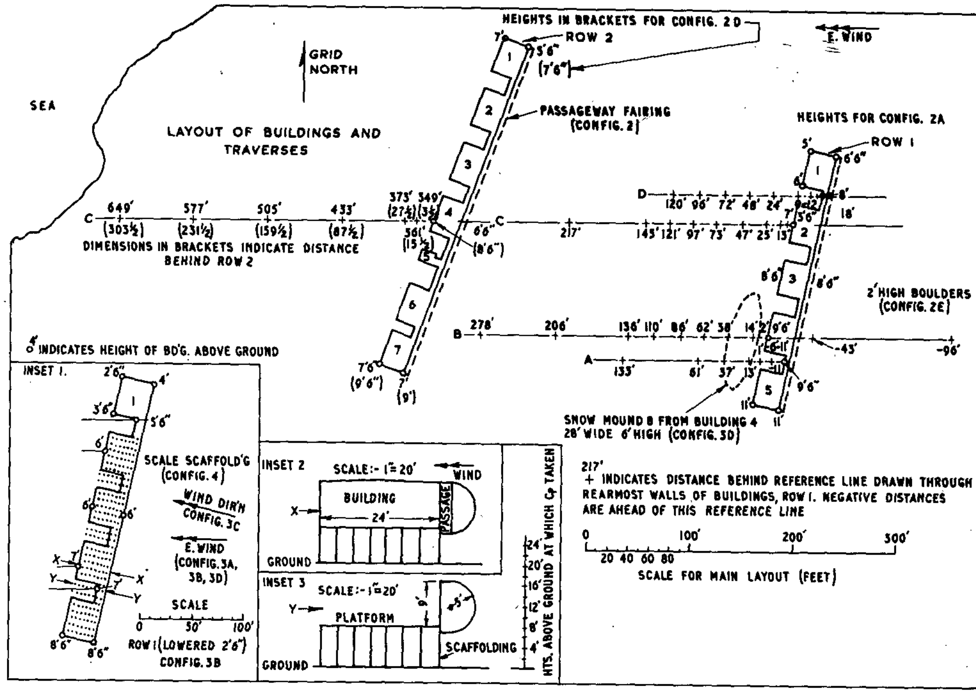

Fig. 6. Detils of main building configurations tested in the large wind tunnel.

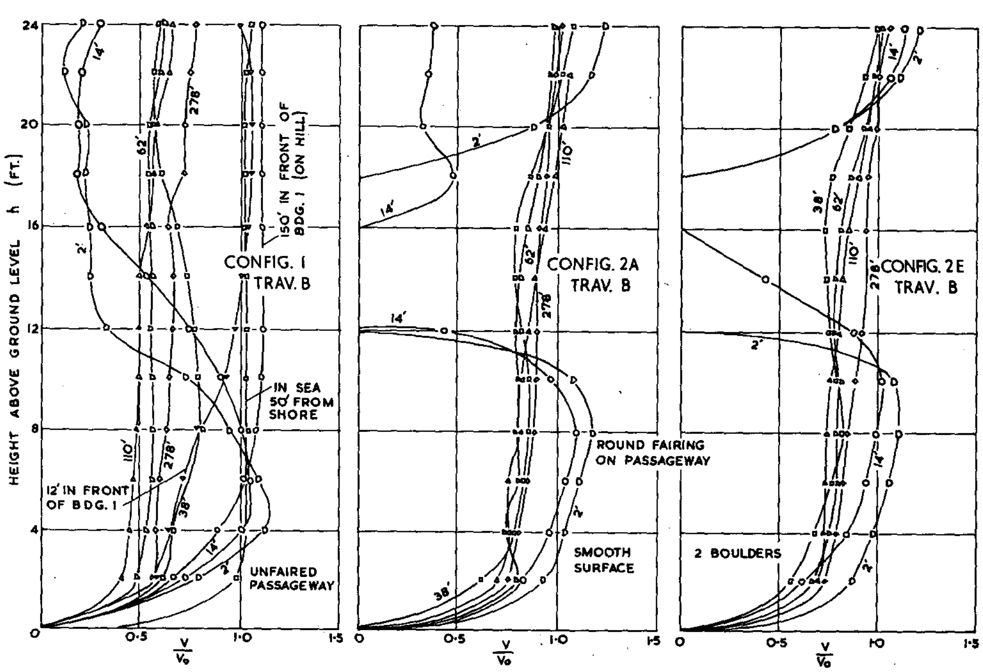

Fig. 7. Velocity profiles along traverse B for configurations 1, 3A and 2E.

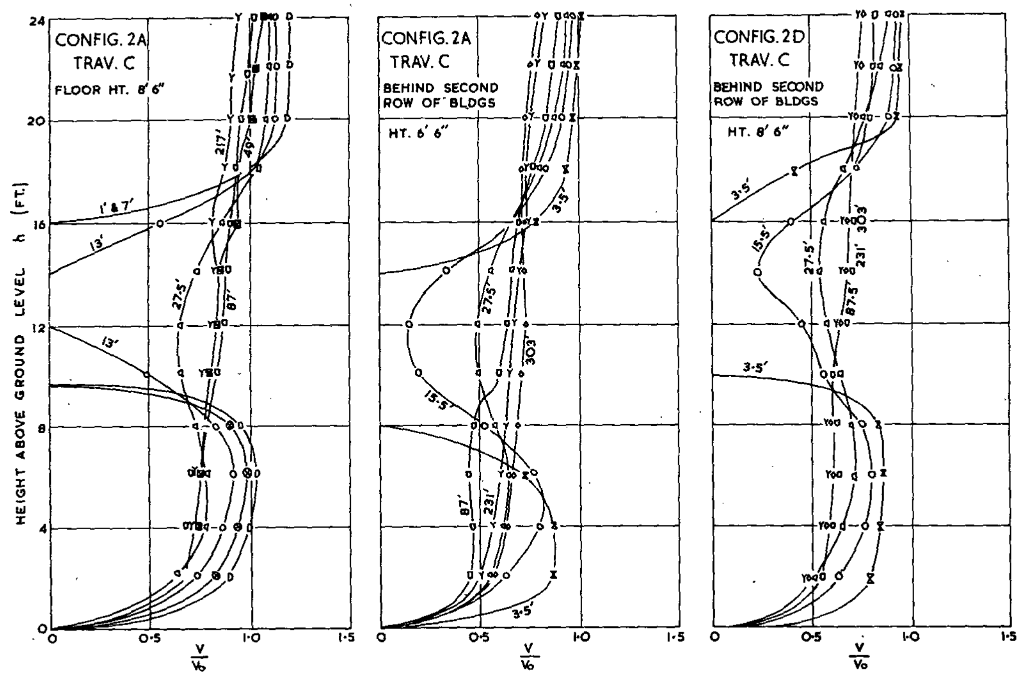

Fig. 8. Velocity profiles along traverse C for configurations 2A behind both rows of buildings, and 2D behind the second row of buildings.

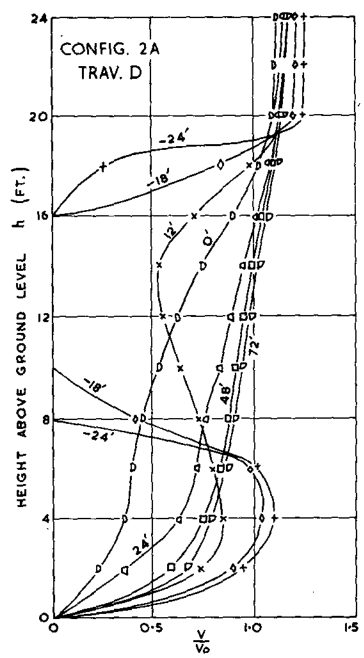

Fig. 9. Velocity profiles along traverse D for configuration 2A.

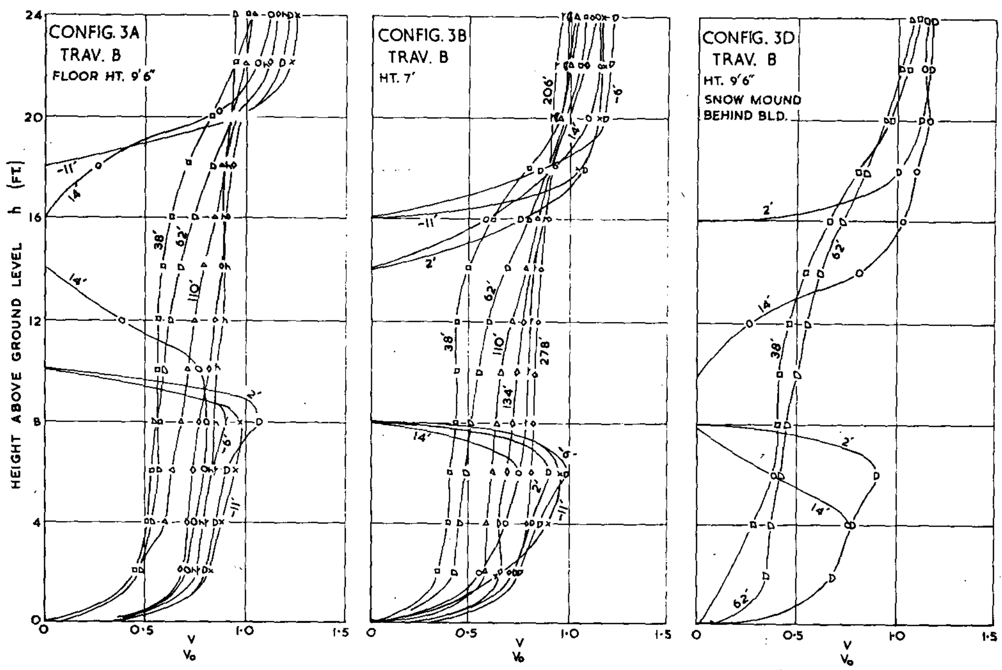

Fig. 10. Velocity profiles along traverse B for configurations 3A, 3B, and 3D, similar to configuration 2A with simulated scaffolding stilts.

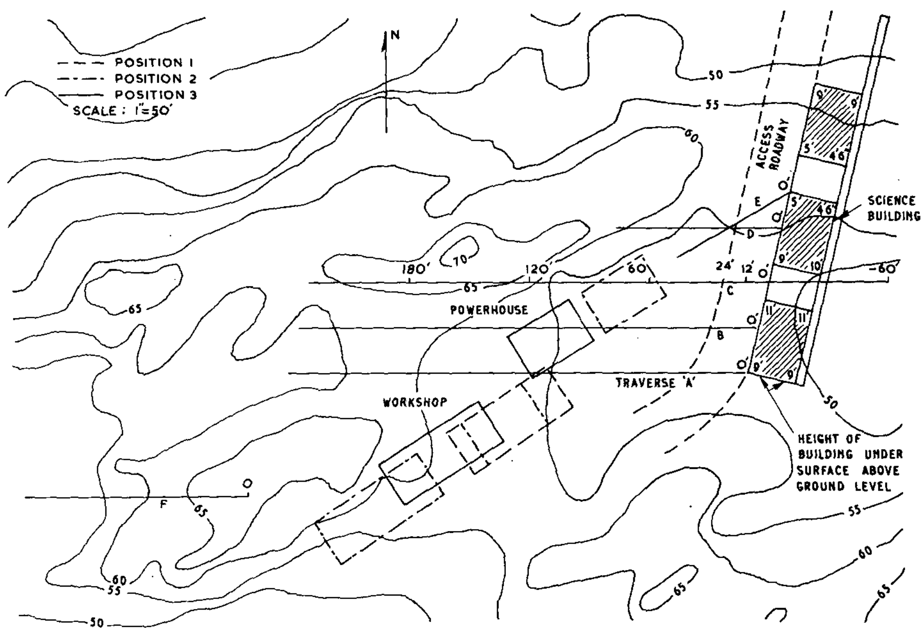

Fig. 11. Details of Powerhouse and Vehicle Workshop Building configurations tested in the large wind tunnel.

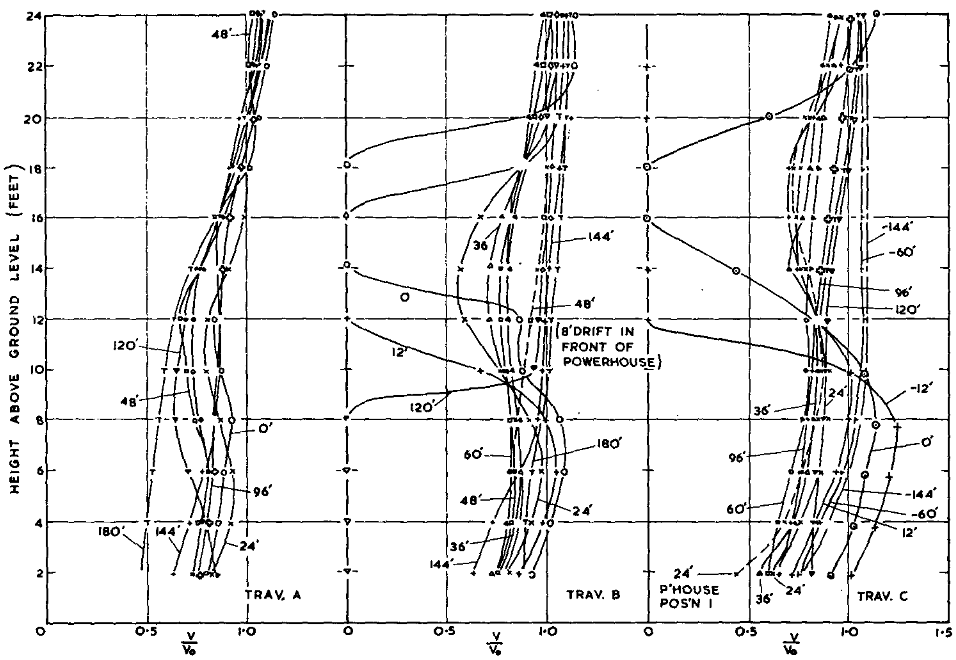

Fig. 12. Velocity profiles, traverses A, B and C with main buildings, Powerhouse and Vehicle Workshop in position 3, wind from east.

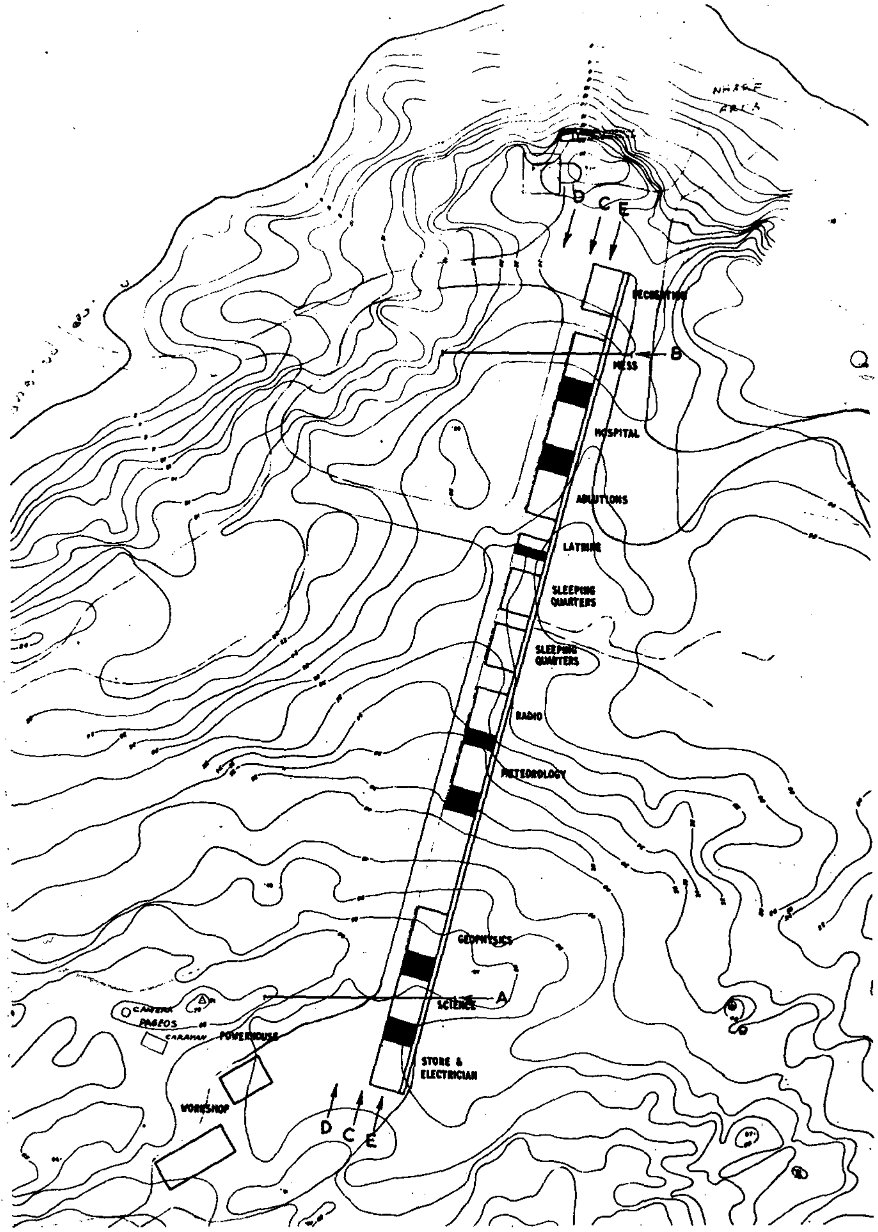

Fig. 13. Repstat site plan showing final positions of buildings and drift measurement lines.

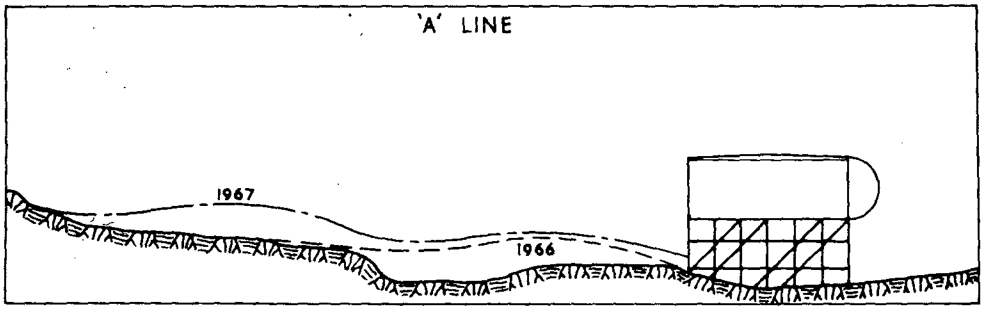

Fig. 14. Drift profile line A through science block, September 1967.

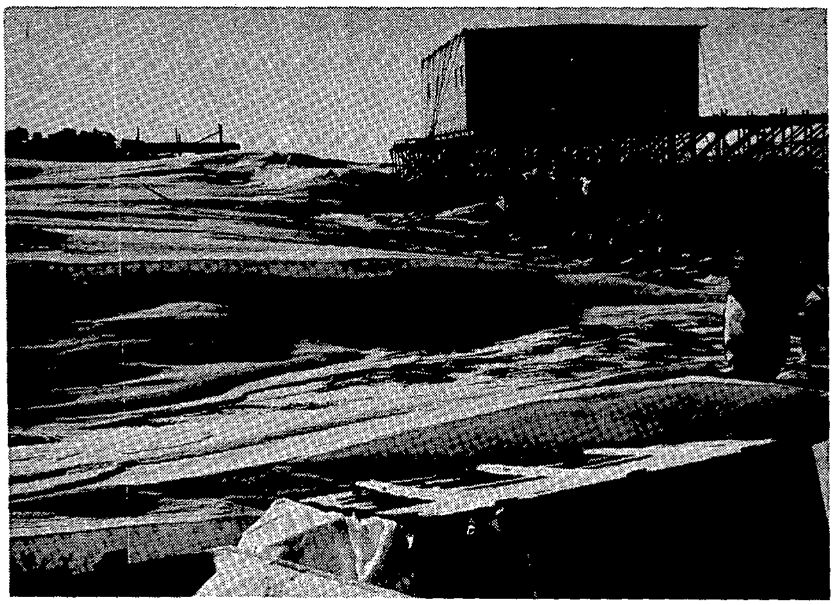

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Fig. 15. Drift in lee of Science Building, Septembar 1967.

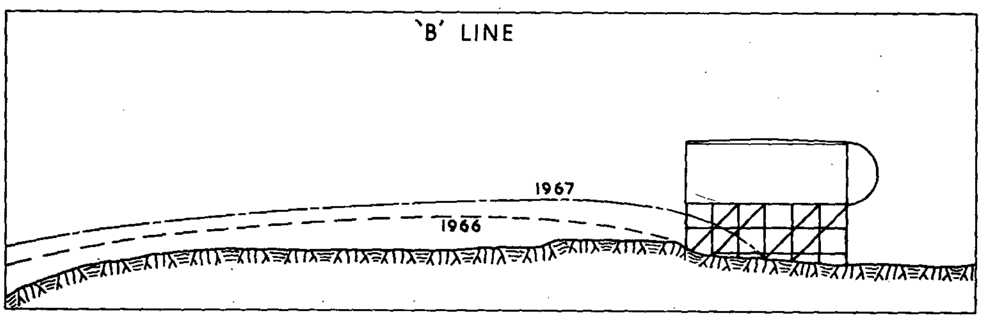

Fig. 16. Drift profile line B through Mass Building, September 1967.

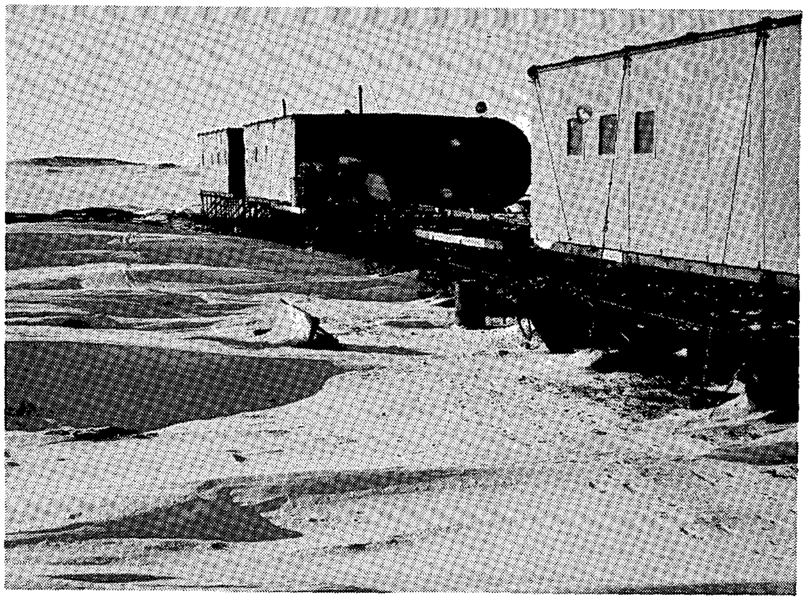

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Fig. 17. Drift in lee of Mess Building, September 1967.

ANARE photo

Fig. 18. General view indicating drift pattern, September 1967.

ANARE photo 17984A

Fig. 19. Aeriar view showing small residual drifts, March 1968.

ANARE photo 17772B

Fig. 20. Drift between Science Building and Powerhouse, September 1967.

STRUCTURAL DESIGN FOR AN ELEVATED STATION

A. M. Brown*, D.M. De Mole** and A.J. Gamble **

Abstract

The substructure for the elevated station is based upon the use of standard scaffold steel tubing and fittings which allows for air flow and rapid on-site work without extensive surveying and preparation of foundations. The building is bases upon earlier experience with panel structures described earlier. The connecting corridor presents a rounded shape to the prevailing wind to reduce the height of the disturbed air flow,

1. Introduction

The Outline Design of a Station to Minimized Drift Accumulations by D. F. Styles and W. Melbourne(1) has presented the reasons for considering aerodynamics in the design of a station, and the outline shape finally adopted. This paper describes the structural design adopted to achieve the outline required.

2. Substructure

To prevent accumulation of drift snow, a fast laminar air flow was required beneath the buildings, and by wind tunnel tests a clearance of not less than five feet was determined (1). It was important that the substructure should cause as little obstruction to the airflow as possible and a framework of small tubular members appeared to meet the aerodynamic requirements.

A substructure with fewer members and larger spans was also considered satisfactory aerodynamically, but deflections under varying live loads were sufficient to affect the seals between the building panels unless deep and heavy members were used. Transport, on-site fabrication and erection problems would have been considerably increased by the use of such a system, and heavy column bases would have been required for stability of the structure.

It was essential to fabricate the structure on-site, as it was planned to erect two buildings in the first year of construction to determine the effect on drift accumulation. At the time, materials had to be purchased and shipped to the site, detailed surveying of the site was in progress, and the exact location of the buildings had not been determined.

The decision was therefore made to use standard scaffolding tubes and fittings. These had already been tested in the field for buildings erected by ANARE for some years (2).

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The system met the need for rapid on-site fabrication admirably because the tubes were readily set into holes bored into rock, readily cut to length and the various fittings quickly installed by unskilled labour. Heavy foundation base and special fabrications were not needed.

In practice, the station was constructed on seven levels to suit the slope of the site, the clearance varying between 5 and 11 feet.

The substructure materials are 1.909 inches O. D. 6-gauge(0.192 inches) hot finished steel tubes (BS1775 Grade 13) connected by standard scaffold connectors and grouted into the bored holes with molten sulphur.

Tests conducted on the mild steel bolts and fittings proved that plastic deformation still occurred when grossly overstressed at - 30° C; thus brittle failure at low temperatures was not a problem at the normal stresses used.

The structure was set out in braced frameworks based upon columns on a six-foot grid and with columns fixed by horizontal members at height intervals of not more than five feet. Extensive bracing of the framework was used to ensure adequate strength and a minimum of vibration due to the high velocity winds (designed for 150 mph). The station was oriented to face the strongest and most prevalent easterly winds, although strong westerly winds could be expected occasionally. Overturning moments of the order of 11,200 lb ft/lineal ft were expected, which would be resisted by the dead weight of the building and the anchoring effect of the tubes grouted approximately 12 inches into the rock. In some places on the site, boulder and gravel moraine deposits cover the bedrock and it has been necessary to agglomerate this material with concrete.

A precautionary guying system was devised as shown in Figure 4, positioned to cause no obstruction to either the corridor or the roadway. The guys were connected to an anchorage system over the buildings. Mild steel straps were used as tension members over the roof, in preference to rods, to reduce interference to air flow. Wind-induced vibration of the straps against the roof was prevented by arragement of connections, so that the straps lay flat, and by bedding in mastic.

Pneumatic percussion drills, with star tungsten carbide-tipped bits, were used to bore holes for the tubular columns, generally to a depth of 9 to 12 inches. Tubes were cut with a pneumatic metal saw and hand cutters.

Each column had a specially modified fork pin inserted in its top, with a jacking screw for height adjustment. The modification provided a short length of tubing on the fork so that a horizontal member could be clipped to it to complete the framework.

Timber bearers of Douglas Fir were laid in the fork pins and fixed with bolts. These bearers carry floor panels of the buildings or open steel grid panels of the platforms between the buildings, as described later.

3. Buildings

The width of the station was limited to thirty feet (including a corridor) in the direction of the prevailing winds.

A basic standard building unit design was prepared, having an external width of 24 feet, and a length of 36.5 feet. Floor to ceiling height is 9 feet.

A modular width of four feet was adopted for external panels to make full use of the selected sheetmetal cladding which is manufacutured to that width. A half-module panel at each end of floors and roofs allows staggering of floor and roof joints with those of the walls, so avoiding a possible plane of weakness through the structure. Floor and roof panels were twelve feet long and wall panels nine feet long. Floor panels were made $4\frac{1}{2}$ inches thick, wall panels 3 inches thick, and roof panels wedge-shaped from 3 inches above the walls to 8 inches at the ridge. The sloping roof has been found necessary to avoid roof leakage after snowfalls. The level ceiling allows all internal partitions to be the same height so that re-subdivision with re-use of partition panels may be realised should this become necessary.

All panels were constructed with Douglas Fir timber-edge frames having tongues, grooves and foam-rubber seals. The panels are filled with blocks of expanded polystyrene, and sheeted inside and out with panel quality zinc-coated steel sheets. Floors have a plywood upper surface instead of the steel sheet. All joints, insulation and sheets are bonded and sealed with a rubber latex emulsion-type compound ("Hornex No. 6"). Panels were held in a press while the compound set. Sheet-metal angle cover strips bedded in butylmastic were fitted around the inside and outside edges of the covering sheets to provide a good appearance at the finished joints, and to hold the sheets in place should they be subjected to fire. (This increases fire resistance of the panel.)

Tie rods are used to connect the panels passing through the full length of the roof, floor, and each wall of the building. The tightening nuts on the ends of the rods remain readily accessible outside the building and serve to compress the sealing gaskets and post-tension the building structure. Bolts fasten roof and floor panels to wall panels. Their connections were subjected to load tests in shear and bending to determine their suitability to withstand the applied loads (4).

Floor panels were securely fixed to the substructure bearers with brackets at the outer edges and along the centre of the floor to provide resistance to aerodynamic uplift of the roof via the internal columns. The force of the wind on the connections of the building to the substructure would be no different at the elevated position from that nearer the ground, and the standard connections were considered adequate. (The net uplift force on the building at the windward side of the building was calculated to be 50 lb/lineal ft.) The floor was always completed and the brackets fitted before erecting walls and roof, thus providing security against high winds at all times.

A steel inverted T-beam was provided to support the ridge of the roof, with the roof panels resting on the beam, and opposite panels bolted together through the leg of the beam. Columns support the T-beam at spans of up to twelve feet. The columns were incorporated in partitioning when required.

Internal partitions were made as prefabricated panels sheeted with flexible asbestos cement on timber framing, and a core of paper honeycomb bonded with rubber latex adhesive.

The prefabricated design was developed to achieve the following objectives:

(1) Rapid on-site erection with a minimum of labour (erection of each building from floor level required about eight men for one day);

(2) Minimum maintenance;

(3) Adequate fire resistance.

A more detailed description of the basic building design and earlier history of its development was presented to the 1962 Symposium at Boulder[2].

4. Corridor

Elevation of the station well above ground level made necessary a connecting corridor between buildings. However, it was essential to proved adequate resistance against the spread of fire from one building to another. External fire fighting facilities cannot be very elaborate or reliable in the severe conditions which frequently occur in Antarctica, so a high level of fire resistance is required. It was therefore decided that the corridor should be constructed either from incombustible materials, or materials rendered fireresistant by enclosing them in sheet metal.

The outer shape was required to minimize the effect of the building structure on wind air flow, which suggested a rounded profile on the windward side. The corridor was placed on the windward side so that -

(i) the fairing would also serve as corridor past each building and not be wasted space;

(ii) continuous fairing would be more effective aerodynamically than discontinuous;

(iii) loading platforms between buildings could be sheltered.

The structure of the corridor once again used the easy on-site fabrication advantage of steel tube and scaffold fittings. To avoid difficulties in fixing of cladding, the corridor was supported internally from the building. Steel angle was supported at roof level by screwing into the roof panel and by steel straps passed over the building. Another steel angle was bolted to the bearer beneath the building. Steel tubular bow frames were bolted to the angles at 3-foot intervals and steel tube girts were clipped to the bows. Steel angles were welded to the bows as floor bearers, and floor panels were set into rubber latex in the angle bearers.

Curved corrugated galvanized iron sheet was adopted as external cladding. It is incombustible, economical and rigid, yet can be fitted together into bundles which saves valuable shipping space. The corrugations allow for expansion and contraction of the very long structure. Plumbers are familiar with it and could apply their experience in tank-making for site assembly.

Tests were carried out to measure the strength of curved corrugated galvanized iron sheets under a simulation of wind pressure. Figure 7 shows a load of over a ton being supported over the full span of 10 feet. To provide stiffness and a support for joints, the cladding was fixed to the girts as shown and so spanned one third the distance.

The first sections of the corridor were erected with polyurethane foam end seals, but the overlapping sheets were unsealed as in normal building construction. This proved to be totally inadequate and drift snow was able to enter freely and accumulate. A section of corridor was erected in Australia and several modifications and techniques were tried. As a result, the design was modified to provide better fitting togehter of the overlapping sheets, a new fastening method ("Huck") was introduced to provide quick and powerful clamping together of the sheets, and special non-setting butylmastics for the cold conditions were developed and applied to the lapping edges of sheets before erection. The modifications have proved successful.

Fire resistant doors were provided at each end of the corridor, and at several intermediate points, to control spread of smoke along the corridor and to assist in fire-fighting.

The lee side of the corridor between buildings was clad with straight corrugated galvanized iron sheets, with an occasional translucent sheet of matching corrugated polyvinyl chloride to admit daylight and to provide an emergency means of escape.

The corridor between buildings is supported from the lee side on a buttressing framework of steel tubing and scaffold-type fittings as used in the substructure of the buildings.

The first design provided an open steel grid flooring but this proved unsuitable because of the noise produced by footfalls, and the dust and rubbish which fell through it. There was also concern that any possible condensation or drift accumulation in the corridor would not escape. Therefore a solid floor of sheetmetal-encased chip-board 0.75 inches thick was provided, together with sheetmetal flashings to exclude dirt and water from the underfloor space. Recent experience indicates that meltwater can escape readily from the underfloor space of the corridor, so it has only been necessary to exclude the dirt.

5. Platforms

Those buildings requiring goods-loading access are provided with platforms at building floor level. The platforms are decked with open steel grid. The grid is a rectangular one with 1 inch x 8 inch load bars, selected to present as little area as possible for snow build-up. As a precaution against snow accumulation, no decking was placed in the first four feet to the lee of the corridor wall. The decking was supplied with a standard black enamel finish, and a test section was painted white to see if accumulation of snow was affected. Neither black nor white deck has collected snow at all.

6. Balloon Inflation Building

A clear height of 16 feet is required inside this building to accommodate the balloons during inflation. The building is mounted on pipe scaffold substructure similar to that previously described, some 7.5 feet above the rock, to allow airflow beneath it and to give height to the launching platform which extends 30 feet out from the leeward side.

To reduce wind pressure on the building, and vibration due to turbulence about it, a semicircular (or extended D) plan form was adopted (Figure 11).

The building is formed of prefabricated insulated panels, as already described. Six of the wall panels are segmental. All panels and the launching doors are sheeted with flexible asbestos cement both inside and outside, instead of zinc-coated steel. The upper surface of the floor is marine-bonded plywood. To avoid impact damage, the roof surface and underside of floor panels has steel sheeting superimposed over the cement sheets.

The balloon-launching opening is closed with two doors each of which is in two leaves (see Figure 12). The doors are hinged behind the jambs on each side and the leading edge of each second leaf is carried on a bogey castor running on a horizontal track. The top of each is guided by a roller in an inverted U track. The king pin of the castor is mounted on the inside of the door, the top guide roller being coaxial with it. When closed and bolted, a sponge-rubber-filled gasket is compressed between the jamb linings and the face of the doors.

To reduce the effects of an explosion in the building, eight frangible panels of a single 3/16 inch thickness of the asbestos cement sheeting have been provided in the upper walls.

Roof panels, floor panels and the flat wall panels are held togehter with steel rods run through conduits within the panel thickness, as in the standard constructions. However, the curved panels have the rods passing over their outer surface in extruded aluminium channels, so acting in the same way as hoops on a barrel.

The launching platform of open steel grid is 30 feet square and dished, as shown in Figure 11. The sloping sides warn the launcher that the edge is nearby and help to arrest his progress. A handrail was not practical. Experience with a similar launching ramp at Wilkes has indicated that a safety net beyond the edge of the platform is unnecessary.

7. Powerhouse and Vehicle Workshop Buildings

Generating sets, vehicles and other heavy equipment must be accommodated on solid foundations and with ready access. It was therefore most desirable that the Powerhouse and the Vehicle Workshop be designed with concrete floors at ground level. Fortunately, wind tunnel tests indicated that these two buildings could be located and oriented to restrict the build-up of drifts about them within acceptable limits [1]. Steel frames were provided in these buildings:

(1) to allow floor areas free of columns;

(2) to avoid the need for external guy wires in the vehicle area;

(3) to provide runways for hoisting during overhaul and maintenance of equipment;

(4) to provide attachments for mounting heavy equipment.

Columns were founded on 4-foot lengths of steel channel which were anchor-bolted to the rock. These channels could be turned about the column axis through 60° which allowed, together with their length, a wide selection of the rock surface for anchorage points.

The steel frame was connected to the building only through its attachments to the inverted T ridge beam. The bases of all wall panels were rigidly attached to the reinforced concrete floor all round the building, and the wall panels support the outer edges of the roof panels. Heads and jambs of the vehicle doorways were rigidly attached to the steel frame.

In most other respects these buildings are similar to the other insulated panel structures described elsewhere in this paper. They are both 24 feet wide and 12 feet high.

The vehicle Workshop is 62 feet long and the Powerhouse is 36.5 feet long.

To each of the three vehicle bays, an opening 10 feet wide and 11 feet high is closed by a set of fully gasket-sealed folding doors similar to those described for the Balloon Inflation Building. In this case the coaming across the foot of the openings is removable to admit the vehicles.

The reinforced concrete floor is founded upon levelled rock and boulders, with a blinding layer of gravel, a polyethene-sheet moisture barrier and an insulating layer of one inch-thick rigid polyurethane foam. The concrete slab is four inches thick and has abrasion-resistant granulated metal surfacing.

8. Construction of the Station

Project planning, programming and construction of the station are described in a separate paper (3).

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(1) Styles, D.F. and Melbourne, W. The Outline Design of a Station to Minimize Drift Accumulations. Antarctic Division, Department of Supply, Commonwealth of Australia, presented to Antarctic Treaty Meeting, Tokyo 1968.

(2) Style, D. F., Brown, A.M., Smith G.D.P., and Lukinovic, Z. Australian Design and Construction of Antarctic Buildings. SCAR Symposium on Logistics, Boulder, Colorado, NAC-NRC 1962.

(3) Smith, G.D.P. The Planning, Programming and Site Construction of an Antarctic Station. Antarctic Division, Department of Supply, Commonwealth of Australia, Presented to Antarctic Treaty Meeting, Tokyo 1968.

(4) Brown, A.M., De Mole, D.M., and Gamble, A. J. Tests on Building Panels for Structural Strength and Fire Resistance. Antarctic Division, Department of Supply, Commonwealth of Australia, presented to Antarctic Treaty Meeting, Tokyo 1968.

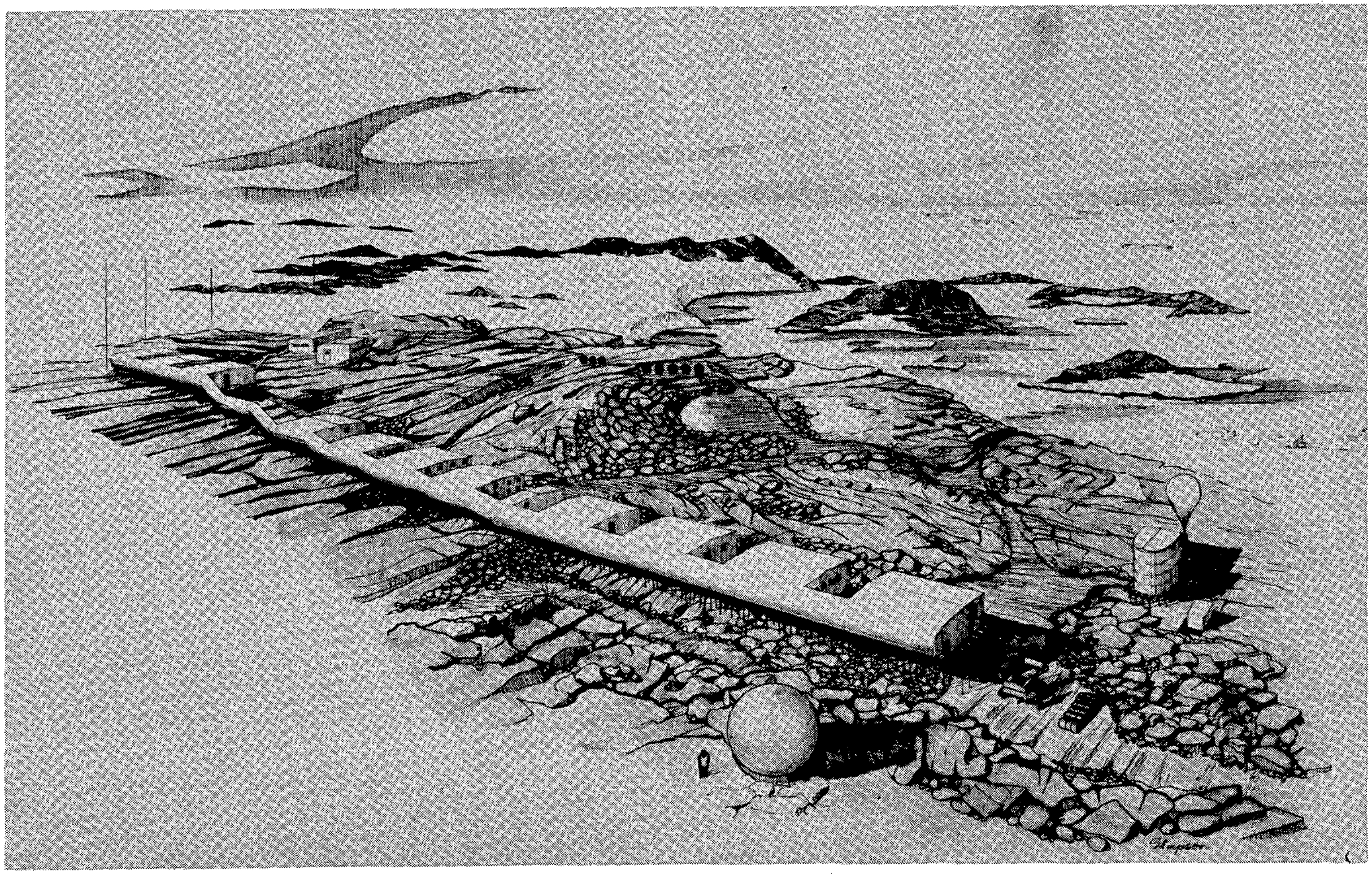
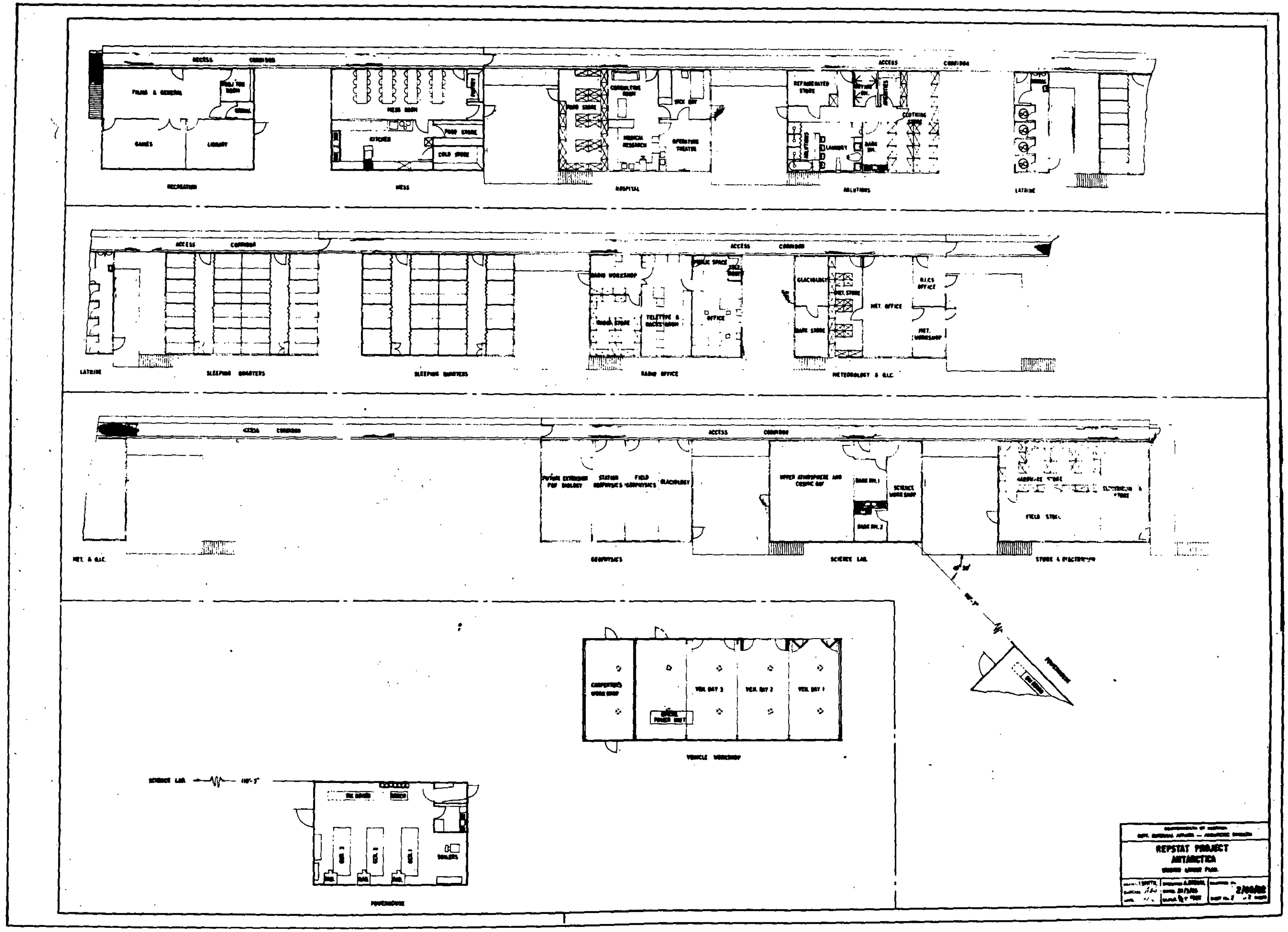


Fig. 1. Architect's perspective of the station.



ANARE Drawing 2/66/02 Sheet 1

Fig. 2. Plan of the station.

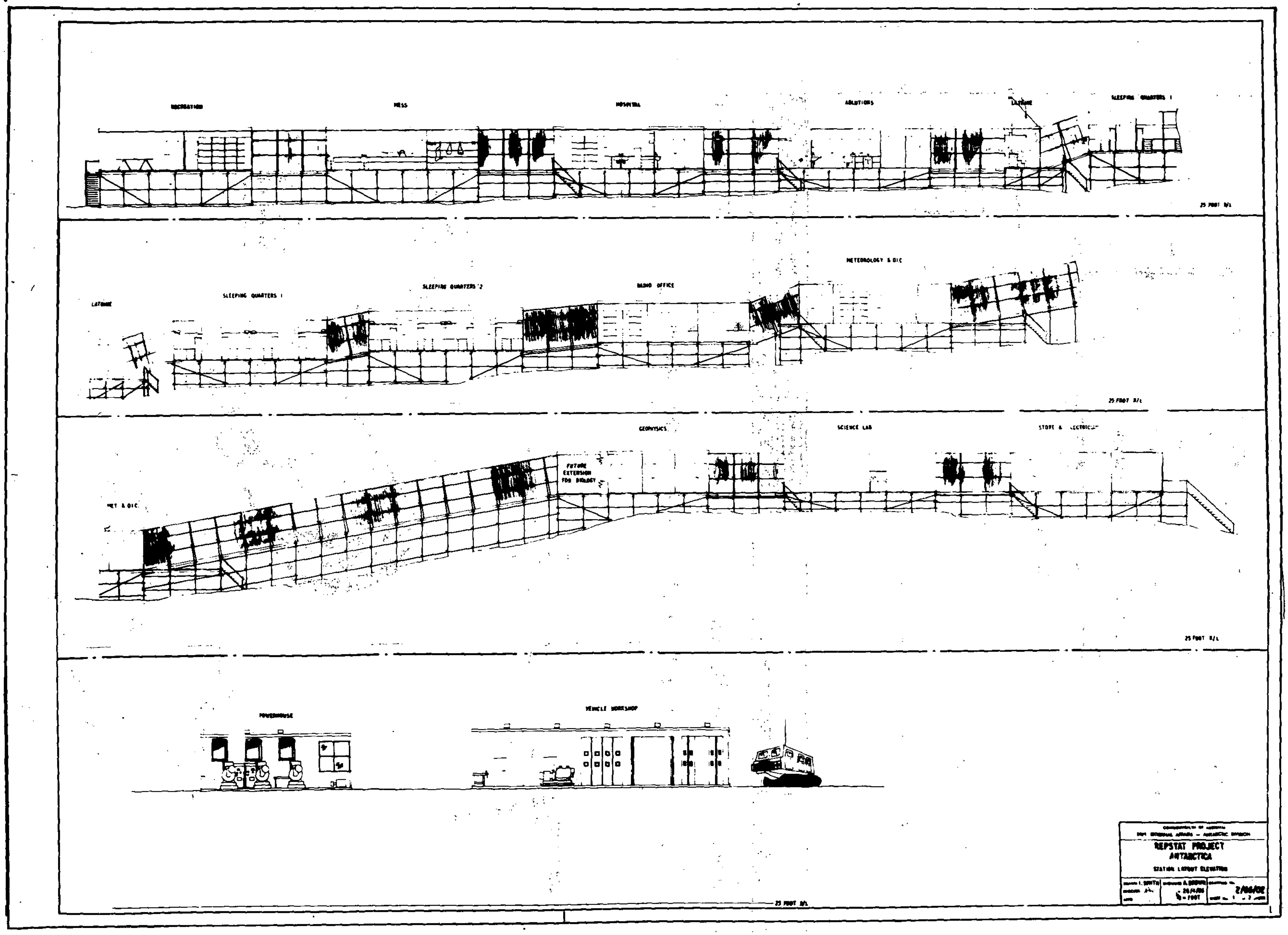


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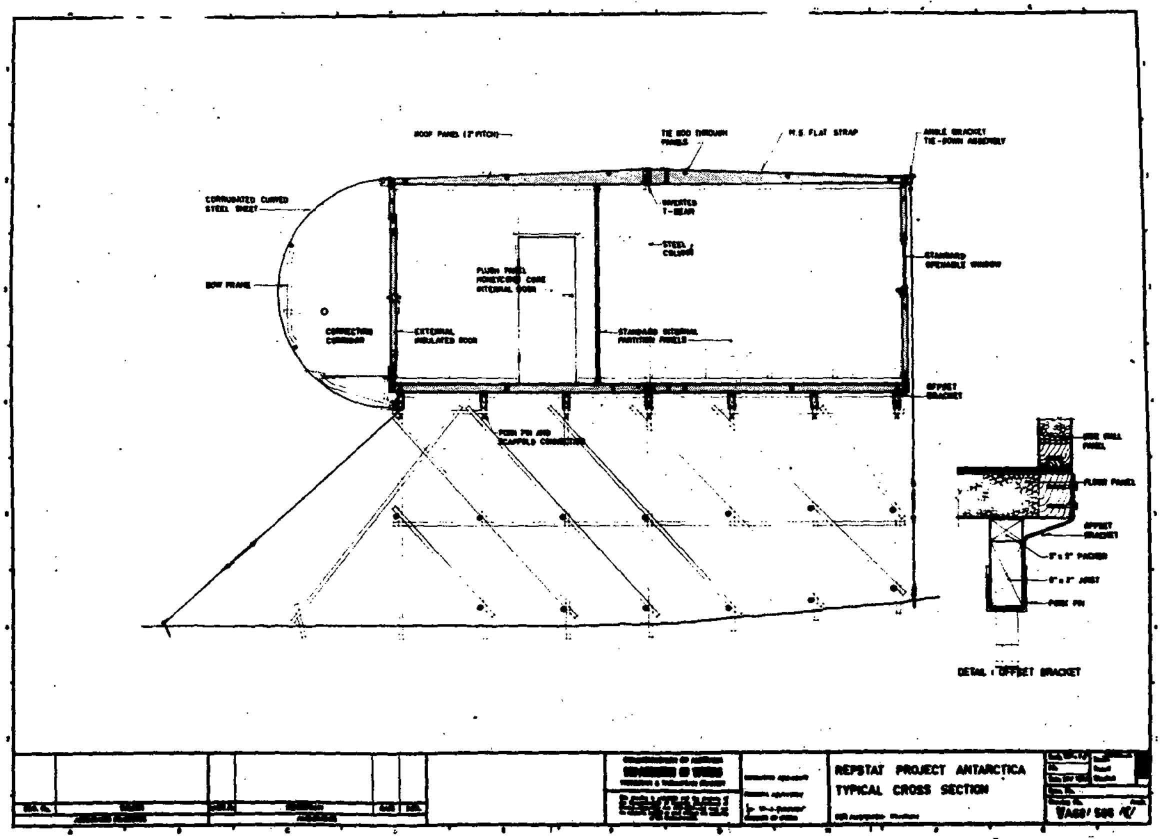
Fig. 3. Elevation of the station.



Department of Works Drawing VA68/506/C

Fig. 4. End elevation of the station.

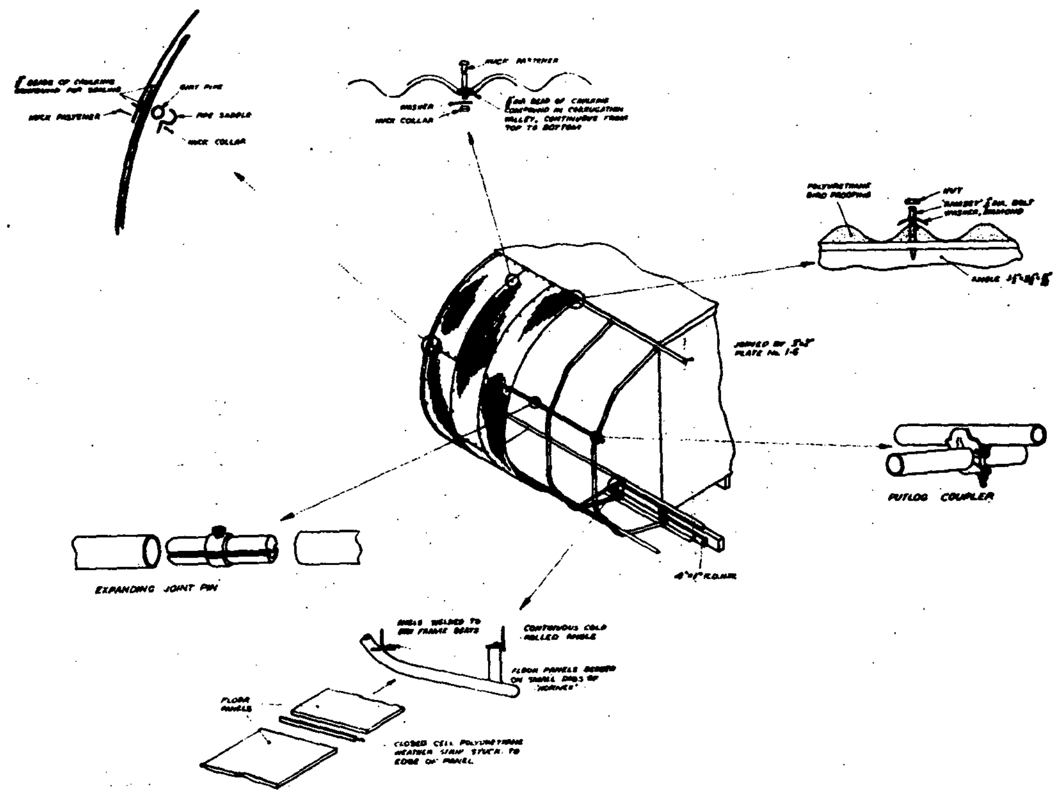


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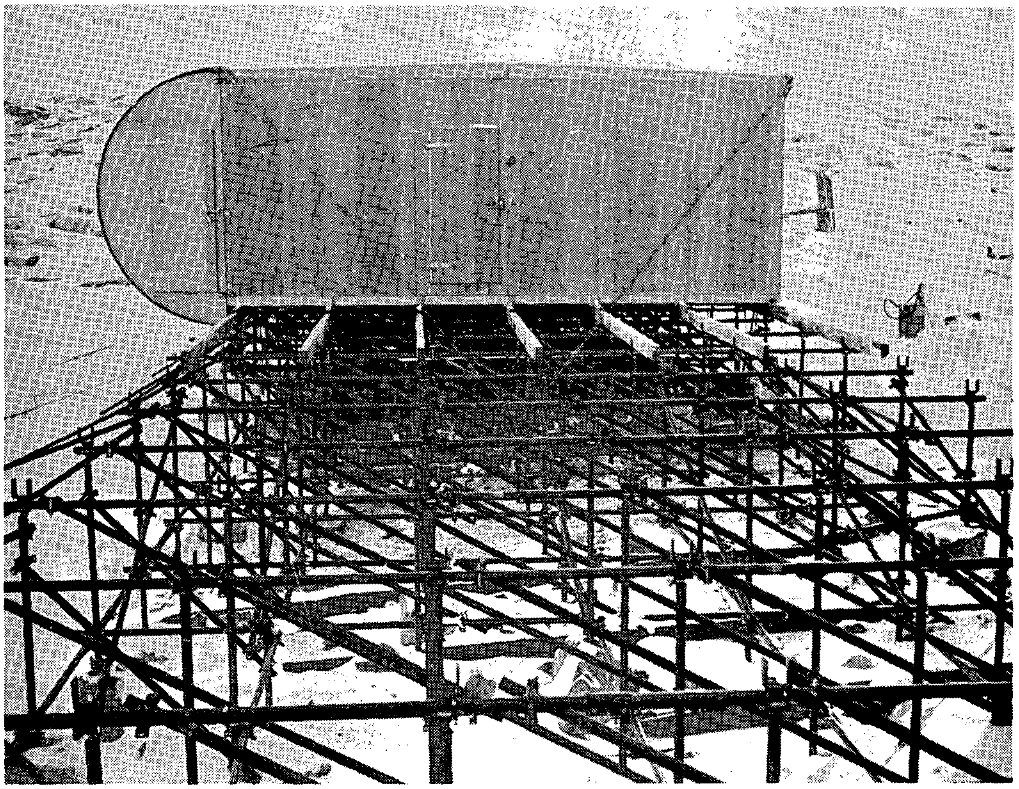
Fig. 5. Construction details of corridor.



ANARE photo 7635

Fig. 6. End view of buildings showing substructure, building, and corridor.

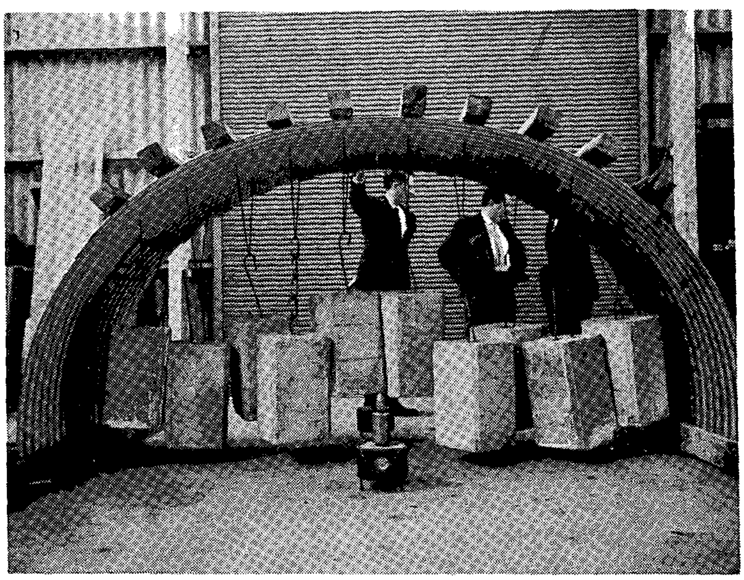


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Fig. 7. Testing of curved corrugated steel sheets for wind resistance.

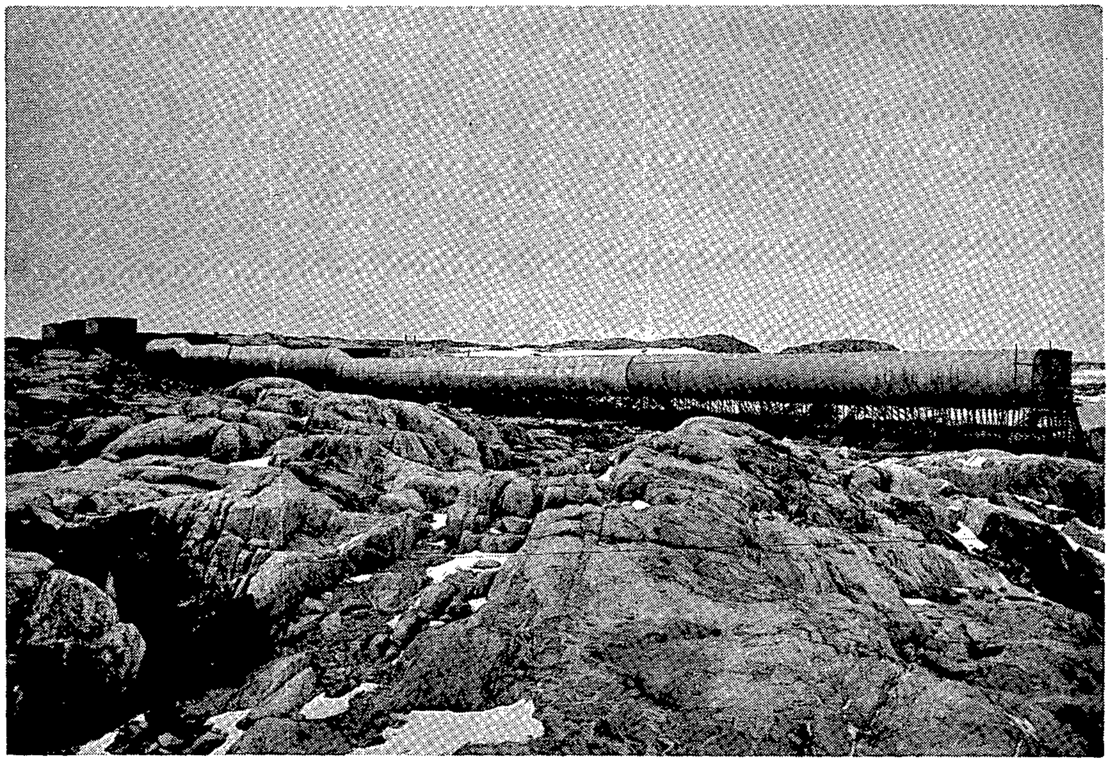

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Fig. 8. Overall view of corridor side of the station.

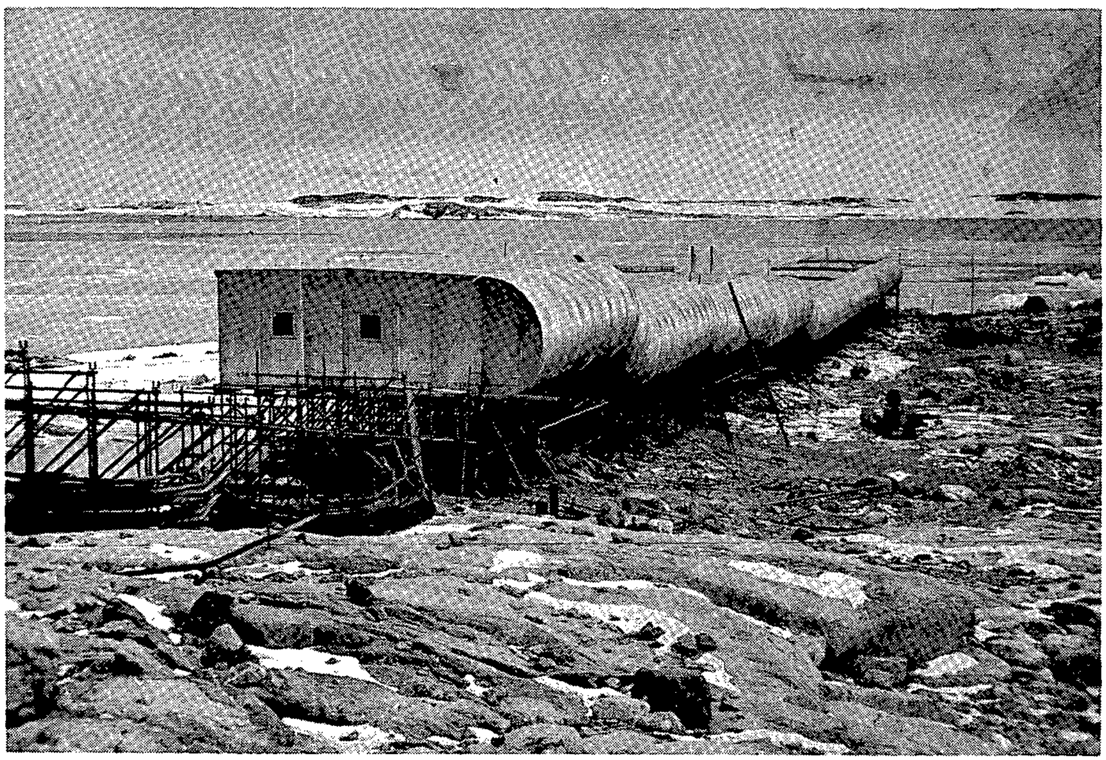

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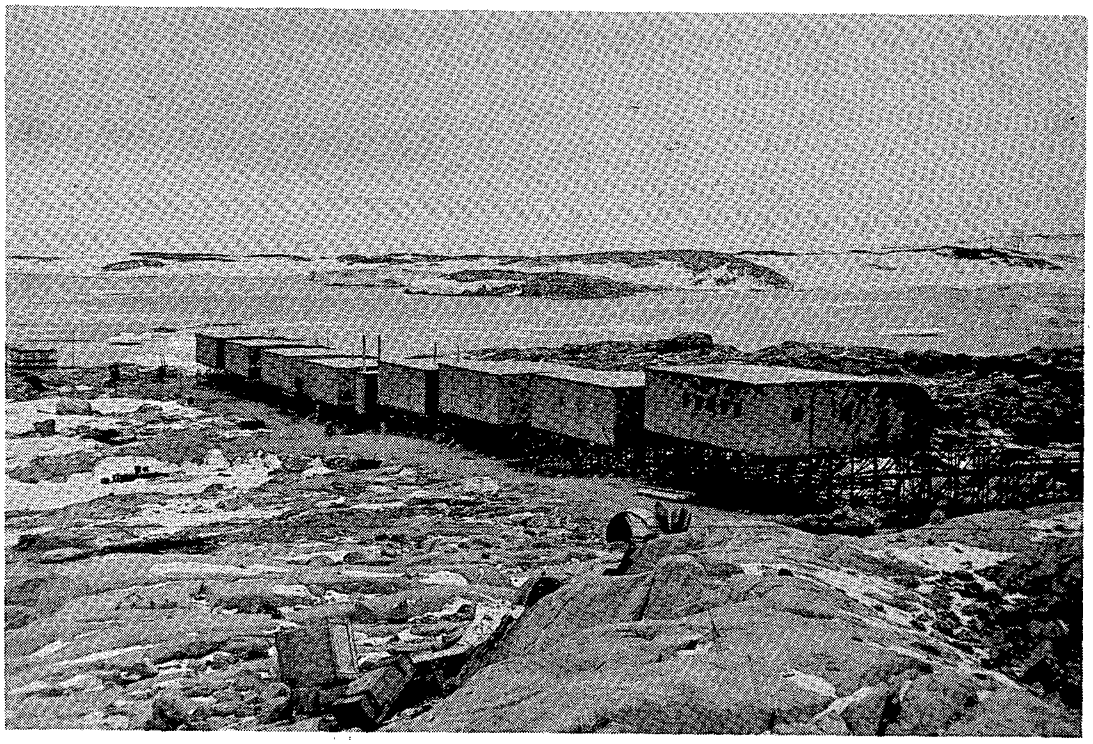
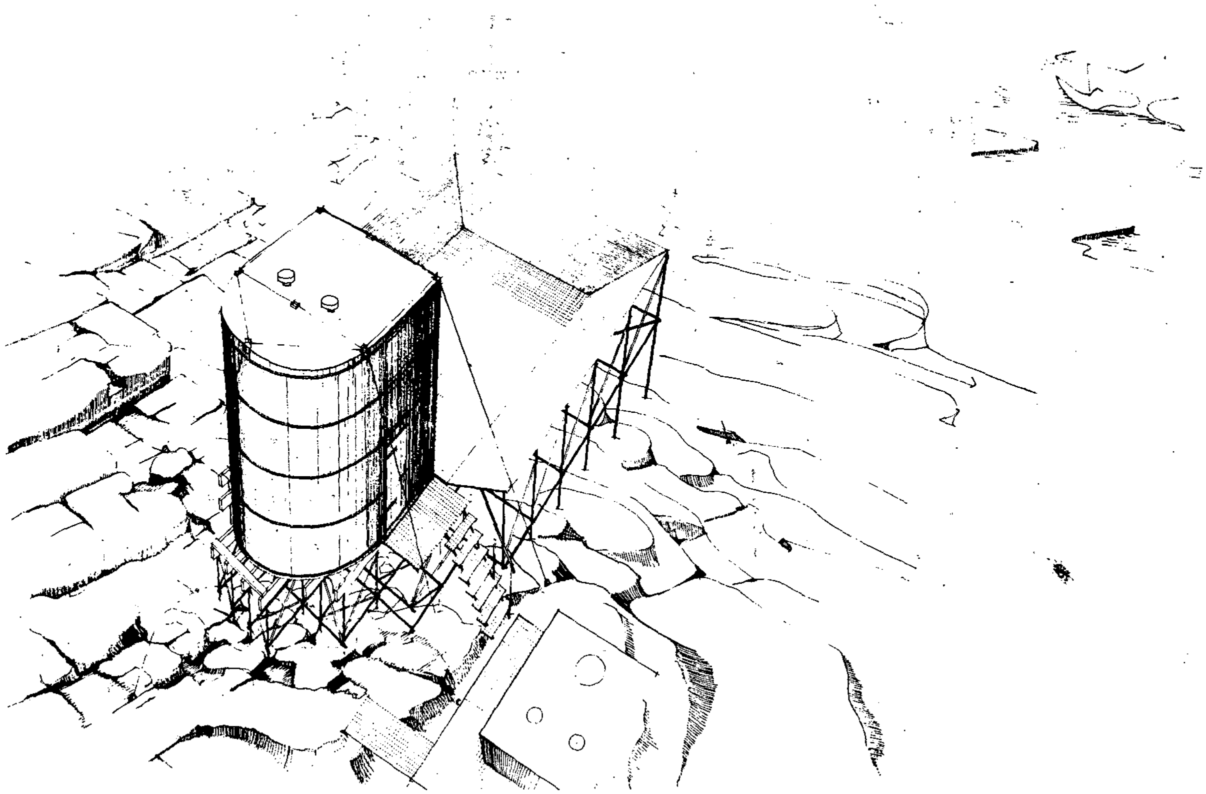
Fig. 9. Overall side view of station.



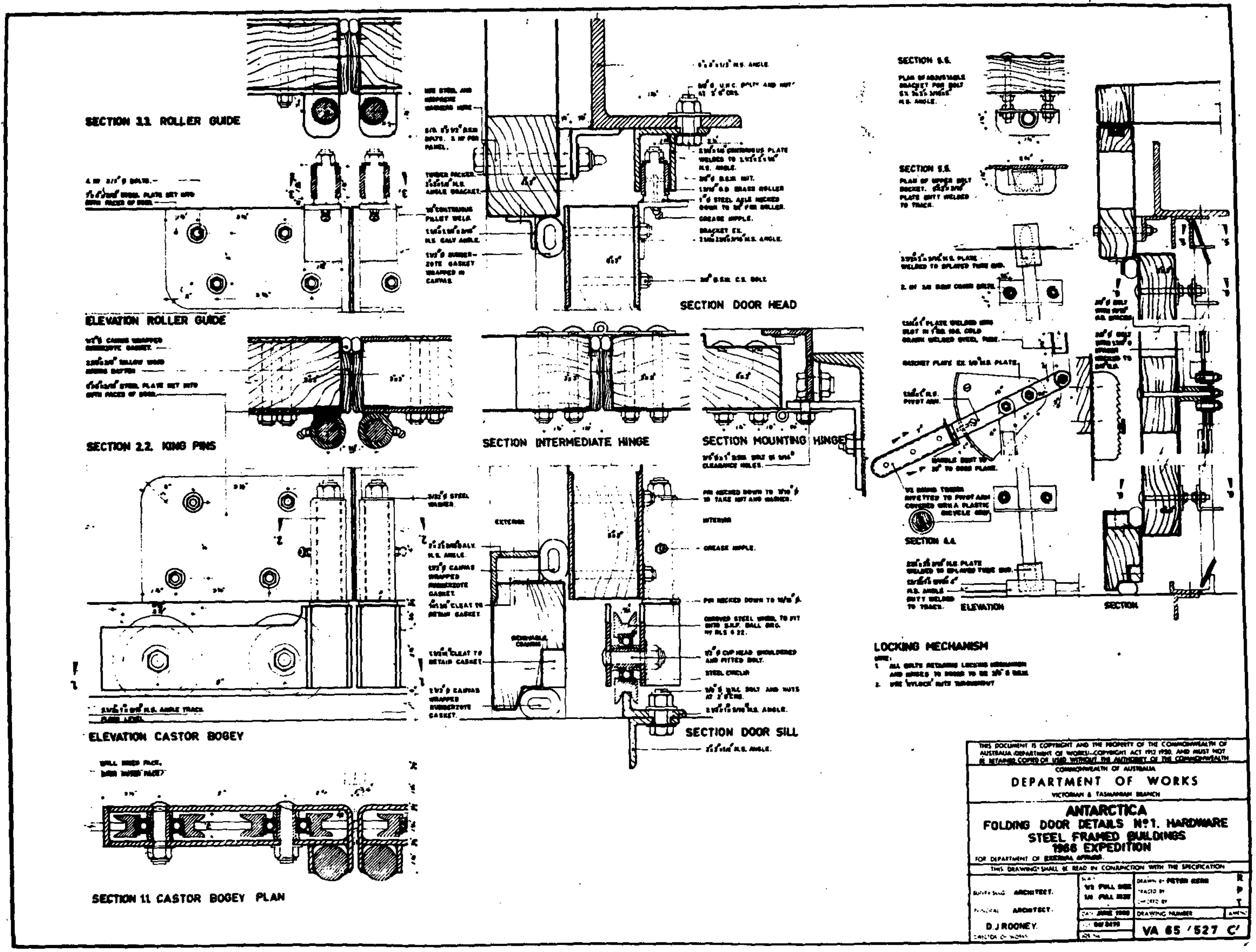
ANARE photo 17888/40

Fig. 10. Overall side view of lee side of the station showing roadway.



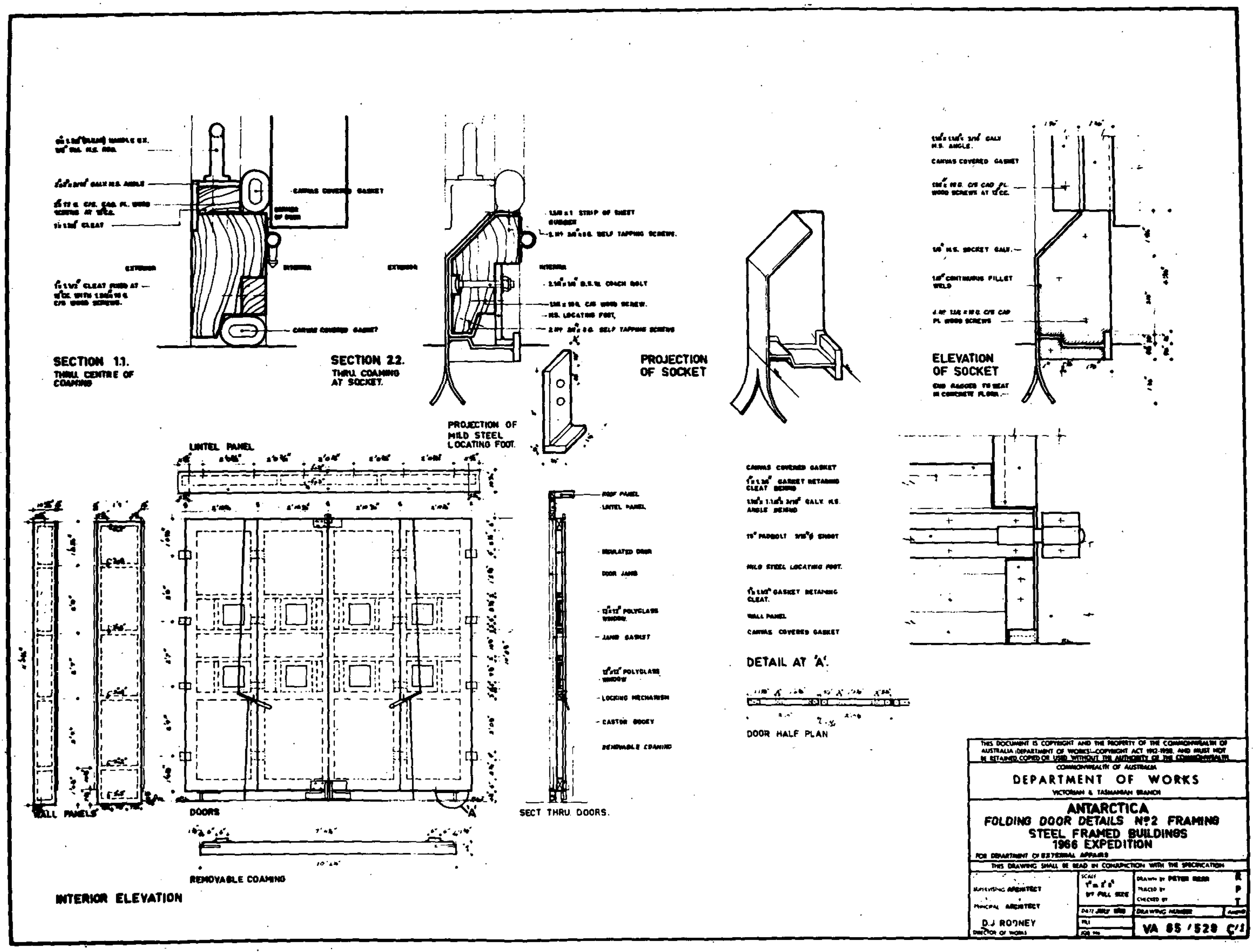
Department of Works Drawing VA65/527/C

Fig. 11. Elevated Balloon Building with rounded windward side.



Department of Works Drawing

Fig. 12. Doors of Balloon Building and Vehicle Workshop.



Department of Works Drawing VA65/528/C

Fig. 13. Doors of Balloon Building and Vehicle Workshop.

ACCOMMODATION FOR A TEMPORARY STATION
ON THE AMERY ICE SHELF

G.D.P. Smith*

Abstract

During 1968 a four-man Australian expedition is wintering on the Amery Ice Shelf, Mac.Robertson Land. This paper describes the portable living, working, ablutions and stores accommodation provided for the party, and discusses the design of the individual structures. These include buildings and caravans of glass-fibre-reinforced plastic construction. The construction of a subterranean storage area with an access shelter and loading facilities is also described.

1. General Plan of Project

A four-man Australian National Antarctic Research Expeditions (ANARE) party has been established to carry out scientific observations on the Amery Ice Shelf (Mac.Robertson Land) throughout 1968, from a temporary base situated about 60 miles inland.

In January, the m.v. "Nella Dan", which carried the party's stores and equipment, was warped into a suitable ice-ledge from which an access route to the main shelf was constructed.

Helicopters ferried most stores from the ice-edge to the site of the base, but unwieldy and heavy items were carried on sledges hauled by Nodwell RN35 tracked vehicles.

The size of items and overall weight of material supplied were restricted by the problem of delivery from the ship to the inland site.

The programme of work planned was as follows:

Summer: Set up base during unloading operations and while helicopter survey work continues.

Autumn: Study glaciology of ice shelf, travelling up to 150 miles from base by motorised toboggans, and camping in tents. Leave base unoccupied with instruments operating and recording automatically.

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Winter: Remain at base, drill hole through the ice shelf and continue other scientific observations.

Spring: Study glaciology of ice shelf, travelling up to 200 miles from base by motorised toboggans, and camping in tents. Take ice drill and caravan 150 miles further inland, using Nodwell, and drill another hole through the ice shelf. Leave base unoccupied, with instruments operating and recording automatically, with visits every few weeks to check and charge batteries.

Summer: Complete spring programme.

Withdraw all equipment to ice edge to be shipped out.

2. Accommodation Requirements

The accommodation of the expedition was required to:

(i) include the following functions: sleeping, cooking, messing, working, storage, ablutions, latrine, recreation and medical;

(ii) be readily transportable from the ship and back, with limited on-site assembly work;

(iii) be structurally suitable for high-wind and snow-accumulation loads;

(iv) be warm and comfortable with a small consumption of fuel;

(v) be fire-resistant and arranged so that an outbreak of fire would destroy only a limited part of the facilities.

To meet these requirements, the expedition was accommodated in 2 vehicle cabins, 2 living caravans, 1 portable laboratory, 1 portable ablutions hut, 1 prefabricated panel building, and 1 stores pit.

3. Living Accommodation

It was decided to use two standard ANARE glass-fibre-reinforced plastic caravans(1), with the interiors modified by reduing the number of bunks and increasing the cooking facilities.

Heating, cooking and lighting is effected by L.P. gas (Propane). The cooking stoves can accommodate bread-baking, and a liberal supply of utensils is provided. The supply of water being extremely limited, many PTFE-coated utensils are provided because they are easier to clean than conventional equipment.

4. Working Accommodation

A portable instrument laboratory was provided for the pursuance of scientific work. This unit, of glass-fibre-reinforced plastic and polyurethane foam sandwich construction, closely followed a design for a portable glaciology laboratory which had been used successfully at Mawson. Figure 1 illustrates the design of this laboratory.

The two Nodwell RN35 tracked vehicles have large all-over cabins, well insulated and heated. These were fitted out for workshop and radio communications functions.

The thermal ice drill and its generator were mounted on a small cargo sledge. A tarpaulin was provided for shelter if required.

5. Ablutions

Figure 2 shows an insulated, reinforced plastic shelter designed to be lifted and transported by helicopter. The lifting cradle also provides attachment points for guying the rather high structure. The runners allow it to be moved into position and provide a firm base on the snow. They are not intended for sledging the shelter very far.

The interior fittings include an earth closet-type pan suite, a small hand-basin and a shower recess complete with a 2-gallon bucket shower. This type of shower required considerable head room, and so determined the height of the building. Intermittent heating is provided by a small, portable, propane gas radiant heater.

6. Storage

It was desirable that some stores should be kept under cover. Limited transport resources precluded the provision of a large store building, and an excavation was required to keep a generous scale of frozen food adequately refrigerated. The two types of storage requirements were combined into a large stores pit.

Components and materials were provided to construct the stores pit as shown in Figure 3. Western red cedar was supplied to support the roof sheets. This timber, which had been chosen for its lightness, became suspect when some members failed under a snow load. Eucalypt hardwood, from "Nella Dan's" stocks, was added and this proved adequate reinforcement.

The pit was excavated by hand, using plastic garbage cans on ropes for hauling up the spoil.

A driftproof, prefabricated access shelter, ladder, and two-level loading platform were also provided. These were constructed from structural aluminium.

7. Medical and Recreation Accommodation

Provision of medical accommodation was considered essential. Although a medical officer forms one of the party, no suitable area exists elsewhere for an emergency operation. The space was also valuable as a less restricted place for recreation.

A commercially produced portable shelter was purchased from a firm in Canada (Parcoll Products) but it did not arrive in Australia until after the departure of the "Nella Dan". This unit, 16 feet x 8 feet, is made up of an aluminium bow-frame covered by insulated fabric. The outside is coloured orange and the inside is reflectorised. This shelter will be used in future inland operations.

As a substitute for this building, an 18 feet x 8 feet prefabricated building at Mawson was dismantled and re-erected at the Amery Ice Shelf. This building is of the current standard ANARE design[2].

8. Services

A power supply of 240 volt 50 Hz AC is intermittently produced from various generators. A 5 KW generating set is associated with a thermal ice drill. A 3 KW generator provides a standby AC supply for the drill and can also produce a DC supply for arc welding. Two portable 1 KW AC generating sets are available for use when the ice drill generator is not required.

A 12 volt DC battery system supplies instruments, lighting and radio. Battery chargers operate from the 240 volt supply and vehicle generators.

A 50 volt DC wind generator provides electric resistance heating to the instrument laboratory.

Propane gas heating, lighting and cooking facilities are provided for normal station functions, but electric appliances are also available. The Nodwell vehicles are fitted with petrol-burning heaters.

All internal combustion engines are fuelled by petrol (gasoline).

Vehicles and buildings are coloured externally International Aviation Orange.

9. Implementation

Current reports indicate that all facilities are functioning and that all structures and services are adequate.

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(1) Brown, A.M., and Smith, F.A. A Small Caravan for Antarctic Traverses. Antarctic Division, Department of Supply, Commonwealth of Australia, presented to Antarctic Treaty Meeting, Tokyo, 1968.

(2) Styles, D.F., Brown, A.M., Smith, G.D.P., and Lukinovic, Z. (1962). Australian Design and Construction of Antarctic Buildings. SCARLOG Symposium on Antarctic Logistics, Boulder, Colorado, 1962. NAS NRC, Washington, DC.

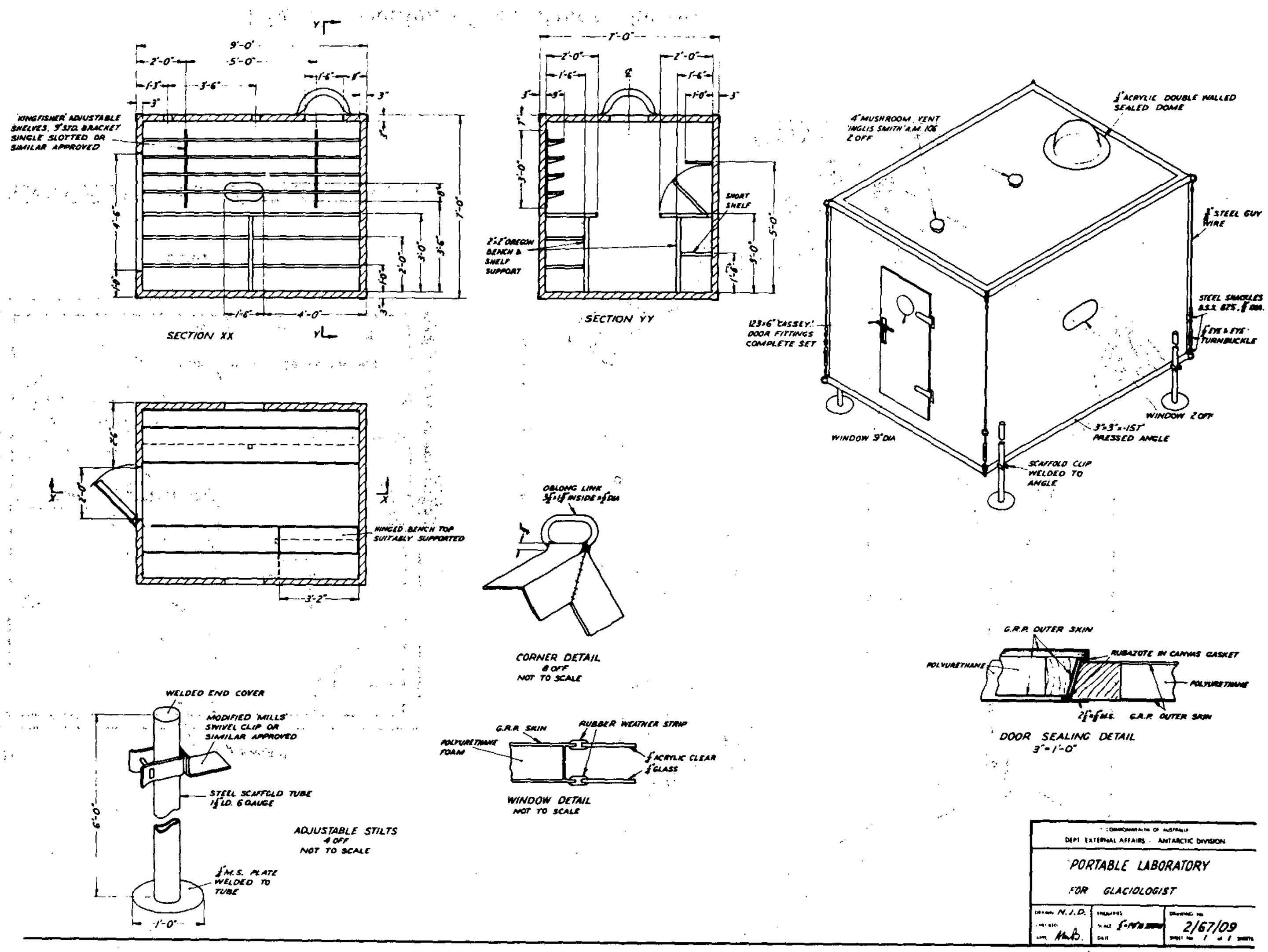

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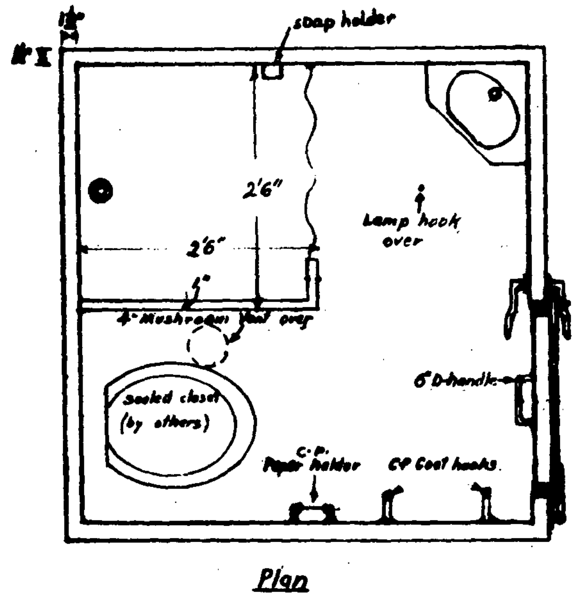
Fig. 1. Design of portable laboratory.



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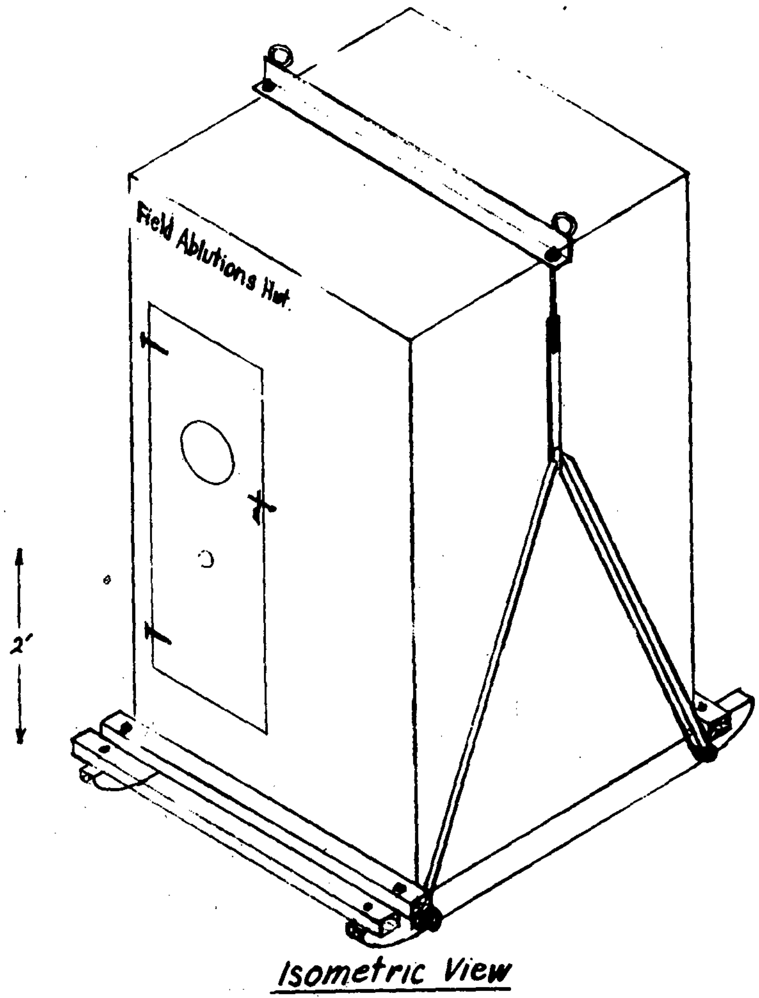
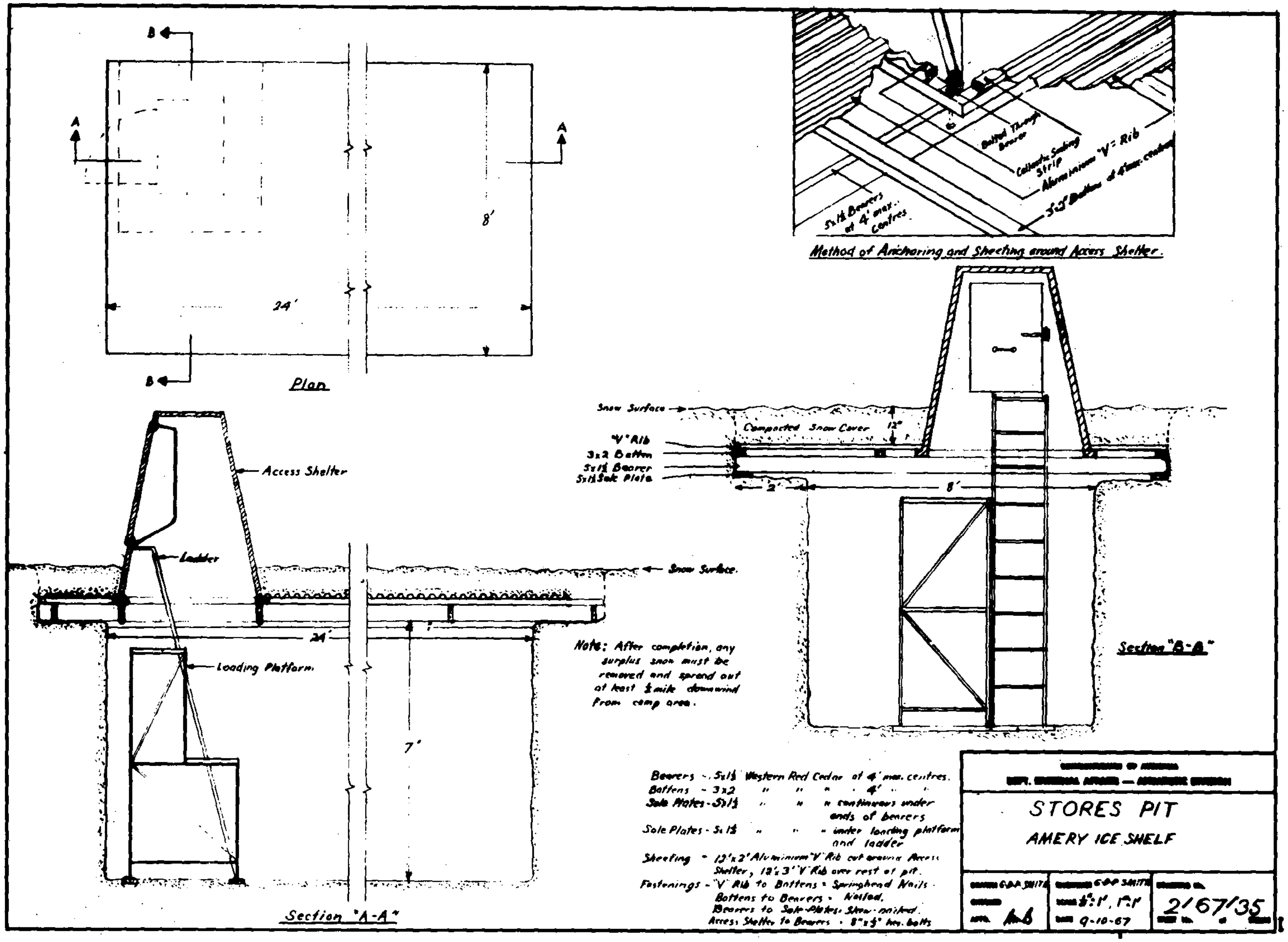


Fig. 2. Design of ablutions shelter.

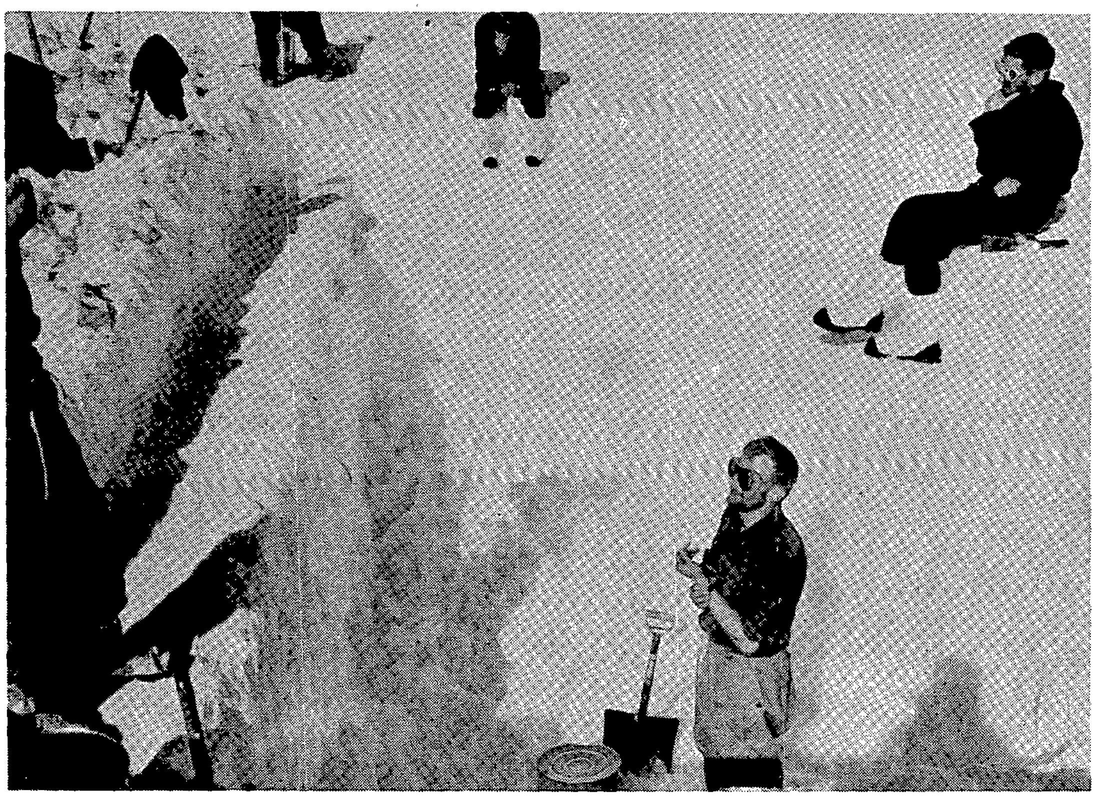


ANARE Drawing 2/67/35

Fig. 3. Layout of stores pit.

ANARE photo 18004

Fig. 4. Nodwells, sledges, laboratory and living caravans at the Amery Ice Shelf depot. Food boxes are stacked in the foreground.



ANARE photo 18001B

Fig. 5. Excavating the stores pit at the Amery Ice Shelf depot camp.

ANARE photo 18008

Fig. 6. Nodwell RN35 tracked vehicle with all-over cabin.

PROJECT PLANNING, PROGRAMMING AND SITE-CONSTRUCTION OF AN ANTARCTIC STATION

G.D.P. Smith*

Abstract

The new Australian National Antarctic Research Expeditions's (ANARE) station on the Budd Coast, Wilkes Land, is scheduled for completion and occupation in 1969. The construction programme is being achieved over a four-year period. Limited resources, especially manpower, require a close degree of planning, implementation and site-control. Constraints imposed on various phases by weather, ice conditions and other unpredictable factors necessitate frequent programme review and re-organisation of resources.

This paper outlines the available resources and describes planning methods, construction techniques, and site administration during intensive summer operations and reduced winter programmes.

1. Introduction

The design philosophy for a station with regard to minimising drift accumulations is presented by Styles and Melbourne(1). The development of the structural design of such a station is described by Brown, De Mole, and Gamble(2). The co-ordination of these and other factors to produce a properly integrated programme, and the implementation of this programme, is set forth in this paper.

2. Planning and Procurement

2.1 Design Procedures

In 1964, ANARE was authorised to build a new Antarctic station to replace the existing one at Wilkes which was deteriorating rapidly.

An identification name, "REPSTAT" (Replacement Station), was allotted to the project, and a committee formed known as the Repstat Design Group.

Members of this group were drawn from the Antarctic Division, then of the Department of External Affairs, the Department of Works, Aeronautical Research Laboratories, and Melbourne University Faculty of Engineering. Dependent sub-committees were formed for the development of the following functions:

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cargo-handling and facilities;

structural;

building services - mechanical;

fire control;

electrical distribution.

The final design called for a main row of twelve pre-fabricated buildings, erected on elevated substructures of tubular scaffolding. Elevated steel-grid platforms were sited between some buildings and a continuous, non-combustible corridor, aerodynamically shaped, connected the buildings. Other buildings, designed for specialised functions, were sited in isolated locations (Brown et al.[(2)]).

The selected site for the new station was on an exposed rock promontory near Wilkes, $1\frac{1}{2}$ miles across the sea or 5 miles around the coast. Access from the sea and to the plateau ice, and unimpeded movement about the station, were essential requirements. A system of roads and landings was therefore devised, including an access ramp for amphibious vehicles.

2.2. Scheduling

The building of the station was planned to take place over a four-year period followed, in 1969, by complete occupation of the station. The project breakdown structure chart (Figure 1) shows the phased stages of the project.

The scheduling of this project was influenced by such considerations as:

(a) financial budgeting;

(b) availability and capacity of shipping;

(c) labour requirements;

(d) labour availability;

(e) activity - time requirements;

(f) climatic constraints.

2.3. Procurement

The purchase of buildings was preceded by the preparation of contract documents including plans and specifications, this preparatory work being followed by the calling and acceptance of tenders. This work was carried out by the Department of Works in liaison with the Antarctic Division. Successful tenderers were carefully selected. Earlier experience had emphasised the inadvisability of entrusting specialised design to inexperienced contractors. Contracts also specified that buildings be erected at the manufacturers' premises before delivery. ANARE tradesmen and other expedition members participated in these trial erections.

As a considerable amount of time was required between the planning and delivery stages, some forward-ordering was initiated for buildings not required for delivery until after a particular year's programme.

Other materials, equipment and plant, although not subject to such detailed procurement arrangements, required careful specification and inspection in order to achieve satisfactory supply.

3. Implementation

3.1 Transportation

ANARE stations are relieved annually, ships being chartered for the conveyance of men and supplies. The ships employed during the construction period were m.v. "Nella Dan" and m.v. "Thala Dan", each of 2,000 tons approximate displacement. The bulk of the Repstat cargo each year has usually been carried by one of these vessels, with additional material sometimes being delivered by the second ship. The normal unloading practice is for ships to anchor offshore in a protected roadstead, the cargo being discharged into amphibious vehicles (DUKWs). Large items such as heavy plant are ferried ashore on inflatable pontoons which are warped into suitable unloading positions.

3.2 Manpower

Prior to the commencement of the Repstat project, ANARE construction work had been carried out at annual changeover periods by incoming and outgoing wintering parties which usually included a carpenter. The magnitude of the Repstat project called for increased skilled labour, so extra tradesmen were recruited for changeovers and for wintering parties.

3.3. Plant

Several items of construction plant were purchased or hired for the roadmaking, site-clearing and other civil engineering projects. Mechanical aids, for building and other structural activities, were also purchased. Mechanical plant and equipment included:

air compressors;

dozer tractors;

traxcavators;

tractor-mounted crane;

farm tractor and trailer;

four-wheel drive tipper truck;

pneumatic rock drills;

portable, motorised rock drills;

pneumatic pipe cutters;

portable power tools;

concrete mixers;

mechanical concrete screed;

mechanical concrete trowelling machine;

motorised builders' hoist, with platform modified to carry building panels;

pneumatic sheet metal rivetting tools;

explosive fastening tools;

portable welders;

oxy-acetylene torches.

Adequate supplies of hand tools covering all trades and functions were supplied. Temporary 240-volt 50-cycle AC electric power was provided by the installation of a $7\frac{1}{2}$ KVA diesel-alternator.

3.4. Accommodation and Messing

Living facilities at Repstat were adequate for the accommodation of both summer and winter work parties. During the first summer most men were accommodated on the relief ship, a few also living ashore in field caravans. During subsequent phases, use was made of the permanent sleeping, ablutions and messing facilities. Supplies of portable water were drawn from melt-lakes or melted snow. This water was sufficient for daily domestic use. Bucket showers of 2-gallon capacity, and fitted with fine jet sprays, provided an adequate means of daily showering.

Furniture, fittings and utensils were provided with the living buildings so that they could be used immediately upon erection. Cooking was effected by using propane gas stoves. Temporary heating was provided by small oil heaters (35000 BThU output).

3.5 Administration

The project was administered by the Antarctic Division and generally controlled by the Division's Engineering Branch. On-site supervision during the summer months was conducted by officers of the Branch. During the remainder of the year the Officer-in-Charge at Wilkes had the responsibility for the prosecution of the project, with a suitable expedition tradesman leading the work force at Repstat.

Party leaders, who were usually appropriate tradesmen, were in charge of particular activities during the summer periods.

4. Project History

The following Tables present the yearly phases of the Repstat project and analyse the planning and performance of the various activities. From time to time revised scheduling was necessary in order to achieve the desired progress. This revision was dictated by sundry unpredictable delays, e.g., dense pack-ice impeding relief ships.

4.1 1964 Programme

The project was initiated in the winter of 1964 so that the year's programme was mainly concerned with planning and procurement in Australia. A detailed survey of the site was made by the 1964 Wilkes wintering party.

1964

Scheduled Activity
In Australia:
Finalise design
Procure 2 buildings
Procure materials for 126 feet of corridor

Procure materials for 18 feet of platform and stairs

Procure roadmaking and construction plant

Procure explosives

Procure scaffolding, general building materials and tools

Survey site

Recruit technical specialists

4.2 1965 Programme

This was the first year of on-site activity. The summer period was mainly occupied by the construction of landings and roads. Labour was drawn from the wintering parties but augmented by two technicians who were employed during the changeover period for earthworking.

1965

Scheduled Activity

On site:

Construct DUKW landing

Construct roads about 3/4 mile in length (drilling, blasting, clearing and gravelling)

Set out buildings and clear sites

Erect 2 buildings (Recreation and Science)

Erect 126 feet corridor *

Erect platform and stairs *

Erect substructures for next four buildings *

In Australia:

Procure 6 buildings for 1966

Procure materials for 1966 programme

Initiate procurement procedures for power plant

* Not completed until 1966.

Dense pack-ice delayed the arrival of the relief vessel; thus the changeover period was curtailed. The structural work, therefore, was almost entirely left to the 1965 wintering party and these tasks proved to be beyond their resources.

4.3 1966 Programme

Two extra tradesmen were included in the 1966 wintering party and eleven tradesmen were employed during the changeover period.

1966

Scheduled Activity

On Site:

Erect 6 buildings (Mess and Kitchen, Ablutions Block, Latrine, 1st Sleeping Block, Power House, Vehicle Workshop)

Erect 190 feet of corridor

Erect 2 platforms and stairs

Erect all substructures for remaining buildings in main row

Instal temporary power plant

Instal 2 x 8000 gallon fuel tanks *

In Australia:

Procure 6 buildings to complete main row in 1967

Design transmitter, receiver, balloon, hydrogen generator and ionospherics buildings for 1968 programme

* Completed during 1967.

Deteriorating sea-ice conditions necessitated the withdrawal of the summer party earlier than planned. Despite this set-back, a great deal of the work was finished in summer. The remaining programme was completed by the wintering party who also completed further unscheduled works such as road improvements and the construction of floating jetties for small craft.

4.4 1967 Programme

Once again, a summer construction party of tradesmen was recruited, as well as a few tradesmen for the Wilkes wintering party.

1967

Scheduled Activity	
On Site:	
Erect 6 buildings to complete main row (Medical Building, 2nd Sleeping Block, Radio Building, Meteorology Building, Geophysics Building, Stores Building)	*
Complete corridor	*
Complete platforms and stairs	*
Instal 2 x 8000 gallon fuel tanks	
Instal 2 x 165 KVA diesel-electric generators	*
Instal bulk of plumbing for heating and water supply	+
Instal electric switchboards and power distribution	+
Instal electric fittings	+
Instal CO_2 flooding system in power house	*
Construct further roads	*
Instal 5 ship-mooring bollards	+
Instal 2 incinerator latrine units	*
In Australia:	
Procure 5 buildings for 1968 programme	
Procure CO_2 system for vehicle workshop	
Procure high voltage transformers and transmission system to transmitter building	
Procure materials for heated main drain	*

1967 (Cont'd)

In Australia:

Procure radio aerial equipment and order main transmitters

* Completed before May 1968

+ Activities which are expected to be completed during 1968, but after May.

The majority of the materials required for the 1967 programme were shipped on m.v. "Nella Dan" which also carried the summer party. The m.v. "Thala Dan" carried the Wilkes wintering party and a few lower priority materials for Repstat. The pack-ice conditions, however, were so severe that "Nella Dan", after several weeks of unsuccessful attempts to penetrate the pack, was forced to abandon the attempt and continue her scheduled voyage to relieve another station.

The "Thala Dan", after becoming beset, was eventually freed with the assistance of the USCG "Eastwind", and reached Wilkes and Repstat. Her Repstat cargo, however, was mostly plumbing and electrical material which could not be used until the main row of buildings had been completed.

The only works carried out on-site during 1967 were the installation of three fuel tanks and the laying of some power cable.

4.5 1968 Programme

The virtual loss of one year's production indicated that the final transfer from Wilkes to Repstat would be delayed for an extra year if the prevailing scale of activities was maintained. In an endeavour to recoup this loss, a four-man Repstat wintering party was recruited. This party, augmented by tradesmen from Wilkes, gave a skilled wintering force of 7 to 9 tradesmen, supported by varying numbers of unskilled expedition members. Seven more tradesmen formed the summer group. The usual unskilled labour was drawn from the Wilkes parties during changeover. The projects originally scheduled for 1967 were included in the 1968 programme in addition to those originally planned for 1968.

1968

Scheduled Activity

On Site:

- 1967 projects carried forward
- Erect five isolated buildings
- Instal 2 x 8000 gallon fuel tanks
- Instal CO_2 flooding system in vehicle workshop
- Instal automatic telephone exchange
- Instal fire detection system
- Erect log-periodic transmitting aerial array (150 ft mast, 3 x 42 ft masts, and dipoles)
- Erect 2 log-periodic receiving aerial arrays +
- Instal radio terminal racks
- Instal high voltage power transformers and transmission line to transmitter building +
- Lay floor coverings and re-paint interiors where necessary +

In Australia:

- Procure wind-finding radar and radome for 1969 +
- Procure remaining radio equipment +
- Finalize plans for changeover to Wilkes in 1969 +
- Commence transfer of equipment and functions from Wilkes +

\+ Expected completion 1968.

The works shown as actually completed in 1968 are up to the time of writing (May 1968). The items marked by asterisks in 1967 and 1968 Tables are expected to be completed during the remainder of 1968. The summer construction party spent the full scheduled period (7 weeks) at Repstat, having been flown in 80 miles by helicopter from m.v. "Nella Dan" over the ice. The m.v. "Thala Dan", which carried the main cargo, successfully negotiated the ice, as did the "Nella Dan" on its return at the end of the season.

4.6 1969 Programme

The installation of the wind-finding radar, an effluent drain, remaining radio equipment and 3 fuel tanks are the only engineering projects planned for 1969. As they are scheduled to be completed during the early summer of 1969 and all other works are expected to be complete by that time, it is proposed to send the 1969 Wilkes wintering party into Repstat at changeover 1969. The transfer of functions and equipment from Wilkes to Repstat is expected to commence during late 1968, the bulk of the transfer to be effected during changeover, making use of amphibious vehicles. All operations at Wilkes should be closed down before winter.

1969

Scheduled Activity
On site:
Instal wind-finding radar and erect radome
Instal effluent drain
Instal 3 x 8000 gallon fuel tanks
Instal remaining radio equipment
Complete transfer of functions, equipment and stores from Wilkes to Repstat
Complete occupation of station

5. Future Plans

It is planned to clear the whole station area of boulders and to smooth out depressions and protuberances in the rock, filling and surfacing where necessary. This smooth surface is expected to minimize drifting and facilitate removal should any drifts occur.

The spoil from this activity will be dumped in a shallow channel between the station and a chain of offshore islets. This spoil will form a causeway connecting these features. Preliminary depth-sounding surveys indicate that the islets shelve steeply on their seaward side into deep water. If further investigation proves its feasibility, the construction of a deep water wharf and a road over the causeway will be considered. These facilities, together with suitable unloading equipment and vehicles, would allow the speedy unloading of vessels berthed at the wharf.

6. Some Comments on the Repstat Project

6.1 Labour

The employment of groups of tradesmen during both summer and winter proved remarkably effective as the productivity of non-skilled expedition men cannot compare with that of efficient, experienced tradesmen, no matter how enthusiastic the former may be.

Tradesmen were carefully selected for qualities of energy, speed and enthusiasm, and usually could be considered as being above the average. The work-pattern required that long hours were worked daily for unbroken periods of several weeks. The loss of efficiency over a long period of this routine was not as great as may be expected in a conventional environment. An example of the estimated average efficiency-loss among trademen during progressive stages of the 1968 programme is shown in the following Table. The efficiency-loss appeared to increase sharply when men were engaged in tasks requiring a higher degree of concentration, e.g., detailed plumbing reticulation, intricate electrical fitting, etc.

Duration of programme	Efficiency on high concentration work	Efficiency on heavy physical work
On arrival	100%	100%
2 weeks	95%	98%
4 weeks	85%	90%
5 weeks	70%	85%
7 weeks	60%	80%

During this period the men averaged $\frac{1}{2}$ day of rest every 2 weeks, interior work being carried out during excessively bad weather. Outside tasks were carried out in wind velocities up to 70 knots, but the productivity fell off sharply in these conditions and it is not economical to pursue tasks in winds of over 45 knots. Movies and other amenities helped to maintain the men's morale during the intensive work period.

6.2 Building Erection Techniques

The erection of elevated standard buildings followed a four-phase routine:

Phase 1 - Erect substructure

Phase 2 - Assemble and anchor floors

Phase 3 - Complete erection of shell and tie down

Phase 4 - Complete interior partitioning and fittings.

Each year, gangs would erect all the substructures and floor assemblies for that year's programme before completing any further erections. Up to three shells per day would then be completed.

Corridor substructures, framing and floors were erected by a gang which included plumbers. This second party fixed sheeting and caulked the structure.

On all tasks, appropriate tradesmen would be reinforced by necessary numbers of non-tradesmen.

6.3 Earthworking Techniques

Explosives used in the early stages for the construction of roads and landings were mainly bore-hole charges of Polar Plastergel, a high-velocity gelatinous explosive. This proved very efficient but became dangerously unstable in storage, exuding nitro glycol. Its use has now been discontinued, A. N. gelignite "60" being substituted. This is a general-purpose gelatine with a high percentage of ammonium nitrate. It tends to become insensitive at low temperatures but regains sensitivity when temperatures rise. It is not used in temperatures below 10°F.

Initiation of explosives was effected by detonating cord, triggering by a single detonator.

Pockets of gravel, sand and moraine debris in the station area augmented the blast-spoil to provide material for surfacing roads. These naturally-occurring materials also provided aggregates for less important concrete projects, aggregate for structural concrete being supplied from Australia.

Some cable trenches had to be excavated through loose gravel and sand, interlarded by reefs and boulders. This task was carried out when this ground was frozen. In this condition it would support bore-holes without subsidence. It was treated, therefore, as a monolithic material and excavated by sequentially-firing gelatine charges by means of 17 millisecond detonating relays.

6.4 Radio Mast Erection Techniques

The log-periodic transmitter masts were anchored by guys attached to 7 ft x 7 ft steel "deadmen" buried in an area of moraine debris. Holes for these deadmen were blasted out by TNT-shaped charges and gelatines.

The 150 ft main mast was raised by a cable passing over a jury rig, through a snatchblock on a parked tractor, and finally attached to a D4 tractor which was driven the distance necessary to raise the mast.

6.5 Site Administration

The application of a network analysis to each year's programme allowed a close degree of site control to be effected. Figure 2 shows a typical network for the 1966 summer programme.

The following Table shows the average times consumed and the numbers of men engaged in the performance of certain tasks.

Activity	Number of men	Performance time (days)
Erection of elevated building substructure	3	1.5
Assembly and anchorage of floor	4	1.5
Completion and guying of building shell	8 - 12	1
Completion of building interior	2	2
Completion of corridor per 100 feet	5	16
Erection of 1 platform and stairs	2	2
Roadmaking per 100 feet	6	1
Site preparation and erection of log-periodic aerial array	3	35

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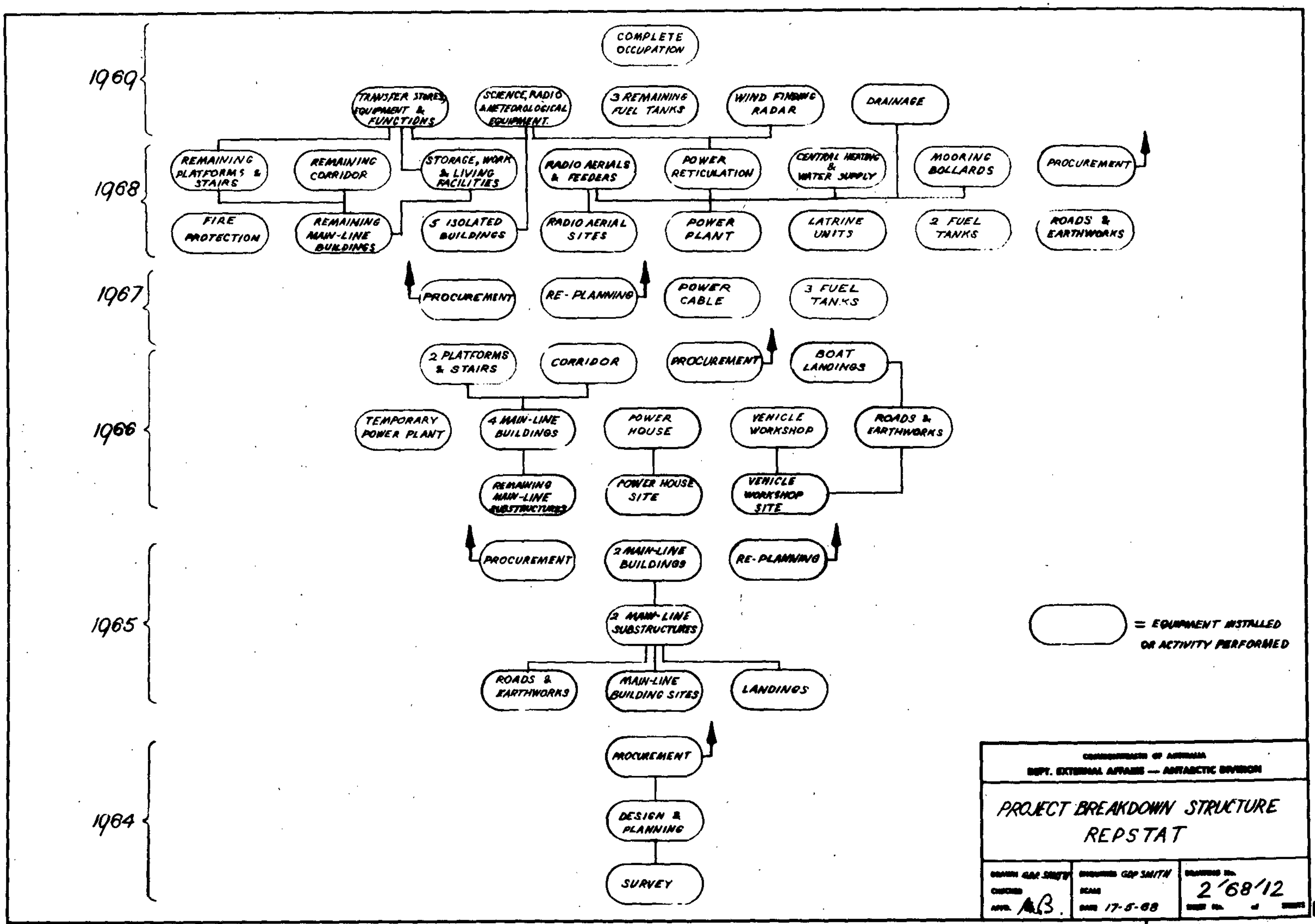
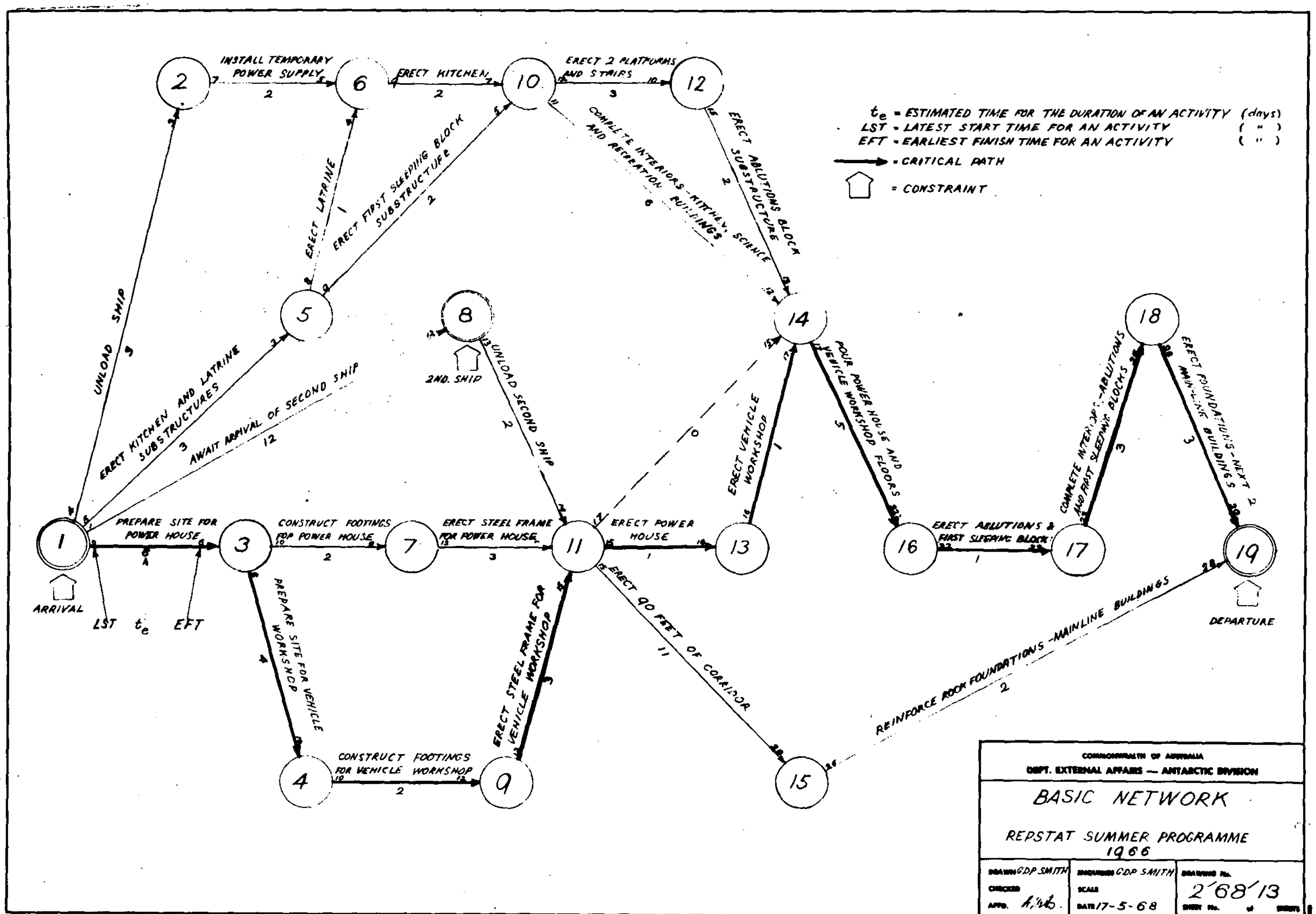
(1) Styles, D.F., and Melbourne, W. H. Outline design of a station to minimize drift accumulations.
Antarctic Treaty Meeting on Logistics, Tokyo, 1968.

(2) Brown, A.M., De Mole, D., and Gamble, J.A. Structural design of an elevated station.
Antarctic Treaty Meeting on Logistics, Tokyo, 1968.



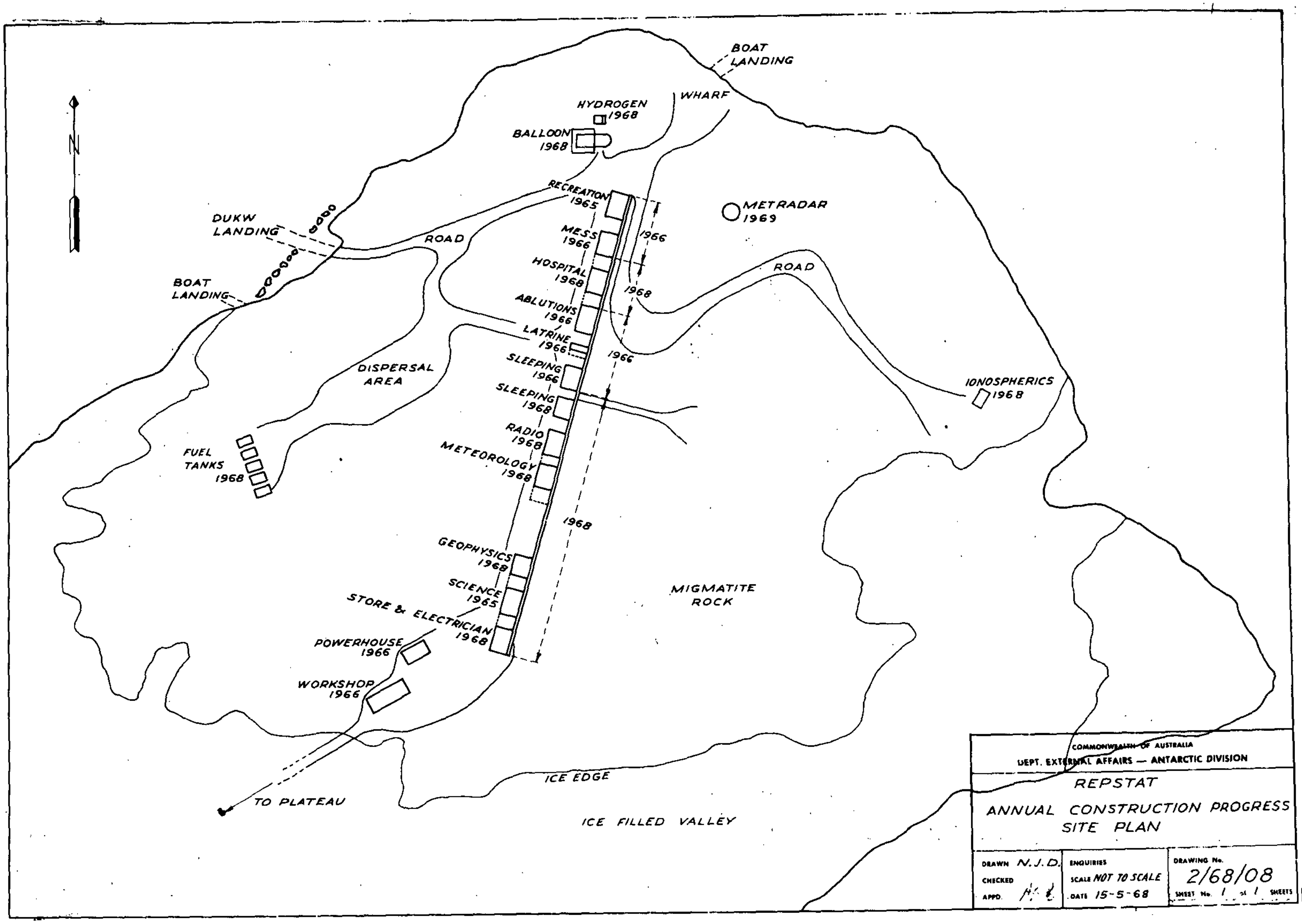
ANARE Drawing 2/68/12.

Fig. 1. Project breakdown structure chart.



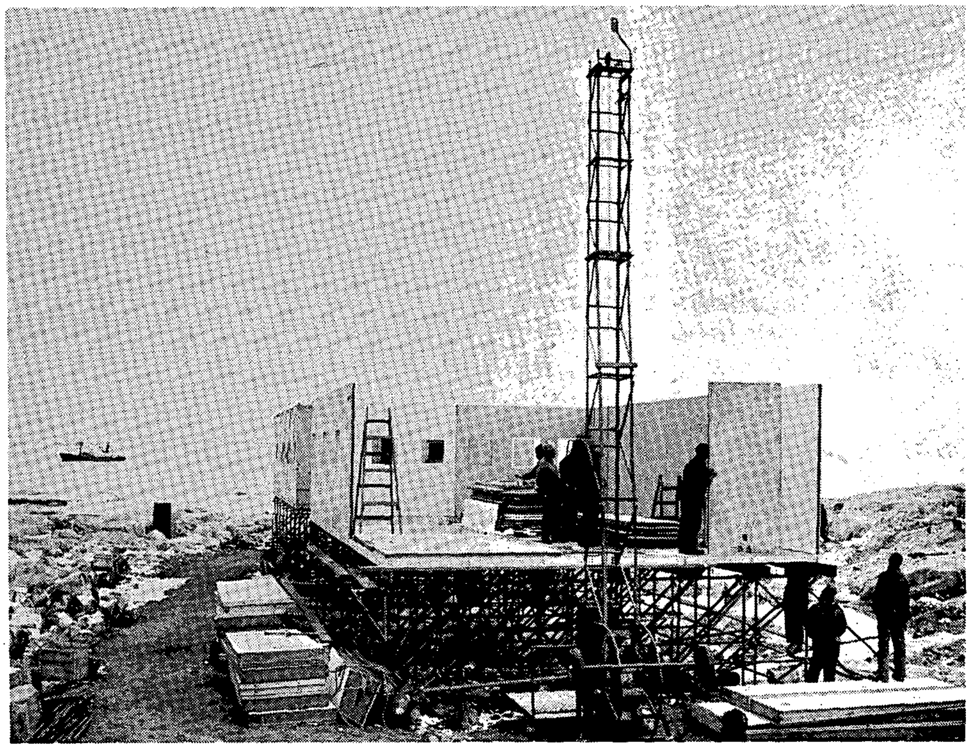
ANARE Drawing 2/68/13

Fig. 2. Network for typical summer programme.



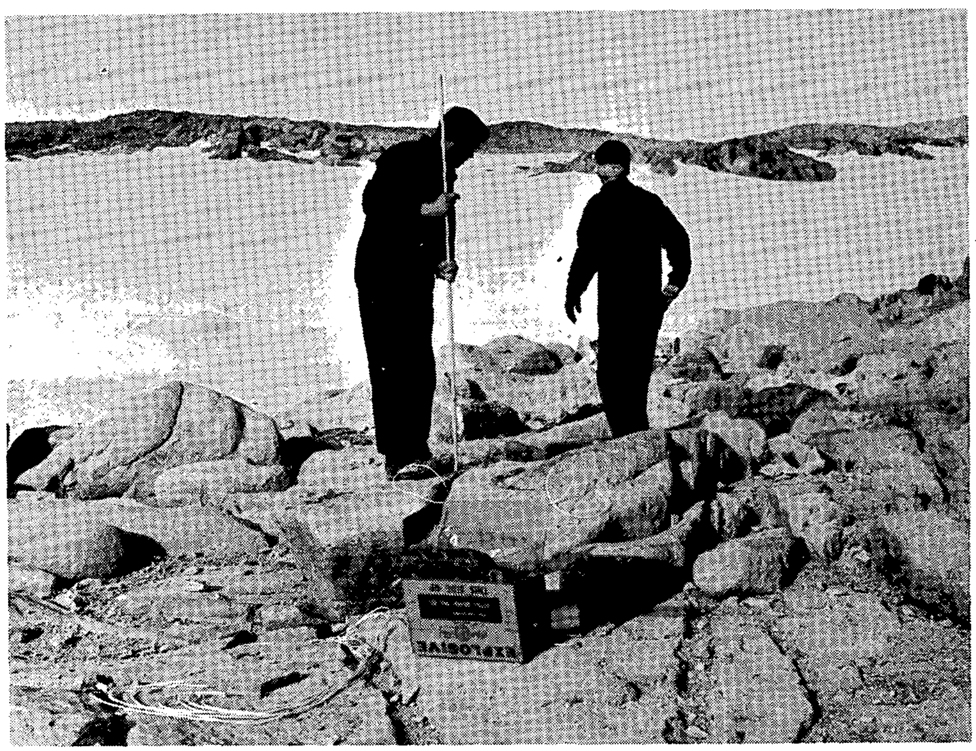
ANARE Drawing 2/68/08

Fig. 3. Repstat site plan.



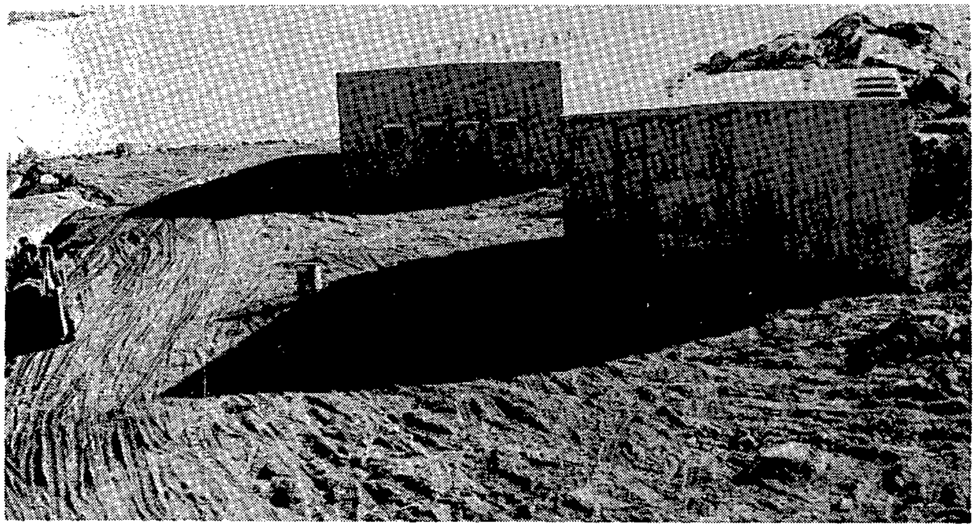
ANARE photo 16607B

Fig. 4. Erection of wall panels on a standard elevated building (kitchen and mess). The hoist platform has been modified in order to accommodate the largest building panels.



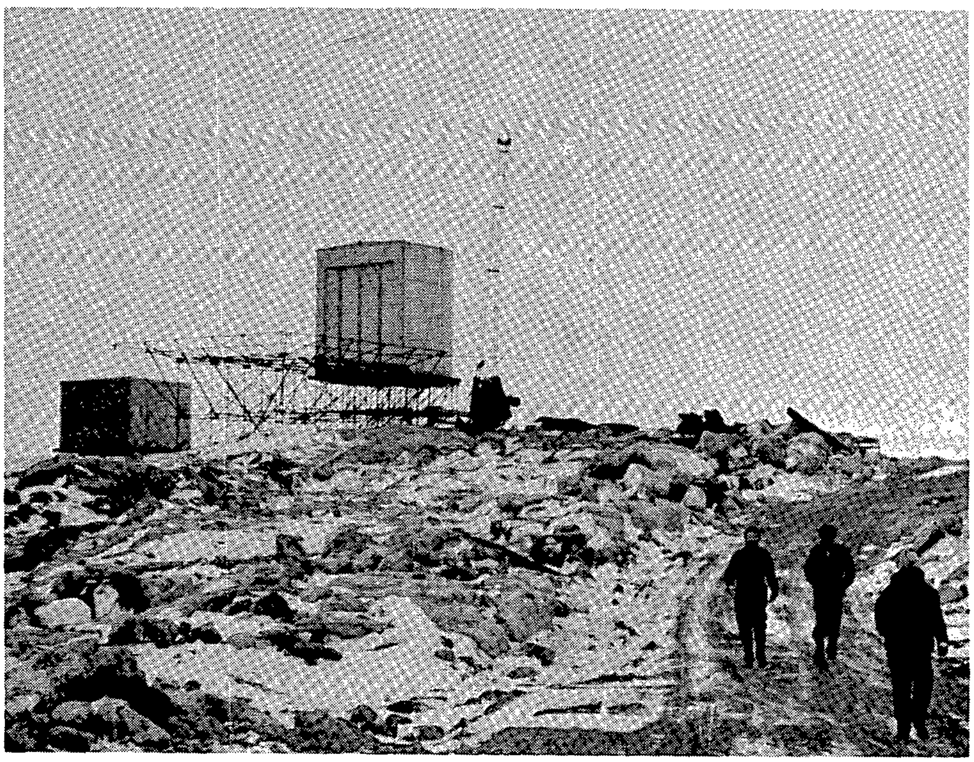
ANARE photo 16606A

Fig. 5. Commencement of blasting operation in vehicle workshop and powerhouse area.



ANARE photo 17996

Fig. 6. Completion of construction operations in vehicle workshop and powerhouse areas. At this stage the road and turning aprons had been constructed and the building erection completed.



ANARE photo 17988

Fig. 7. Balloon release building, launching platform, hydrogen generator building, and erection equipment.

INTEGRATION OF POWER, HEATING AND WATER SUPPLIES APPLIED AT AUSTRALIAN ANTARCTIC STATIONS

Alan M. Brown*

Abstract

Systems at Australian Antarctic stations recover waste heat from diesel generators for central heating and water services. This integration is achieved by unusual piping arrangements designed to minimise operating complications and controls. The result is very efficient utilization of fuel for minimum capital cost.

1. Introduction

Recovery of otherwise wasted heat at Antarctic stations is an obviously worthwhile project.

All fuel must be imported on the relief ships and forms a large part of the supplies taken to a station. It is accordingly a very significant factor in the logistic support of expedition activities.

The major portion of the fuel supplied is used by diesel generating sets to provide electric light and power which is used for scientific equipment, radio communications, workshops, living quarters, refrigeration and heating. (Some electric heating is virtually unavoidable, particularly for small isolated heat loads and accurate temperature control. The use of non-electric heating often introduces complicated equipment, maintenance problems, and fire hazard.) The thermal efficiency of diesel generating sets is approximately 33%, the remaining 67% being dissipated as heat energy.

With the exception of a relatively small quantity used in vehicles, the fuel supplied is used in direct-fired boilers, stoves, or furnaces for space heating, water supply (snow-melting), hot water supply, and cooking. The thermal efficiency of such equipment is generally between 60 and 85%.

By the installation of a central heating system and the recovery of waste heat from the diesel generators, an integrated system is introduced which, at the same time:

(i) saves the fuel normally required for heating by other means;

(ii) raises the overall powerhouse efficiency to that of direct-fired equipment (Note that any electrical heating which is required is made economical.);

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(iii) provides comfortable, safe, reliable services, with far less maintenance than is possible with a multiplicity of heaters;

(iv) provides cool powerhouse conditions for better engine performance. (Frequently, drifting snow makes ventilation of a powerhouse difficult in Antarctica.)

However desirable it may be thermally, to be successful at our Antarctic stations the system must be such that it can be easily installed, commissioned, operated, and maintained by mechanics with no knowledge of heating systems and with a full work load.

2. Waste Heat Recovery from Diesel Engines

The energy released by combustion of fuel in diesel generators is divided approximately equally into three parts: electrical energy, coolant heat, and exhaust and radiant heat. Normally, the latter two parts are wasted and the thermal efficiency of the plant is therefore approximately 33%.

Houston (2) has presented typical figures and graphs to show the distribution of heat output for various conditions and types of engine. Figure 1 shows the distribution for a typical naturally aspirated engine at constant speed, and Figure 2 shows the slightly different distribution for a typical turbo-charged engine. This information is generally sufficient, but the manufacturer of a particular engine may be able to provide information to assess the heat available under various conditions more accurately. The exact distribution will depend upon the size, type and condition of the engine, and its loading and speed. As some of these important factors are not constant, the system must be designed to be able to operate under the varying conditions which occur.

Each part of the output has certain characteristics which must be appreciated before proceeding with the design of a heat recovery system:

(i) Electrical energy output
Electrical output of a generating set is determined by the connected load, and this controls the input of fuel, although not usually directly. A light electrical load results in less fuel being used and consequently less output of heat in coolant, exhaust, etc. Therefore, the design of a system to use the latter outputs must incorporate means to provide sufficient heat output for requirements at all electrical loads expected.

(ii) Coolant heat output
Heat output from the engine cylinders and heads is borne away by air or water, depending on the type of engine. In either case,

minimum and maximum temperature must be carefully controlled within the engine design limits to avoid damage to the engine. The choice of coolant is governed by the following considerations. Using a water-cooled engine, the control of temperature and the transfer of heat for use elsewhere is accomplished readily with little heat loss and using little power. Freezing and boiling of the coolant must be avoided, and the system must be designed to avoid leaks and corrosion.

On the other hand, using an air-cooled engine, the control of temperature is difficult to achieve, although the effect is not so critical on the engine. The transfer of heat released for use elsewhere involves greater heat losses and considerable power requirements. If the heated air is used directly, a large and complicated system of ducts and fans is required which carries engine smells and noise, and a fire hazard is created.

Lubricating oil coolers are generally provided on all but the smallest stationary diesel engines. Generally, only 1 or 2% of total heat is removed in this way, but special oil-cooled piston designs may raise this figure to 7%. It is convenient to transfer the heat from the lubricating oil to the engine collant and, as the oil is heated on starting or light loads, the heat exchanger is sometimes called a temperature stabilizer. A common arrangement of an oil radiator, mounted in the air stream from the coolant radiator, is not suitable if the air flow through the radiator will be stopped when the heat is to be directed elsewhere.

(iii) Exhaust and radiant heat output

Exhaust heat output is in the form of a mixture of condensable and non-condensable gases, oil and carbon, at a temperature of about 700°F. Recovery of waste heat is arranged by passing the exhaust through a heat exchanger, which often also serves as noise muffler and must be capable of operating dry without damage. Condensation, fouling, corrosion, and excess backpressure must be avoided, and typical recovery is 10 to 15% of the heat released by the fuel. There are difficult design problems which, if not properly solved, result in excessive maintenance and short life. Local cooling effects make it more difficult to design for production of low-temperature hot water than high-temperature water or steam. Exchange of exhaust heat to air is less difficult, and this may be a simple and economical way of augmenting the heating of the powerhouse if required.

Heat is radiated by the whole of the engine and is usefully employed if the powerhouse requires heating. This is generally so in Antarctica when coolant heat is not released into the powerhouse.

A small heat loss is released into the powerhouse by the alternator and is also usefully employed if the powerhouse requires heating.

3. Description of the Systems at ANARE Stations

3.1 Diesel Engines

Two diesel generating sets are installed to carry the load alternately, with provision for a third set when the load requires two sets to be run in parallel.

The whole of the coolant heat output is transferred to a central heating system. The fan of each coolant radiator is driven electrically under control of a thermostat in the water, leaving the engine so that it only operates when heat released exceeds the demand of the central heating system.

The system does not recover the exhaust heat output, because there is sufficient heat available from the coolant for nearly all requirements, and the additional expense and maintenance is not warranted. If additional loads were added to the central heating system, without additional electrical loads to balance them, exhaust-heat recovery would need to be reconsidered.

Radiant heat from the engine and alternator losses warm the powerhouse. The rate at which heat is released is not sufficient to keep the powerhouse above freezing point if there is poor thermal insulating of the building.

3.2 Boiler

A small oil-fired boiler is installed in the powerhouse. The boiler is used to maintain the minimum return water temperature required for satisfactory operation of the engines and the heating system (150°F) by making up any discrepancy between the heat demand of the central heating system and the engine heat output. This would occur particularly when the electrical load was light and the heating load was heavy. In practice, in this installation little fuel is used by the boiler because the heat available from the engines is sufficient to satisfy demand at nearly all times. The boiler also serves as standby plant for the heating system, if engine coolant is not available for any reason, and assists in the rapid warm-up of the system after shutdown.

An electric water heater is provided in the central heating system at stations where the generator capacity is sufficient to meet diurnal and seasonal load peaks, and future increases in consumption. With large engines, low electrical loading for extended periods gives poor engine performance and poor thermal efficiency, compared with higher loading. The electric water heater, with capacity 25% of generator capacity, is therefore provided, and the heat balance diagrams show how the electric boiler load results in the release of more heat to the engine coolant. A thermostat controls its operation and is set higher than the oil-fired boiler control thermostat. The oil-fired boiler only operates if the electric water heater does not provide sufficient heating effect to meet demand.

3.3. Central Heating

A number of buildings near the powerhouse at each station can be conveniently heated by a central system.

Heat conduction and infiltration of air are very well controlled in the buildings. Conduction and ventilation requirements contribute about equally to heat requirements. The total heat requirement at the minimum design ambient temperature of minus 30°F, and inside temperature of 65°F, is approximately comparable with the heat available from the coolant of one engine at three quarters of rated maximum continuous load.

3.4. Water Services

Heat is required for melting ice, storing the water, and for hot water service. Inclusion of this load in the system provides a thermal storage to help in stabilizing the system. The average heat required for water services is not very large. A hot water cylinder, with an indirect heating coil connected to the central heating system, provides all heat requirements for water services. Hot water from this cylinder is reticulated to kitchen, bathroom and laundry, to the storage tanks to warm them, and to the snow-melting tank when required. Small bore piping has been used in reticulation to limit flow and usage. Water must be conserved because of the labour of collecting ice.

Provision has been made in design of the piping systems for desalination plant to be added to the system at each station.

4. Piping Arrangements

The diagrams show a method of connection which is designed to minimize operations and be self-balancing. The usual circuit of an engine's coolant is through the engine block and head, via the engine thermostatic bypass valve to the engine radiator, and returning through the oil cooler to the engine-driven pump and thence to the engine. This is retained entirely in the system and the water takes this course should the central heating system be shut off or closed down.

The radiator fan is driven electrically under the control of a thermostat in the water leaving the engine, operating only when heat released exceeds demand.

An electric pump in the flow line of the central heating system circulates water from the powerhouse round the heating system. The engine circuits and the boiler are connected in parallel to flow and return headers.

It will be seen in Figure 5 that the flow and return connections of the central heating circuit to each engine circuit are both into the pipe from the engine to the engine radiator, so that there is a short length of pipe common to both circuits. The central heating pump forces circulation through this common pipe. If the engine is operating, its pump acts to draw water from the return connection and discharge it from the flow connection, and the common pipe between the two connections carries a balancing flow. The circulation from the central heating system is increased when the engine pump is operating.

A small circulation through the inoperative engine keeps it warm for easy starting and helps to warm the powerhouse.

It is not necessary to change valve settings when changing over from one engine to the other.

A heat exchanger between engine coolant and central heating system was considered to be an unnecessary complication, provided the piping was properly installed to be completely reliable.

One system is pressurized by a semi-rotary pump and an air cushion vessel. A pressure relief valve is set at a 10-ft head. A header tank was not desirable for aesthetic reasons. The other systems have a conventional header-tank arrangement.

Piping is of light gauge copper with capillary fittings to minimize site labour.

Insulation of piping between buildings is generally 2 inches-thick mineral wool, covered with sheetmetal sheathing. At one station a 10 inch-diameter steel pipe, 3/16 inch thick, forms a duct for pipes and insulation for spans up to 40 feet between buildings.

It has been necessary to insulate piping mains inside buildings both to limit uncontrolled emission from the piping and so prevent uncomfortable room conditions in warmer weather.

5. Controls

Only simple controls are required and their action is easily understood.

The oil-fired boiler and the electric water heater are each controlled by a return line thermostat to maintain the minimum operating temperature. Each has a high-level safety thermostat in it to shut down the burner if the water temperature rises to 205°F.

The engine radiator fans are each controlled by a thermostat in the water leaving the engine set at 190°F. A safety thermostat in the same place shuts down the engine at 205°F.

Various heating radiators are controlled by self-acting thermostatic valves.

No other controls are required.

6. Operating Experience

The Davis plant was commissioned in May 1963, and proved reliable and efficient prior to closing the station in 1965. The boiler used no more than 6 gallons of oil in a month and usually much less. The engine radiator fans only operated occasionally, and additional heating was required in the powerhouse in cold weather.

Ethylene glycol was added at first as a precaution against freezing, but experience has indicated that this is not necessary, and it is potentially dangerous as a poison. In the unlikely event of an extended power failure while using no antifreeze, it would be necessary to drain the system before freezing occurred.

The Macquarie Island system which linked the powerhouse to an existing central heating system, was commissioned in 1967.

A large system is being installed at present (1968) at the new station near Wilkes, and will be commissioned in 1968.

A system is being installed at present (1968) at Mawson, connecting up the existing buildings, and will be progressively commissioned over the next two years.

7. Conclusions

Waste heat recovery from diesel engines can be accomplished with very few complications and minimum expense, and integrated into a central heating system to give considerable operating economies with virtually no additional maintenance. The principles may be readily applied in many other situations.

8. Acknowledgement

Grateful acknowledgement is due to the men of the expedition who installed and commissioned the equipment with enthusiasm and skill, despite lack of experience in this kind of work.

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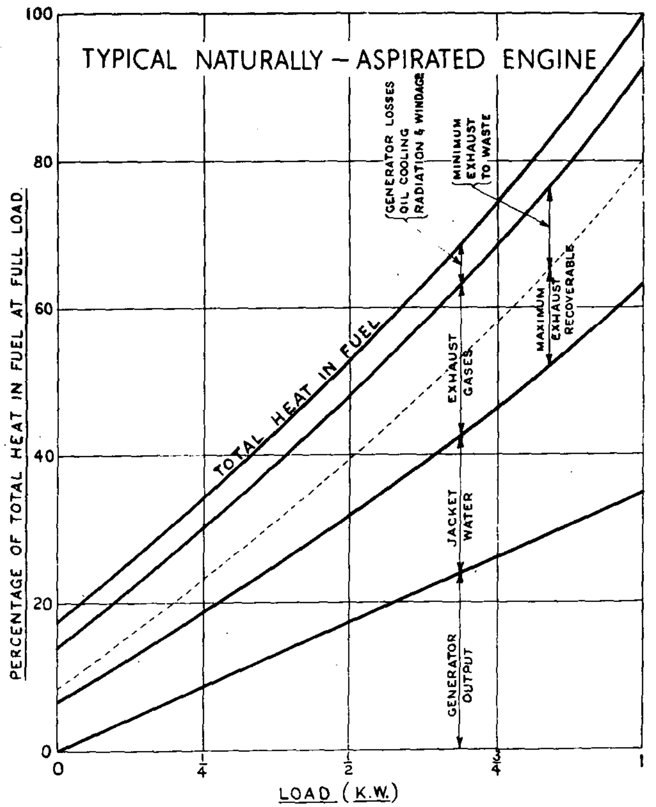


Fig. 1. Graph of heat distribution versus load, naturally aspirated engines. (From Houston Ref. 2)

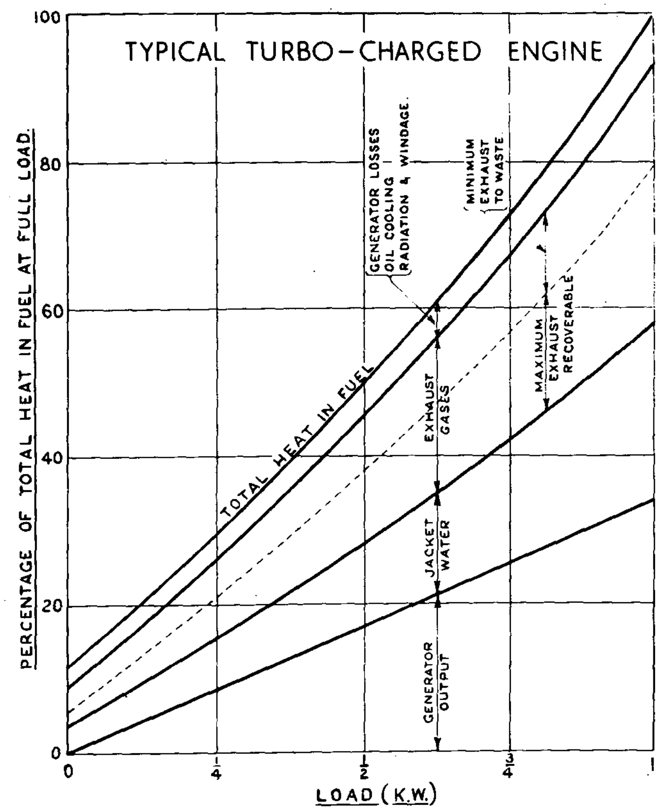
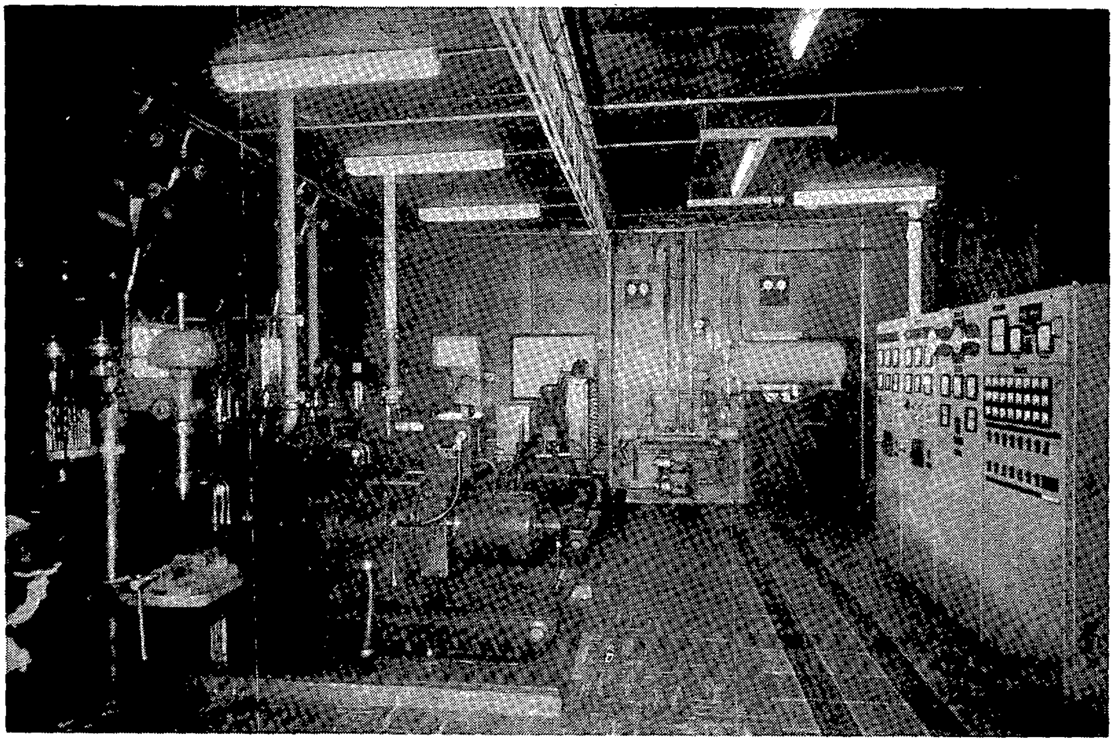


Fig. 2. Graph of heat distribution versus load, turbo-charged engines. (From Houston Ref. 2)



ANARE photo 13225 by A. Campbell Drury

Fig. 3. Davis powerhouse.

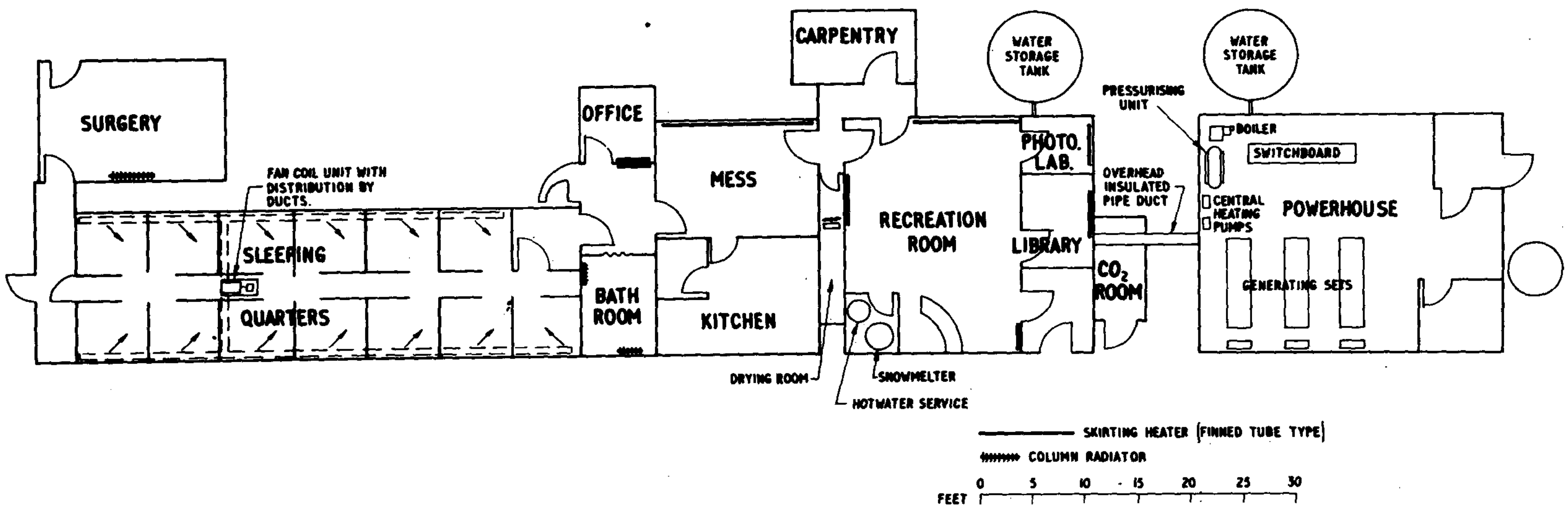


Fig. 4. Plan of centrally heated buildings at Davis.

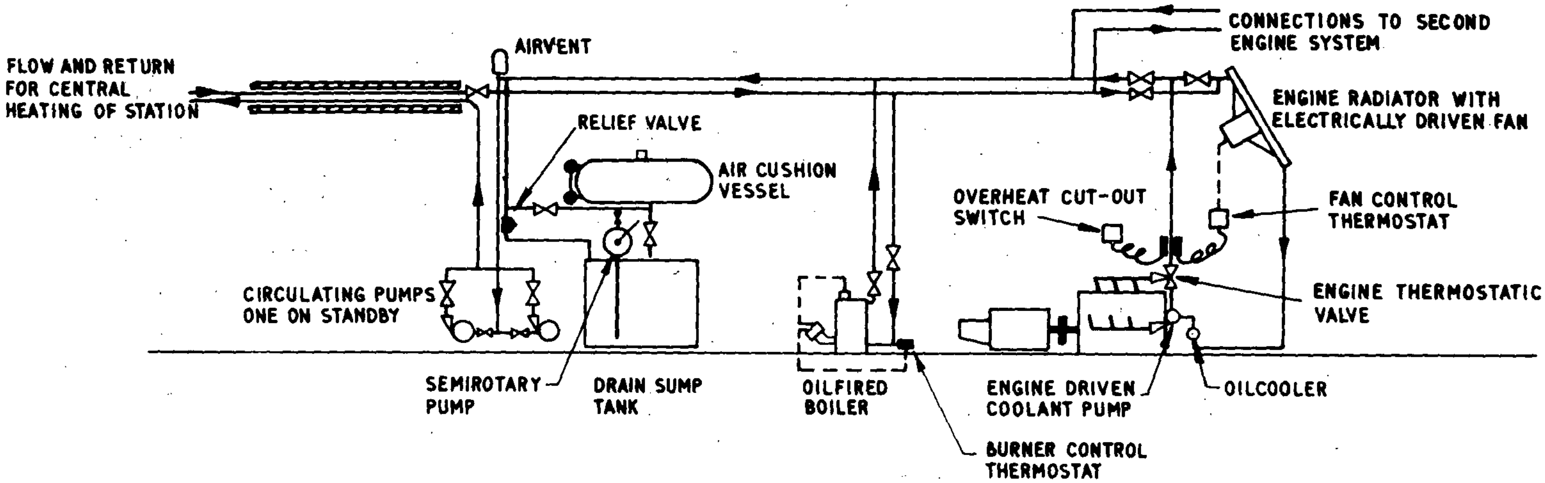


Fig. 5. Schematic diagram of piping in powerhouse.

EXPERIENCE IN CONCRETING IN ANTARCTICA

G.D.P. Smith*

Abstract

This paper described some difficult aspects of concrete technology experienced by the Australian National Antarctic Research Expeditions (ANARE) and techniques developed in order to ensure a reasonable degree of quality control.

1. Scope of Projects

Concrete, being a strong, plastic material, is the most widely used structural component in the world today. These qualities which make it so attractive in temperate climes, are no less desirable for Antarctic activities. ANAR Expeditions have used concrete at their stations since their inception in 1947. Projects have ranged from simple foundations to massive machine blocks and steel-reinforced heavy-duty floors. It is especially valuable for blinding irregularities in the rocky terrain of most ANARE stations in order to produce flat, level surfaces. Projects have included:

foundations
piers
vaults
paths
pads
structural anchoring points
survey cairns
machinery blocks
water storage tanks
heavy duty floors
light duty floors
suspended floors
walls
ship mooring bollards
radar emplacements
radio mast bases and guying points

2. Former Use of Conventional Materials

During the earlier years of ANARE operations, concrete projects were comparatively simple, and conventional concrete materials were almost invariably used for the basic components, i.e.,

(a) Ordinary Portland cement. This was originally used with no admixture, and the placed concrete was protected and heated for 2 to 6 days, varying according to weather conditions and placement temperatures. Eventually, calcium chloride accelerators were added in order to reduce the necessary protection period.

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(b) Blue-metal coarse aggregate. Both coarse and fine aggregates were shipped from Australia in 44-gallon steel drums. Moisture present in the coarse aggregates when packed, froze in the colder latitudes and often caused some difficulty in extracting the material from its drums.

(c) Fine aggregate. This was usually sharp concrete sand of an unspecified grading, and consequently its fineness modulus varied from batch to batch. The freezing of the sand's moisture content produced a frozen, monolithic mass in a distended steel drum. To extract this from the drum was quite impossible without burning away the steel from the frozen sand-block. It was then necessary to thaw the block before it could be used. The most common method was to ignite petrol poured over the block.

(d) Water. This was usually drawn from station supplies, and was heated to an unspecified temperature, the mix being considered satisfactory if it was steaming when placed. As far as possible, concreting was limited to mid-summer periods of continuous sunshine so that minimum supplementary heating was required.

The work was often initiated and carried out by inexperienced expedition members who were not necessarily tradesmen.

It is not surprising that the quality of these early projects was somewhat unpredictable and that the results were often disappointing.

3. Improvement of Techniques

As the scope of ANARE activity expanded and its construction projects became more sophisticated, there was an increased demand for higher quality concrete. It soon became apparent that the former rule-of-thumb practices would need to be replaced by more precise standards if the target strengths of these newer projects were to be achieved.

Reports of the successful use of high alumina cement concrete in Arctic regions encouraged its use by ANARE.

4. Mixing, Placing and Curing High Alumina Cement Concrete

After employing high alumina cement in some pilot projects, suitable techniques were developed for producing acceptable concrete from it. The comparatively prolonged and critical initial setting time requires that the concrete be protected from excessive heat loss during this period. Concrete is placed at a temperature not exceeding 40°F. This temperature is achieved by heating the mixing water, the temperature of the water being raised as the ambient temperature decreases. It has been found that no heating of mixing water has been necessary when ambient temperature has exceeded 35°F. Otherwise, mixing water is raised to a sufficient temperature to attain the following target mix temperatures:

temperature of dried aggregates	=	ambient;
temperature of cement	=	ambient;
temperature of mix at discharge from mixer	=	60°F;
temperature of mix at placement	=	40°F.

The temperature of the placed concrete is maintained above 32°F until the initial set has taken place, usually 3 to 6 hours, although this may be prolonged if the temperature criteria mentioned above are not achieved. The placed concrete is protected from freezing during this period by insulated quilts, protective tents or exposure to continuous summer sunshine. Warm air from heaters is played beneath tents when required. If concrete is poured within an insulated building, a heater within the building usually provides sufficient protection.

Once high alumina cement concrete has been placed and finished, a continual watch is maintained until at least 24 hours after initial setting. During this 24 hours, the heat development is extremely rapid and frequent water-curing is essential during this period, water needing replenishment at least once an hour. When this cement was first used by ANARE it was considered that snow placed on the surface of the placed concrete would be melted by the heat generation, and an automatic flow of cooling water would be maintained. It was found, however, that any melt which may have occurred at the undersurface of the snow was immediately reabsorbed by the porous snow and it even seemed that the snow was drawing moisture from the concrete. A snow and water slurry, however, placed after the heat-acceleration rate has commenced to level out (about 12 hours from initial set), will maintain a continuous flow of cooling water (Figure 4). The following curing process has therefore been established:

0 - 6 hours:	protect from freezing;
6 - 12 hours:	wet down with cold, fresh water at least once an hour;
12 - 24 hours:	strip forms and cover with a snow/water slurry, replenishing when necessary.

5. Aggregates

In recent years, both coarse and fine aggregates have been machine-dried before packing in drums for shipment. This material can now be readily used without having to be thawed out. Water - cement ratios are able to be established without recourse to adjustments for the water-content of aggregates.

At the new ANARE station near Wilkes (1), naturally-occurring pockets of good gravel and sand were found, in some cases the natural intermix of coarse and fine aggregates being within acceptable limits for structural concrete. Areas of sand and other areas of seemingly uniformly graded coarse aggregates also occur in this locality. A random sample of naturally-occurring combined aggregate was tested in Australia with the following results:

fineness modulus:		4.4;
Los Angeles abrasion grading:		A (35.3%);
aggregate crushing value:		26.7%;
sodium sulphate test:		Coarse - 1.7%, Fine - 0.7%;
specific gravidy:	Dry,	Coarse - 2.62, Fine - 2.49;
specific gravity:	S.S.Dry,	Coarse - 2.64, Fine - 2.57;
bulk density, loose:		115.5 lb/cubic ft.;
bulk density, rodded:		124.8 lb/cubic ft;
organic colour:		satisfactory.

Generally, the sample contained no deleterious minerals or other substances. The samples included mostly granite and quartz types, and were unweathered and unstressed.

These naturally-occurring aggregates have been used for several less critical tasks, such as agglomeration of building subgrade, mass piers and levelling pads. Some pockets of sand and gravel found on features further inland from the station area were densely overgrown by large lichens. Although no formal tests were carried out on this aggregate, rough tests on-site showed an unacceptable colour, and the presence of vegetable matter was evident.

Some naturally-occurring aggregates at Macquarie Island have been used, but the presence of peat, kelp, seal-droppings, salt and other deleterious materials restrict its use to less critical work. Dunes of windblown sand at this station consist of extremely fine, rounded-polished and salt-laden particles, once again unsuitable for high-strength concrete.

6. Admixtures

Calcium chloride may be added to Portland cement to hasten the set and avoid freezing during this period. Usually a solution of 1 lb of calcium chloride (flaked) to 1 pint of water is added to the mixing water at the rate of 1 fluid ounce of calcium chloride solution to 1 gallon of water. However, calcium chloride is incompatible with high alumina cement and no acceleration of the set is practical. The only admixture now used with this cement is an air-entraining agent, added at the rate of $\frac{1}{2}$ fluid ounce to 1 gallon of water to obtain good workability with less mixing water (thus lessening the risk of damage by freezing), and to improve quality.

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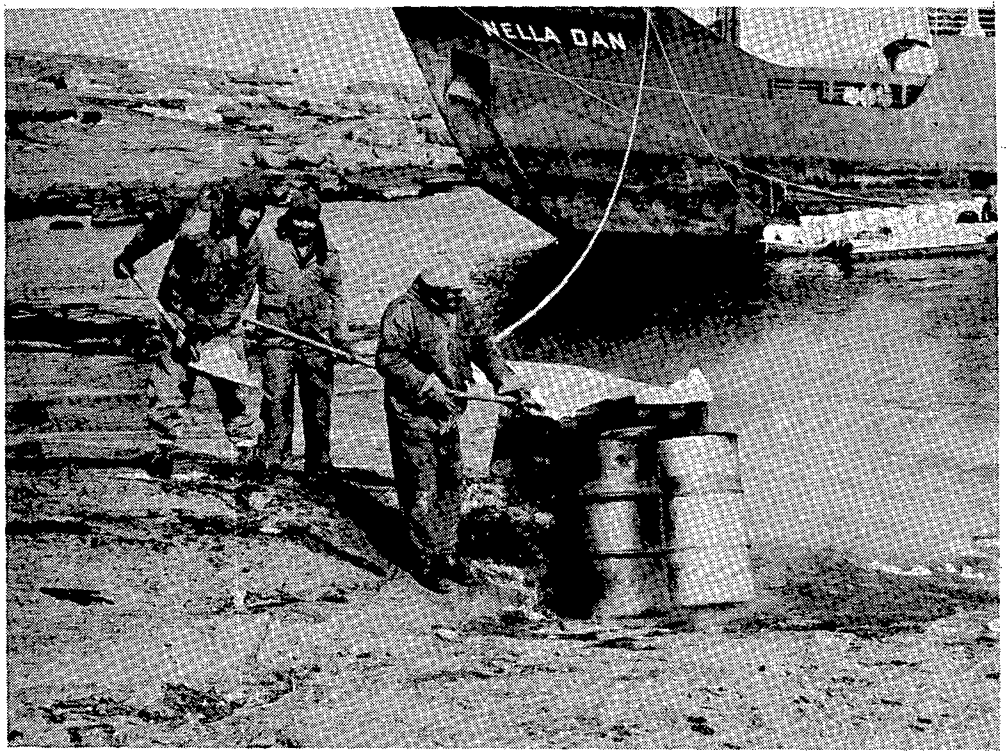

ANARE photo 17875

Fig. 1. Melting snow to produce heated mixing water for concreting. Drums are being heated by brown coal briquettes.

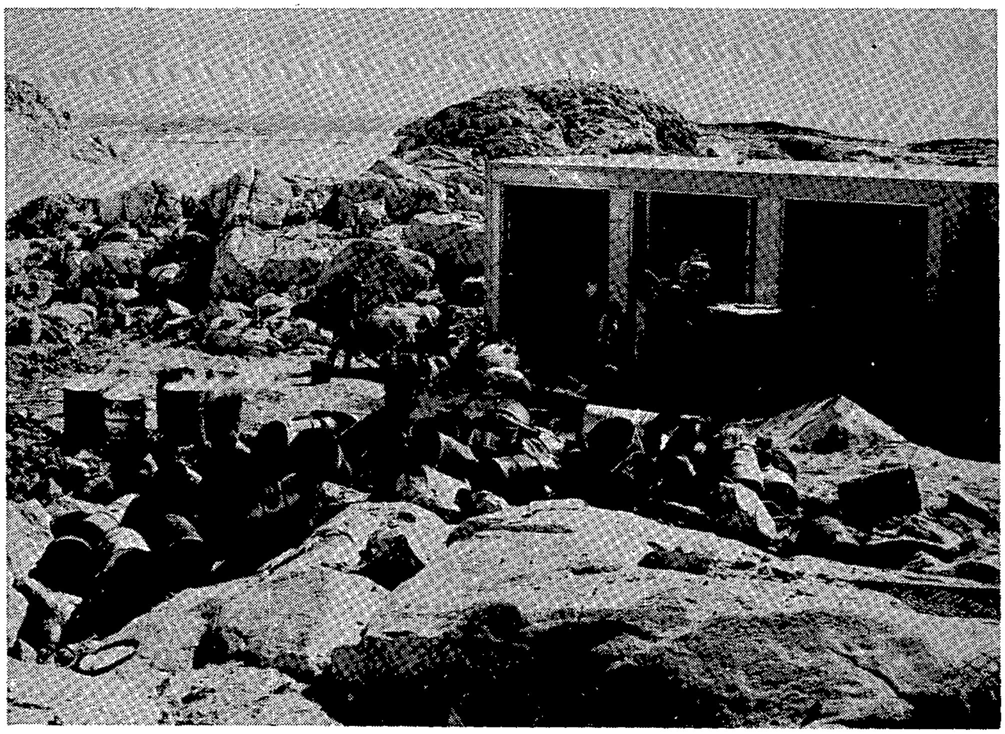

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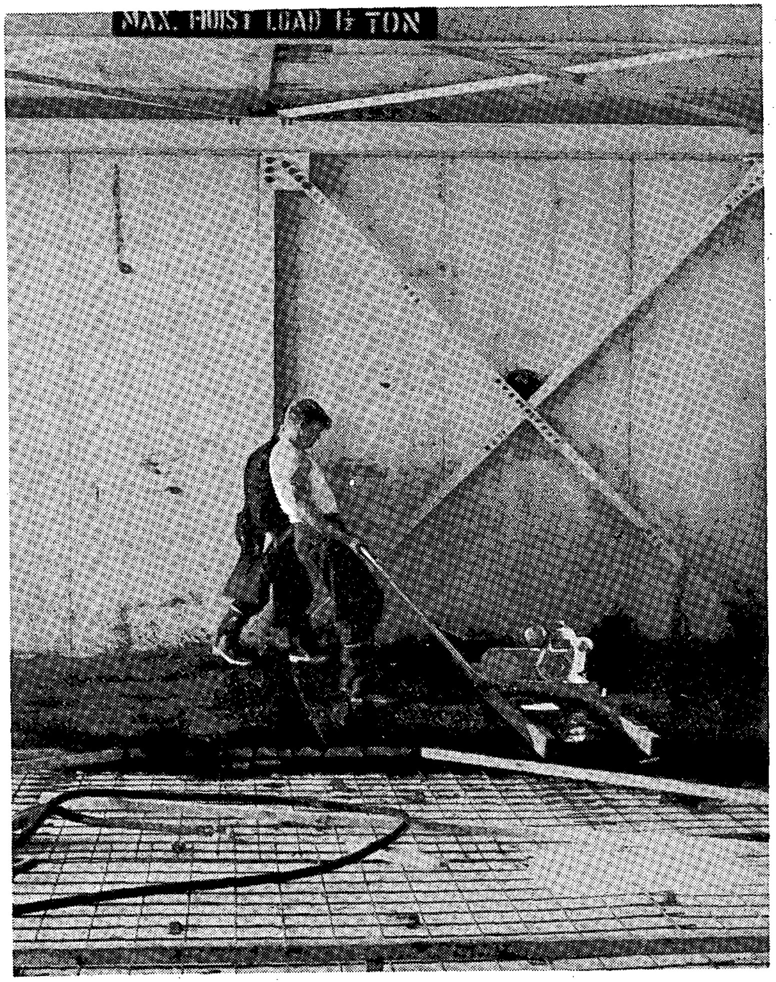
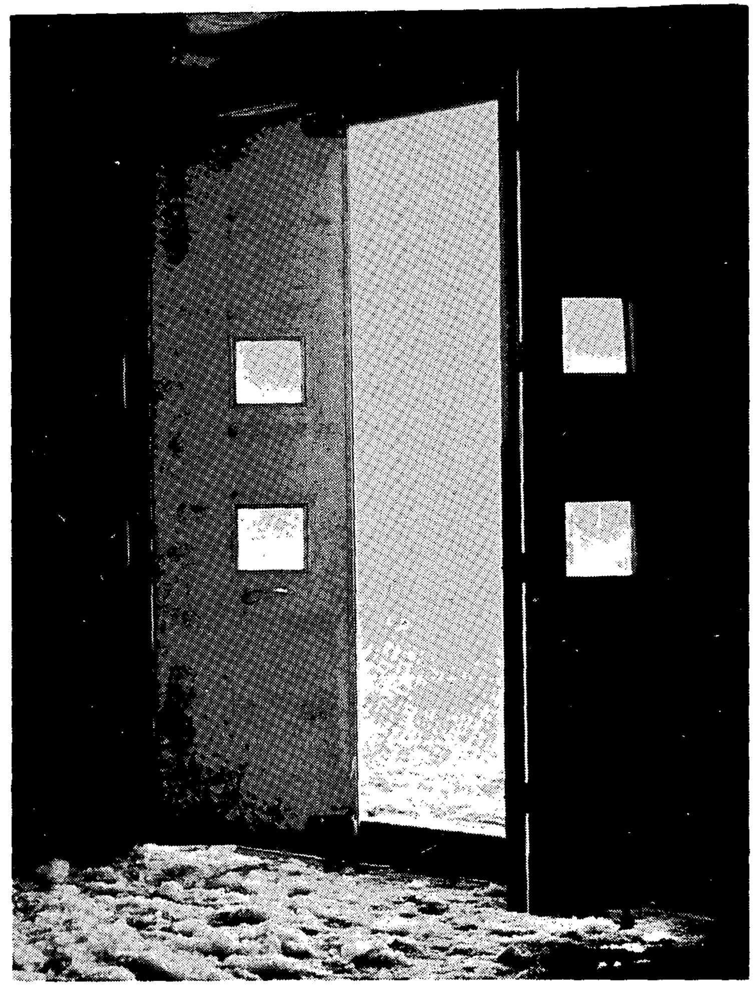
Fig. 2. Pouring a concrete floor in the Repstat vehicle workshop. Note heated mixing water and expended aggregate and cement drums.



ANARE photo 17994

Fig. 3. Finishing a poured floor bay in the Repstat vehicle workshop. A petrol (gasoline)-operated vibrating screed is being used for this purpose. The dark colour is characteristic of high alumina cement concrete. Note the layer of expanded, foamed polyurethane beneath the reinforcing mesh.



ANARE photo 17995

Fig. 4. A slurry compounded of cold water and snow being used to cure a freshly poured floor in the Repstat vehicle workshop. The heat of hydration melting the wet snow maintains a flow of cold water.

TESTS ON BUILDING PANELS FOR STRUCTURAL STRENGTH AND FIRE RESISTANCE

D.M. De Mole*, G.D.P. Smith** and A.M. Brown**

Abstract

Standard antarctic building panels were subjected to full scale strength and deflection tests, to determine their resistance to wind loads. Test panels of similar construction were subjected to fire resistance tests to determine the safe distance between buildings. A method of reducing this distance was developed and tested.

Part A Strength Tests

Introduction

Satisfactory field experience with prefabricated panels for building construction has guided the development of "stressed skin" panels of great structural strength and resistance to the extreme conditions encountered in Antarctic and sub-Antarctic stations.

Static bending and shear resistance tests were carried out to determine the strength of the panels ultimately developed and the method of construction used in the Repstat station.[1]

Tests were conducted on a pair of typical wall panels each 9 ft x 4 ft x 3 inches.

The core of expanded polystyrene was edged with timber frames of oregon, the members being 3" x 3" at the ends and 3" x 2" at the sides, joined at the corners by mortice and tennon.

Each face was covered with a single sheet of zinc-coated 24-gauge steel glued to both core and frame with rubber latex adhesive.

The edges of one face were bound with ½" x 3/4" x 24-gauge steel angles bedded in butyl rubber mastic and nailed through the edges of the panel, but not through the face.

For the shear tests the panels were joined with timber tongue-and-groove and sponge-rubber gaskets. They were pulled together with three half-inch diameter mild steel rods passed through the pair from edge to edge and pulled up tightly with the usual nuts and washers used in the buildings.

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As usual, 3/16" spacers prevented the rubber gaskets from being over-compressed.

Results of these tests are as follows:

1. Deflection Test

1.1 A single panel was simply supported over an 8'8" span. A uniformly distributed load of 65 lbs/ft^2, was applied by using bags of cement of average weight of 94 lbs. This simulates the load on a wall due to a 160 mile per hour wind.

1.1.1. Results,

	Maximum Deflection	% Recovery
Immediately	0.378"	
After 15 minutes	0.390"	
After unloading	0.038"	90.5.

1.2 The same panel was then similarly loaded to 45 lbs/ft^2, which load was maintained for 24 hours.

1.2.1. Results.

	Maximum Deflection	% Recovery
After 24 hours	0.283"	
Upon unloading	0.037"	87.0.

2. Shear Tests

2.1 Two panels were connected side by side by means of the special tie rods and attachments supplied. The nuts were tightened until the neoprene washers distorted and subsequent measurement showed that the torque was then between 14-16 ft lbs.

The panels were then placed on 4 steel balls which were positioned between steel plates, and held as shown in Figure 1 (a).

Loads were applied with a mechanical screw jack, the load being recorded by an electrical resistance load cell.

Movement was recorded by 3 dial gauges graduated to read to 0.001", and 6 Demec-type reference points were glued on the panels at 3 points. The movement between these points was measured with a Demec gauge.

Upon loading, it became apparent that the adopted method of restraint was unsatisfactory, because deflections were developing by separation of the end-piece from the panel just below the restraining point.

The method of restraint was then modified to that shown in Figure 1 (b).

2.1.1. Results.
At a load of 1120 lbs, a movement between the 2 panels of 0.162" was recorded, and a sideways deflection of 0.113". The load was held constant, and was considered to be the initial general slip load. Upon increasing this again the panels slipped, and the load did not increase until the tie rods came into bearing in the drilled holes. At 6100 lbs the panels had moved 1.348" relative to each other with an average sideways deflection of crushing of the timber underneath the loading plates the test was terminated at this load.

2.2 One panel was lcaded and restrained as shown in Figure 2 (a).

2.2.1. Results.
A load of 6384 lbs was reached before the test was stopped due to excessive crushing of the timber under the loading plates.

2.3 Ultimate Deflection Test

2.3.1. A panel was simply supported with a span of 8'8", and loaded at the quarter points. The magnitude of the load was recorded by a Maclow Smith Load Cell, and the deflections measured by means of dial gauges on either side of the centre line.

2.3.2. Results.
An average load/deflection curve is shown in Figure 3.

The ultimate load reached was 5200 lbs, and the maximum deflection 2.849". Average residual deflection immediately upon unloading was 0.693".

3. Testing of Panels for Elephant Seal Resistance

A prefabricated panel and modified system of construction has been developed for the extremely wet and windy conditions experienced at the sub-Antarctic station on Macquarie Island. The station is invaded annually by hordes of elephant seals which weigh up to 4.5 tons. When fighting, they often strike a building with their heads with great force. It was observed that stud-framed walls sheeted with 3/4" rebated pine weather-boards could resist such onslaughts.

To establish whether the panel proposed was strong enough, it was tested to destruction in both static and simulated impact load conditions in comparison with a panel of the weatherboard construction.

In both static and live load tests, the stressed skin panel proved superior to the weatherboard construction.

In the static deflection test, the weatherboard panel failed at 1,300 lbs load on the 9" diameter platen of the testing equipment, whereas the stressed skin panel failed at 2,250 lbs when the platen sheared through the face of the sheeting.

In the impact test, similar panels were tested by allowing a 114 lb sand-filled bag to drop onto each specimen from a series of heights increasing by 6" increments. The weatherboards failed at a drop of 36" whereas the panel failed at 42".

The construction of the panel is similar to the steel-sheeted ones described above, except that flexible asbestos cement is used in place of steel. The sheeting is 3/16" thick giving an overall thickness of 2 7/8" to the panels.

Part B Fire Resistance Tests

Introduction

A series of radiation exposure tests were conducted in the Fire Test Laboratory at the Commonwealth Experimental Building Station, Sydney, Australia, on prefabricated building panels of standard construction, and with various shielding methods designed to increase resistance to the effect of an adjacent burning building.

The reports of the CEBS have been used in the preparation of this paper.

The panels were submitted to the Commonwealth Experimental Building Station for an assessment of their potential fire resistance. Following an unfavourable report on their potential fire resistance, it was proposed by the CEBS that, provided it was accepted that in the event of fire any one hut is expendable and the huts were separated by sufficient distance to prevent direct flame impingement, the panels could be designed to have a high resistance to external heat radiation, rather than to be truly fire resisting. A reflective panel can be a very lightweight structure, but to be truly fire resisting, a panel needs to possess an appreciable mass.

It was considered that in the case of fire in a building of the prefabricated panels, the whole facade of the burning building should be considered as a radiator, and that a radiation intensity represented by the whole wall area as a black body at 900 to 925°C, giving an emitted radiation of 2.75 cal cm^{-2} sec^{-1} would simulate a fire of the intensity to be expected in other-than-fuel-storage huts in Antarctica.

Further, it was assumed that a burning wall 9 ft high and 15 ft long would represent the type of fire situation which could threaten an adjacent building at ANARE stations.

The assessment of radiation exposure hazards from fire in buildings was calculated, using diagrams and information published by the CEBS[2] on source intensity, effects of thermal radiation on materials, and intensity of radiation received at surface, for various building configurations.

The Fire Test Laboratory at CEBS is equipped with a radiator consisting of sixteen 1 ft-square radiant tiles which attain a surface temperature of 900 to 925°C, burning town gas. The general arrangement is shown in the photographs.

1. Description of Specimen Panels

The test panel was constructed 4 ft-square to suit the radiation test equipment as shown in Figure 4, and included all features of the standard building panels - oregon timber frame, fire retardant grade expanded polystyrene insulation, 24-gauge zinc-coated steel sheet ('zincanneal') inside and outside covering, rubber latex adhesive, horizontal and vertical tongued-and-grooved joints with foam-rubber gaskets, and sheet-metal cover straps, tie rods and bolts.

Test 1

The aim of the first test was to determine the behaviour of the wall panel with no protection.

As this was the first test, it was somewhat arbitrarily decided to simulate a distance between buildings of 10 feet. By calculation, the expected radiation intensity at the centre of the panel would be of the order of 0.83 cal cm^{-2} sec^{-1} and this was obtained by placing the test panel 3.45 ft from the radiator.

The panel was exposed to the radiation for one hour.

No ignition occurred, nor was paper attached to the non-exposed face ignited. To give the effect of flying sparks, a pilot torch was applied throughout the test to the vapours given off from the distillation of the fire-retarded polystyrene insulation and the timber framing.

The photographs (Figures 6 to 8) illustrate the behaviour of the specimens throughout the test.

Experimental work conducted in the USA has indicated that $1\frac{1}{2}$ in x $1\frac{1}{2}$ in x 4 in wood blocks in a stream of hot air at 662°F ignite in 1 to $1\frac{1}{2}$ minutes. From the plot of temperature: time for the various surfaces of the panel tested (Figure 5), it can be seen that the exposed zincanneal surface exceeded 352°C, so that it would have been expected that timber touching this metal would have ignited. The end-view of the specimen shows, however, that the sheet has sprung away from the timber, forming an air gap which has protected the timber.

Australian Standard A.30 1958, Section 4, which covers fire-testing of elements of structure, requires "that the average temperature of the unexposed surface shall not increase by more than 139°C above the initial temprature, and that the temperature of the unexposed face shall not increase at any point by more than 180°C or reach a value higher than 221°C, whichever is the lesser value". (It is considered that combustible material against surfaces at temperatures above these are likely to ignite.)

Although ignition of paper behind the test panel did not occur, this established criterion of failure for elements of structure could well be applied in determining failure of specimen panels subjected to radiation. In Figure 5 it can be seen that the temperature of the unexposed face reached 221°C in 15 minutes.

Test 2

A method of shielding the standard wall panel was devised, consisting of 24-gauge corrugated galvanized sheet steel fixed to the panel with 2 inch spring-head nails at every third corrugation, with corrugations vertical and $\frac{1}{2}$ inch-thick "asbestolux" spacing strips. These strips were located top and bottom, only. The air gas formed was thus well ventilated all round.

As considerable improvement was expected, it was decided to simulate a space between buildings of 6 feet (c.f. 10 feet in Test 1). By calculation, the expected radiation intensity at the centre of the exposed shielding would be 1.47 cal cm^{-2} sec^{-1}, and this was obtained by placing the test panel 2.0 ft from the radiator.

The timber framing ignited at 21 minutes, and the paper attached to the non-exposed face at 24 minutes. (The non-exposed face reached 221°C at 22 minutes).

The photographs (Figures 9 to 12) illustrate the behaviour of the specimen.

Test 3

After some intermediate tests showed that commercial aluminium corrugated sheet behaved as an absorber and radiator, similarly to the galvanized steel already tested, shielding was constructed having double-sided fire retardant fibreglass reinforced aluminium foil laminate ("Sisalation 450") between the panel and the corrugated galvanized steel sheet. The foil laminate was held against the panel by the ½ inch asbestolux spacing strips. The strips were located around all edges and on the vertical centre line joint of the test panel. The corrugated galvanized steel sheet was fixed as for Test 2, with 2 inch spring-head nails through the spacer strips into the panel timber, and so the airgap between it and the foil laminate was ventilated only through the ends of the corrugations at the top and the bottom of the panel.

The test again simulated a 6 ft spacing between buildings, i.e., centre-incident radiation intensity 1.47 cal cm^{-2} sec^{-1}, and distance of shielding from radiator 2.0 ft.

Apart from slight buckling of the zincanneal cover of the panel itself, and of the corrugated shielding, together with evolution of volatiles (which could not be ignited with a pilot torch), there was no further visible change in the panel after 2 hours.

Temperatures recorded after 2 hours:

non-exposed zincanneal surface at centre = 116°C;

at centre of zincanneal surface under reflective insulation = 260°C;

at centre of corrugated sheet shielding = 482°C.

At this stage the panel was moved 4½ inches closer to the radiator and, after 15 minutes, the temperatures of both the non-exposed face and the zincanneal in contact with timber framing were still below that likely to cause ignition of combustible material in contact with the non-exposed face of the panel.

The panel was finally caused to ignite internally by moving it to a distance of one foot from the radiator, so subjecting it to a radiation in excess of 2 cal cm^{-2} sec^{-1} when the non-exposed face reached 160°C and metal in contact with timber reached 350°C respectively. The test simulates a very close spacing between buildings.

The photograph (Figure 13) shows the effect of the radiation on the panel.

Test 4

This test was similar to Test 3. The aluminium foil laminate was replaced with 0.006 inch reflective aluminium.

The test again simulated a 6 ft spacing between buildings, i.e., centre incident radiation intensity 1.47 cel cm^{-2} sec^{-1}, and distance of shielding from radiator 2.0 ft.

The temperature recorded for the non-exposed face, at the zincanneal under the 0.006 inch reflective foil, and at the centre of the galvanized shielding, were all considerably lower than for Test 3. This was considered to be because the galvanized surface of the shielding in Test 4 was brighter, due to less natural oxidation of the zinc coating. Therefore, after one hour the panel was moved closer to the radiator to accelerate oxidation, then withdrawn again to the 2 ft spacing. Following this, the recorded temperatures tended to approach the temperatures recorded in Test 3.

Photographs (Figures 14 and 15) show the effect of the test on the panel.

2. Conclusions

From Test 1

It would appear that, with unshielded panels on a building exposed to a similar building facade 9 ft high and 15 ft wide at a distance between of 10 ft, a period of 15 minutes would be available from the breaking out of the fire in the burning building during which measures to remove combustibles and cool the inside face of the panels of the threatened building could be taken. The test indicated some possibility of ignition of the internal timber of the panel if the exposed zincanneal sheet remained in contact with the framing and air for combustion could enter the panel.

From Test 2

For similar conditions, but with distance of only 6 ft between buildings, a shield of corrugated galvanized iron spaced half an inch from the panel provides a period of the order of 20 minutes, but internal timber framing of the panel is likely to ignite very shortly after this. A more effective shielding was required.

From Tests 3 and 4

Shielding of the panel with aluminium foil laminate or 0.006 inch reflecting aluminium and corrugated galvanized steel sheet, fixed with a $\frac{1}{2}$ inch air space ventilated top and bottom, provided protection against ignition for at least one hour's exposure under similar conditions and a distance of 6 ft between buildings. The tests were carried out with galvanized surfaces oxidised either naturally or otherwise. The reflective aluminium surfaces can be expected to remain effective, since they are protected from weathering, and the Antarctic environment is relatively non-corrosive and dust-free.

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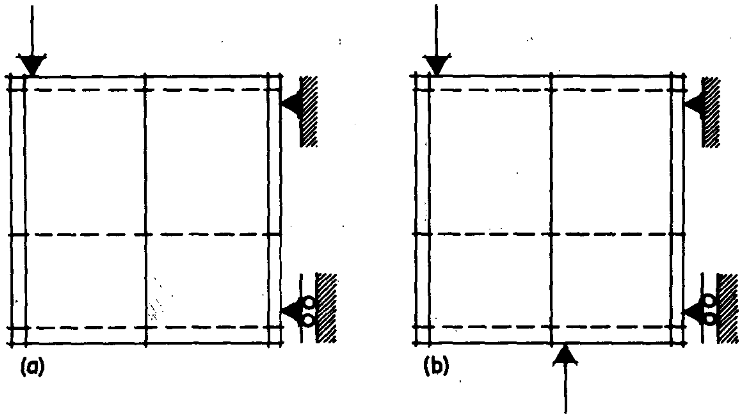

Fig. 1. Shear test of panel joint.
(a) Loading and restraint of panels, unsatisfactory method.
(b) Loading and restraint of panels, satisfactory method.

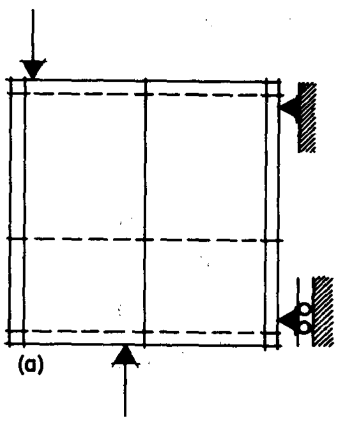

Fig. 2. Shear test of panel loading and restraint locations.

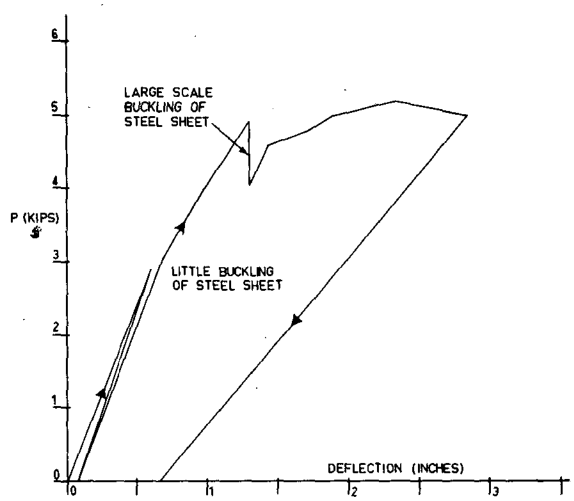

Fig. 3. Ultimate deflection test of panel as a simply supported beam.

Part B. Fire Resistance Tests

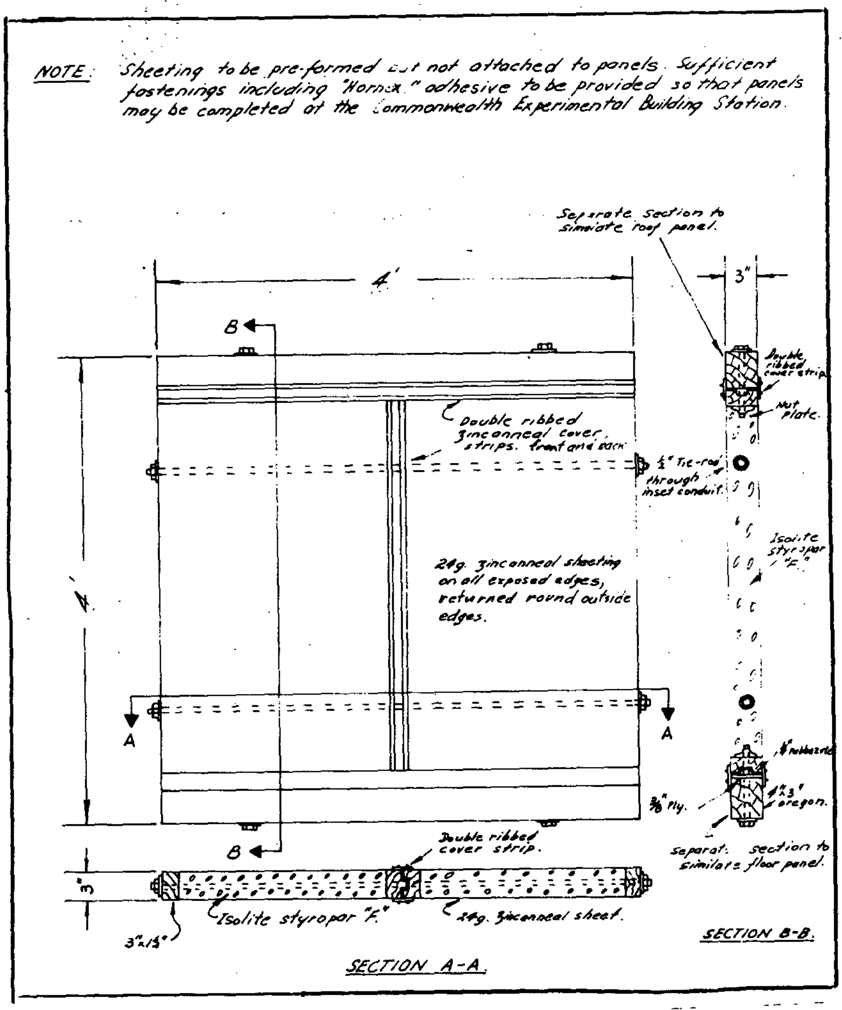

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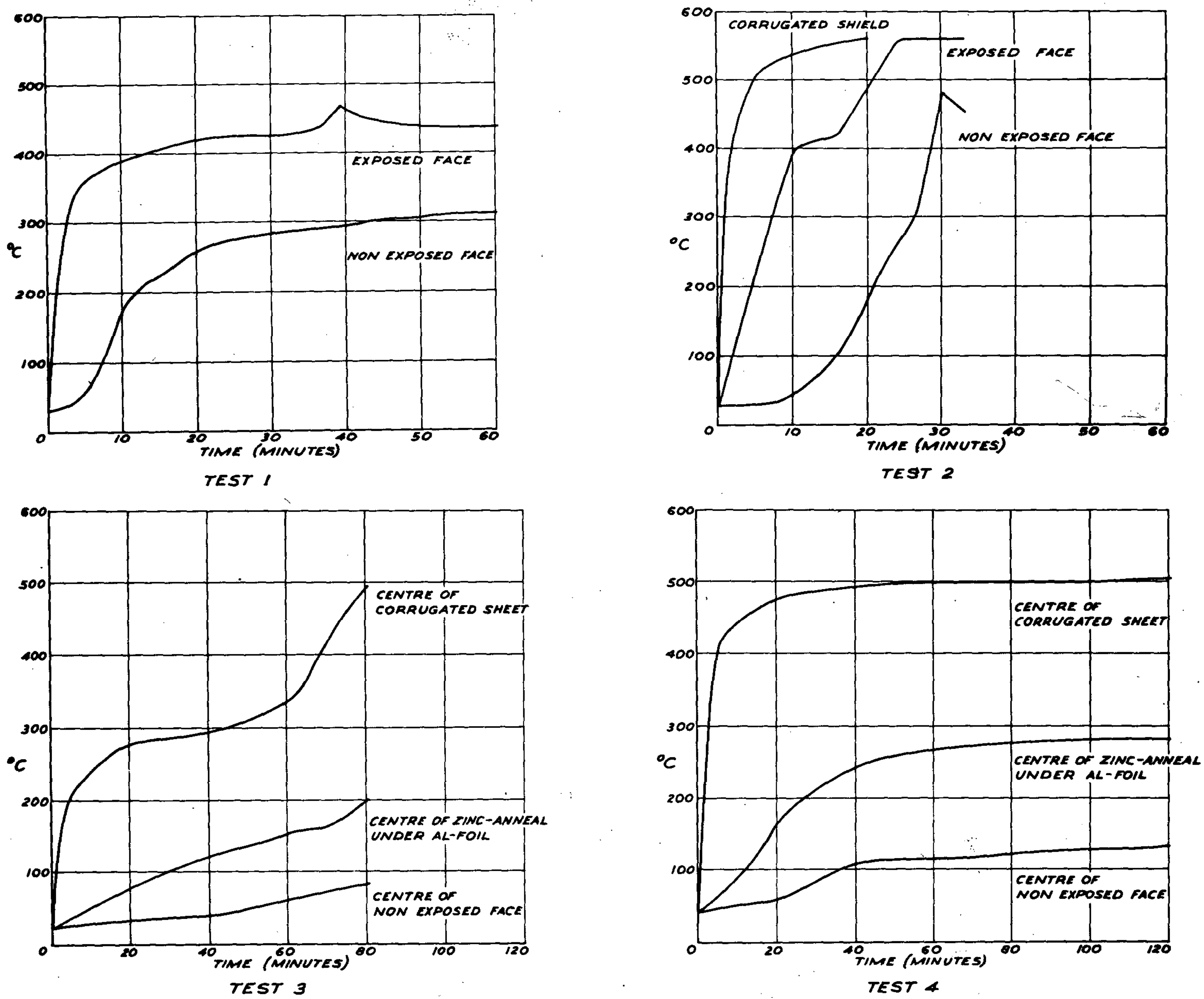
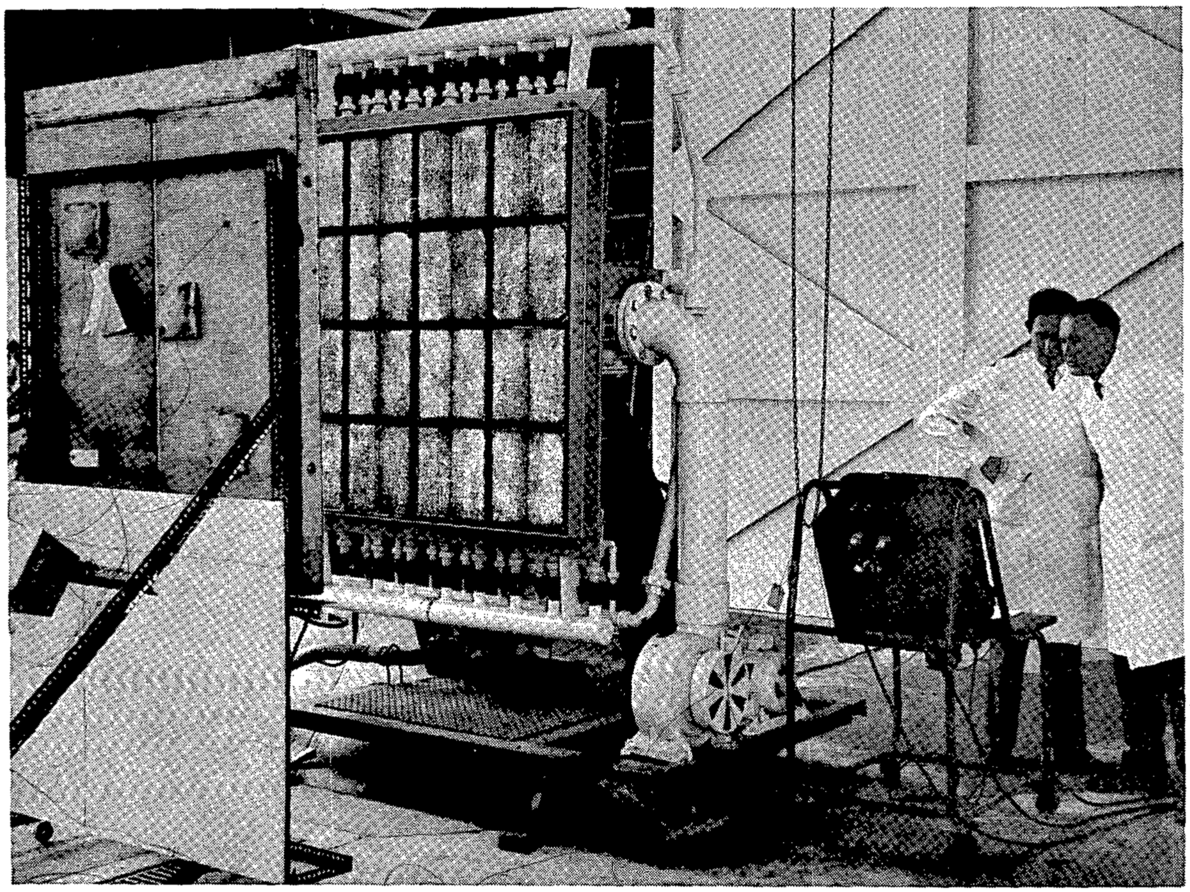
Fig. 4. Construction of test panels.



ANARE Drawing 2/68/11

Fig. 5. Temperature-time curves for various points on panels during tests.



CEBS photo 5675

Fig. 6. Test 1. 3 minutes after start.

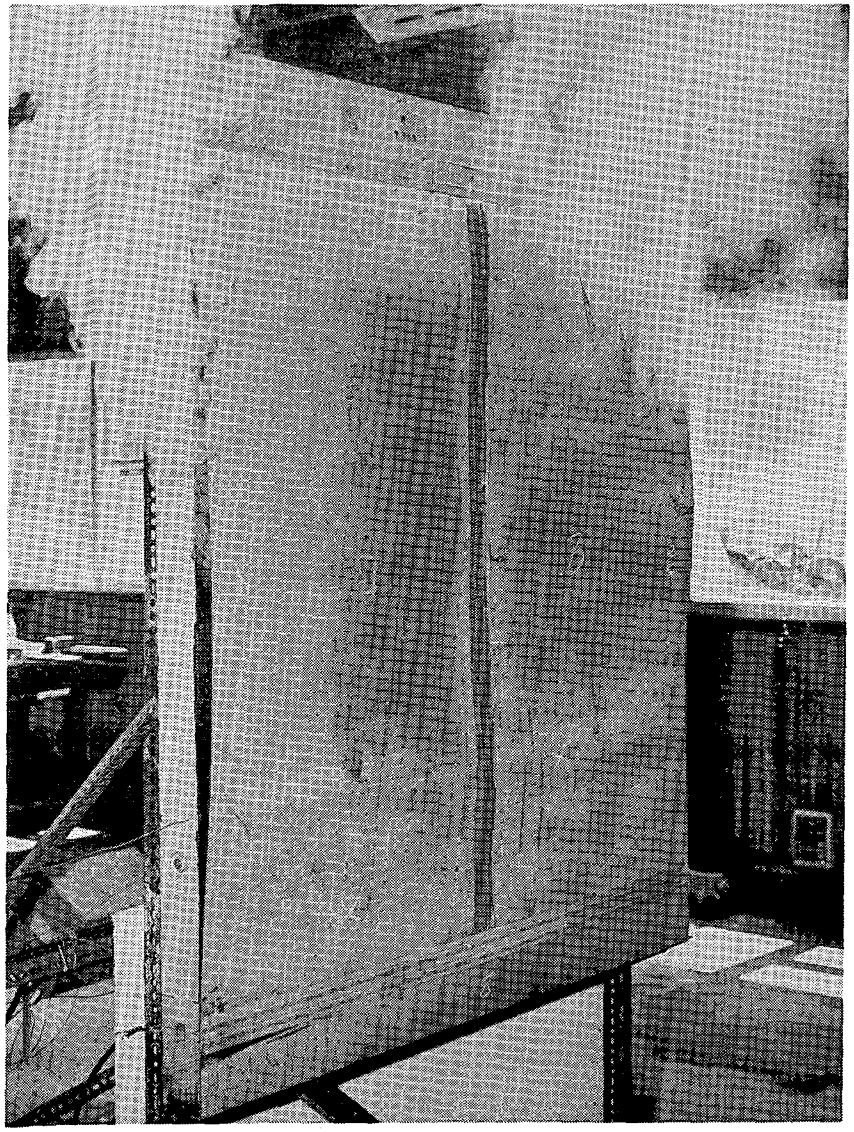


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Fig. 7. Test 1. 10 minutes after start.

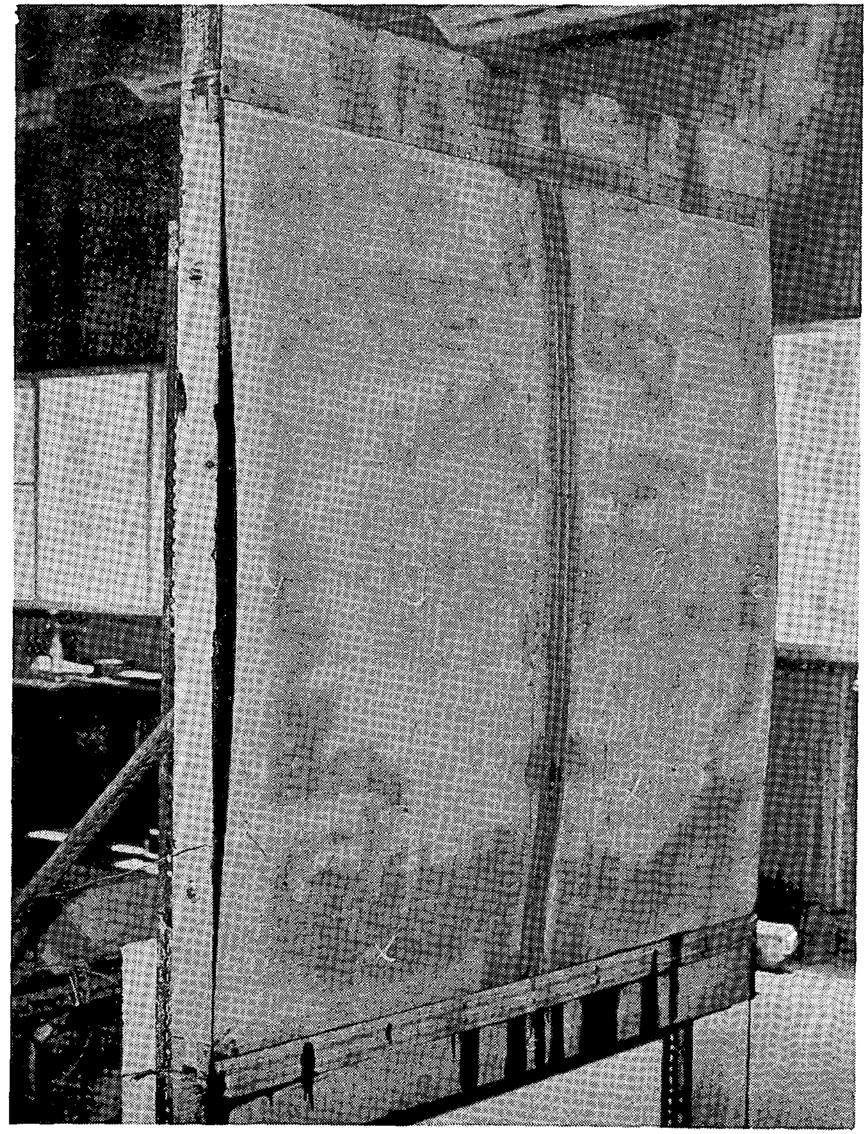

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Fig. 8. Test 1. 1 hour after start.

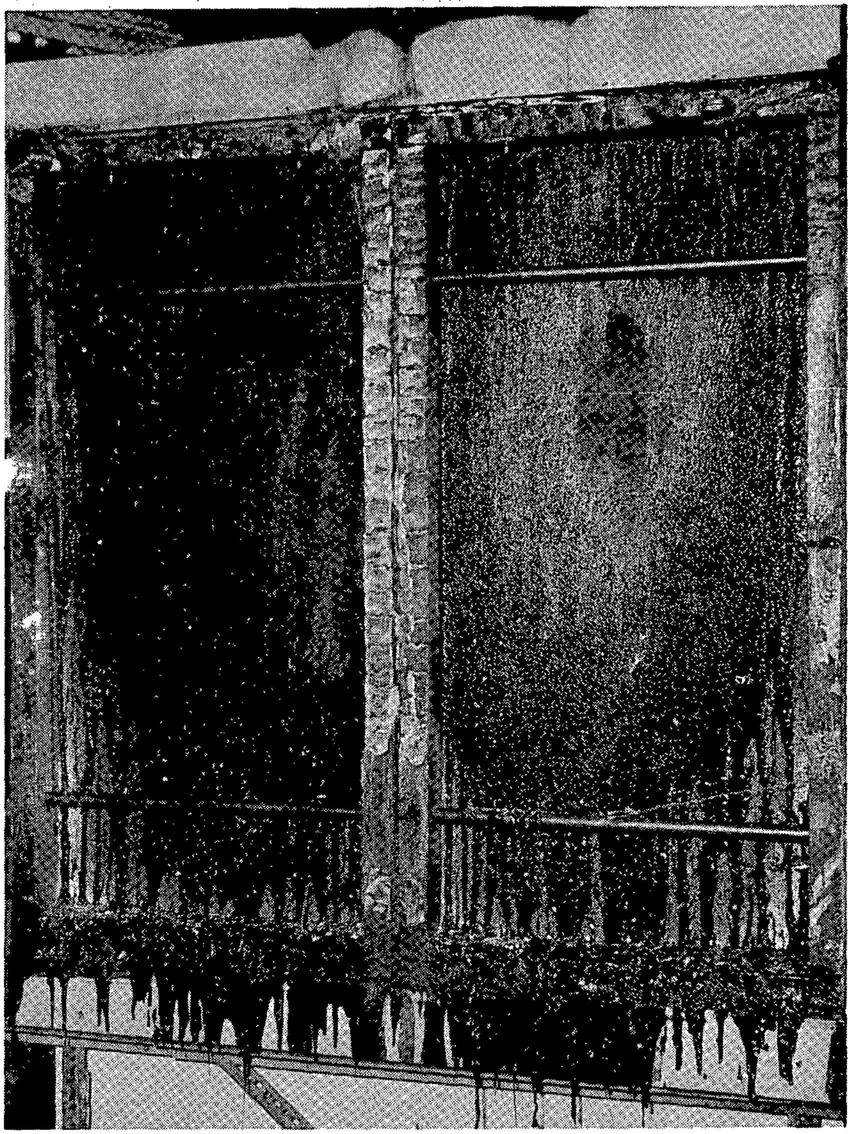

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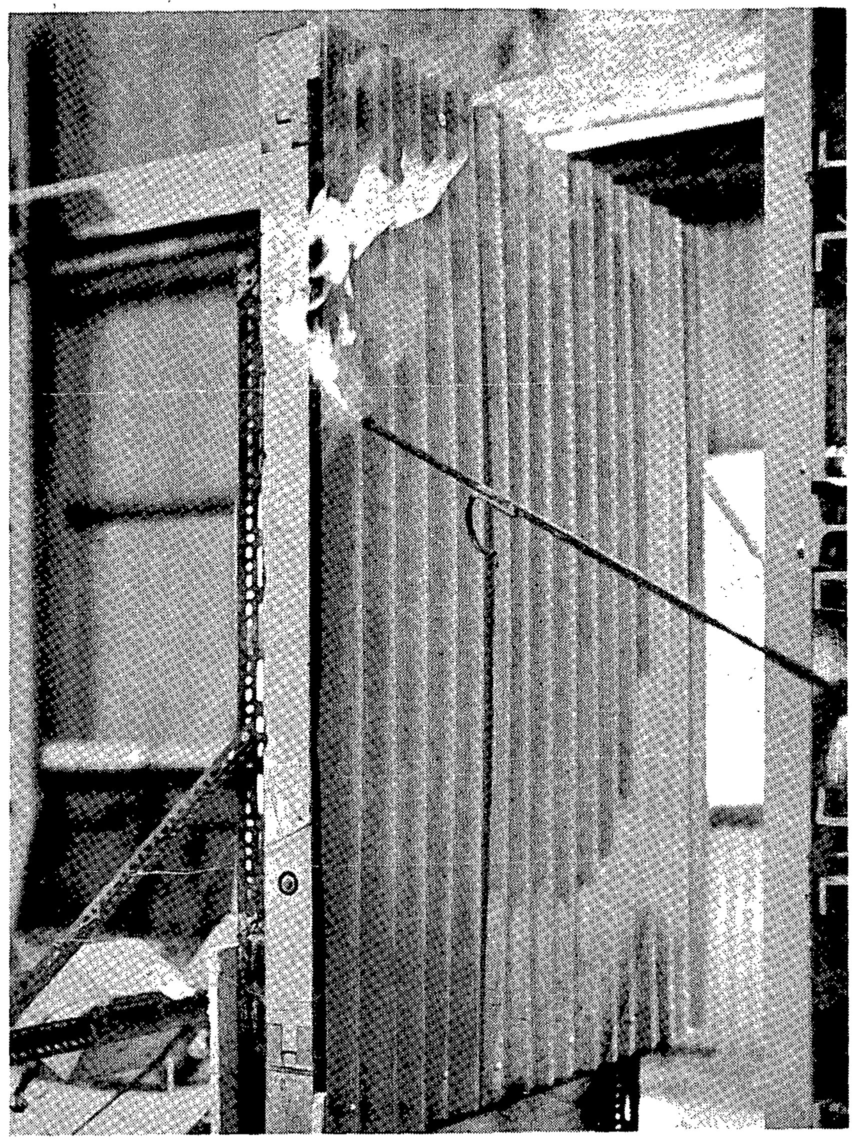
Fig. 9. Test 2. After test. Exposed sheeting removed and showing charring of timber and melted polystyrene inside the frame.



CEBS photo

Fig. 10. Test 2. 10 minutes after start. Ignition of vapours for 15 seconds.

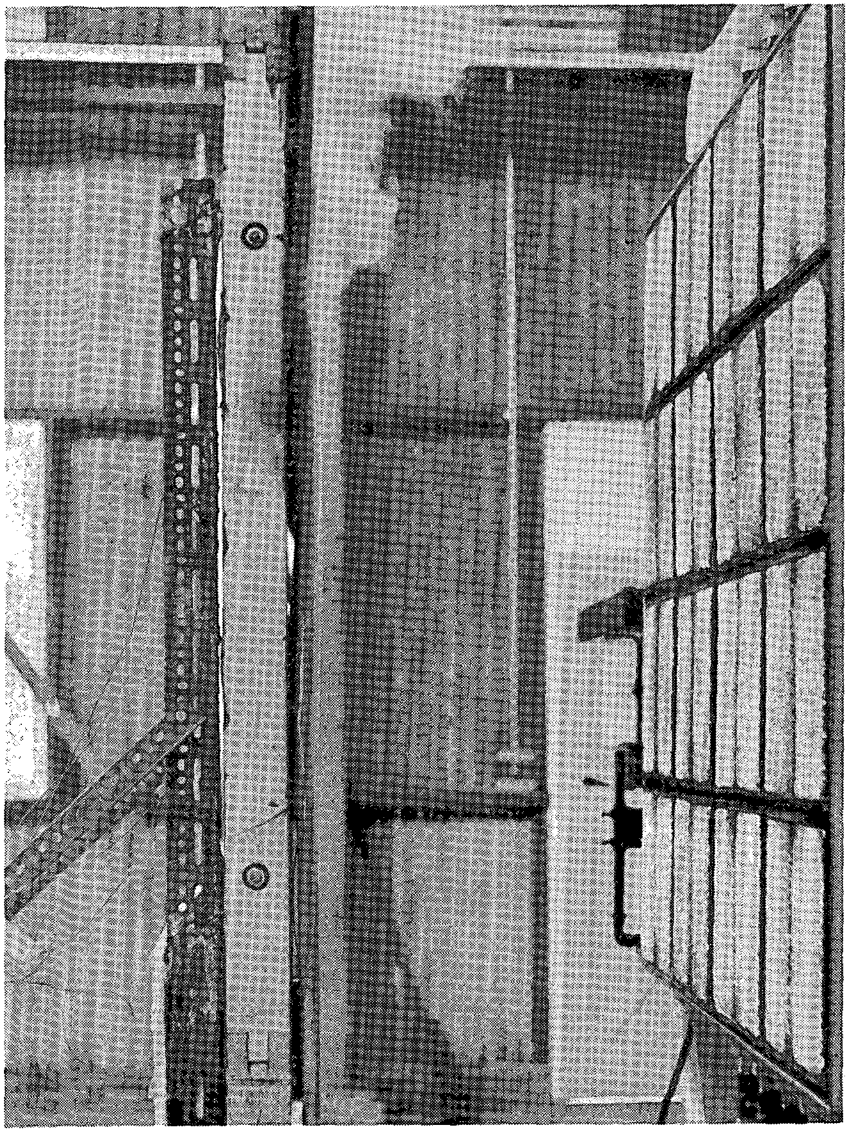


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Fig. 11. Test 2. 21 minutes after start. Internal timber alight.

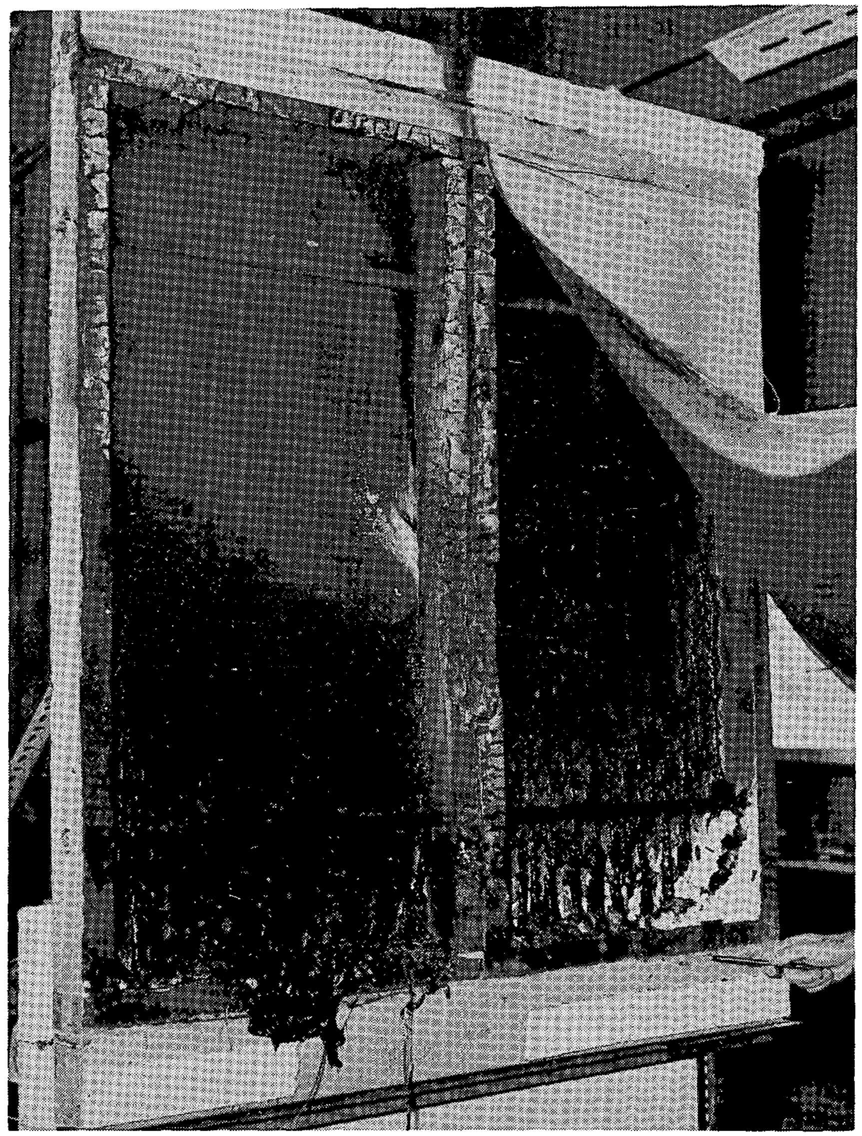

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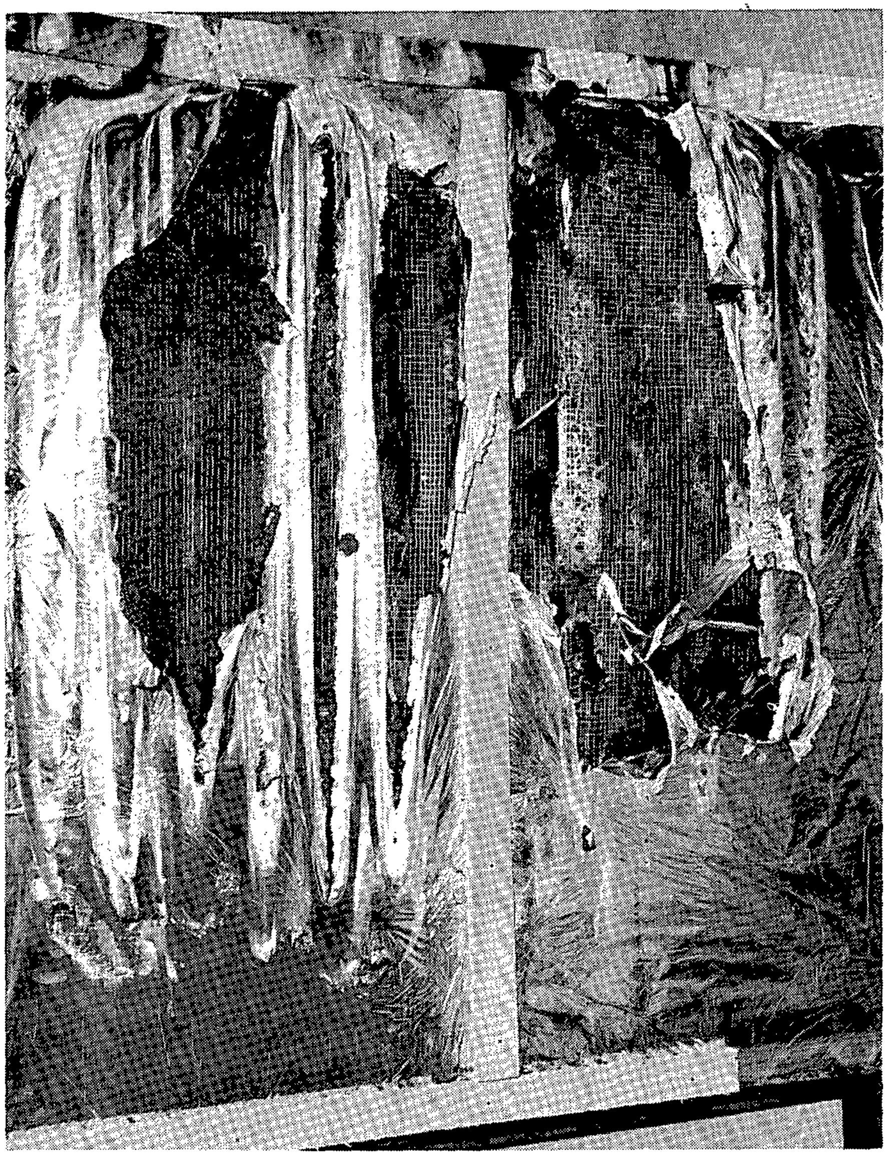
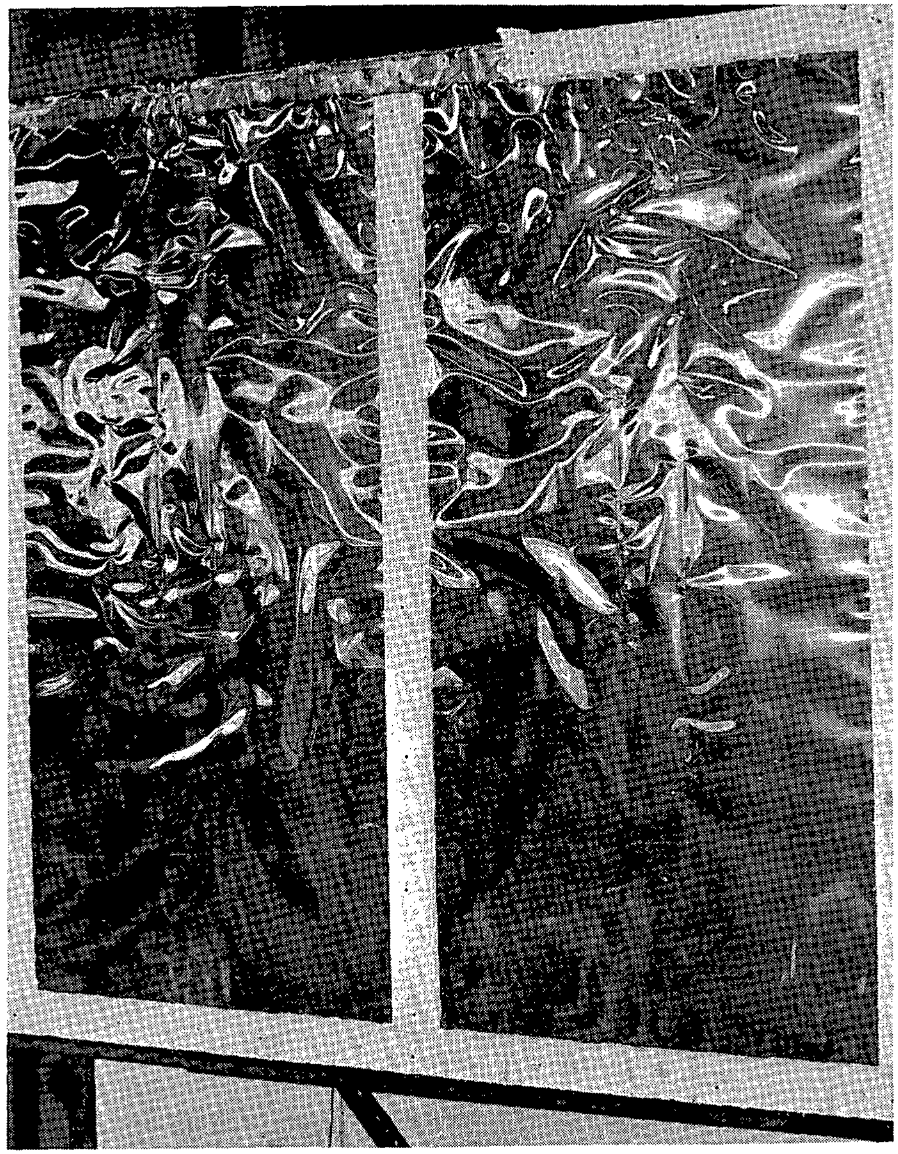
Fig. 12. Test 2. After test with shielding and exposed facing removed.



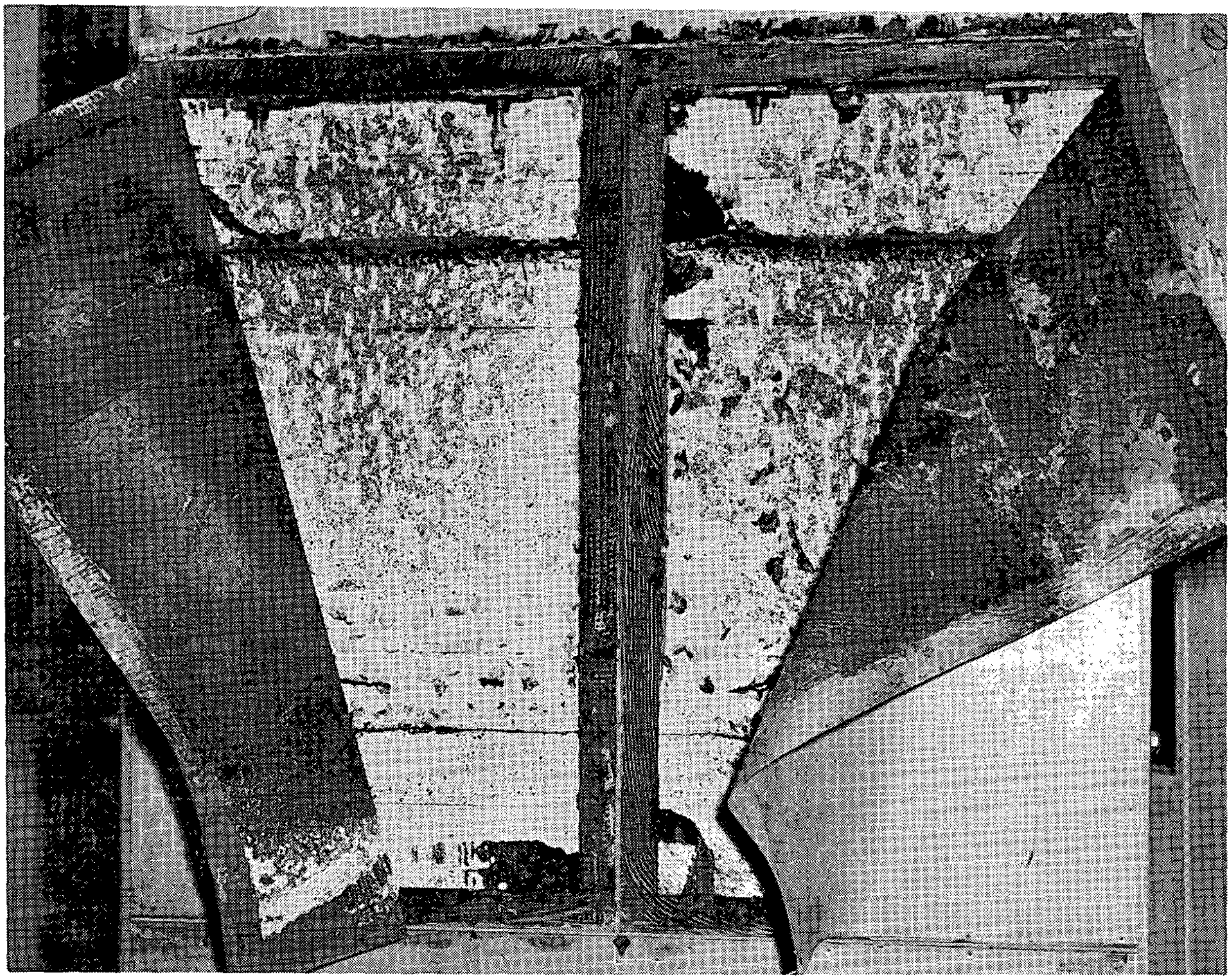
CEBS photo 6161

Fig. 13. Test 3. After test with shielding removed showing delamination of foil by extreme radiation.



CEBS photo 6165

Fig. 14. After test with shielding removed showing good appearance of foil.



CEBS photo 6167

Fig. 15. Test 4. After test with panel cover removed showing good conditions of timber and polystyrene foam.

DUMONT D'URVILLE BASE DRINKING WATER SUPPLY

Expeditions Polaires Françaises

The problem of the supply of drinking water for the Dumont d'Urville Base has been one of the main concerns when dealing with re-equipment of installations on Petrel Island.

Up till now, drinking water has been produced by melting snow, a method of production giving rise to a series of difficulties such due to:

- The position of the base on an island where the accumulated snow reserves are solied by the penguins, and where the falls of fresh snow vary considerably from one winter to another, the strong winds blowing away the snow and causing a short supply in summer.
- The high cost of electric power, which must further, satisfy in priority the ever-increasing needs of scientific research.
- The tiresome snow chores to supply the melting tanks, leading to the loss of many work hours.

Thus, it was necessary to find an answer that would avoid all these disadvantages and taking into account the local potential.

The seawater being the only constant element for the provision of drinking water, it was decided to install a seawater desalination unit, using as main source of power the heat re-captured from the cooling water of the diesel motors of the power station.

The study for the whole of the equipment was assigned to S.O.G.R.E.A.H. (Sociéte Grenobloise d'Etudes et d'Amenagements Hydrauliques) in collaboration with the Technical Office of Expéditions Polaires Françaises; it dealt with the following main points:

- pumping of seawater (special screens, pumping station) and delivery of this water to the power station through piping with a length of 350m,
- design and construction of the desalination unit installed in a power station,
- storage of fresh water produced and distribution through the living quarters (kitchen, washroom, W.C.'s),
- evacuation of waste water from these quarters,
- protection devices to avoid freezing in the different circuits; safety device (also against freezing) in case of stoppage during winter.

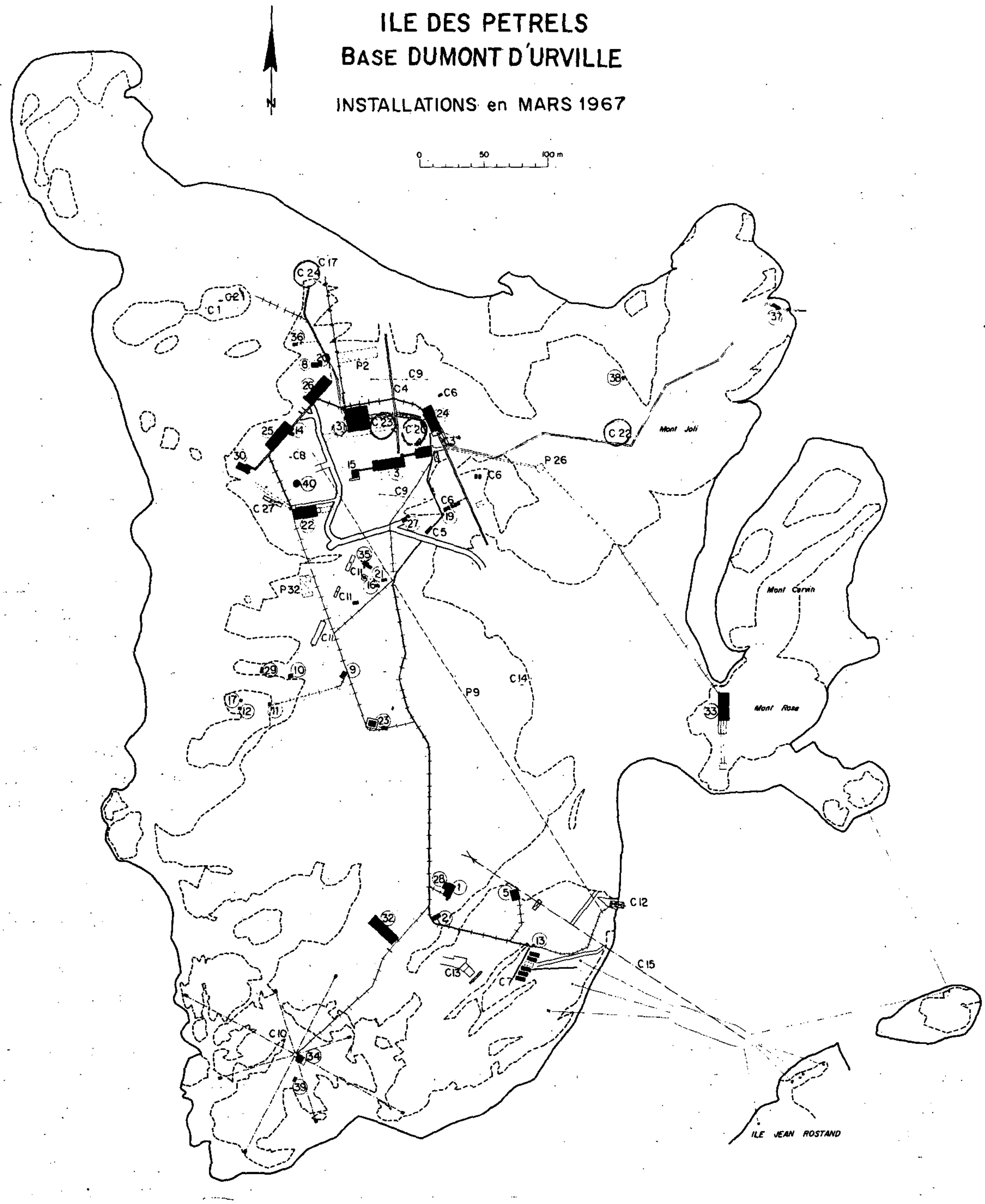


Fig. 1.

37 — Seawater pumping station.

C 22 — Doudle concentrical pipe for seawater pumping and hot brine discharge.

24 — 10 m³ fresh water tank.

C 23 — Pipes for fresh water distribution (by continuos loop) and for hot brine discharge.

31 — Living quarters.

C 24 — Waste water and hot brine discharge pipe.

This equipment, and in particular the seawater desalination unit are described hereafter by Mr. Hubert HANF, S.O.G.R.E.A.H. Engineer.

In view of the special conditions prevailing in Adelie Land (the danger of freezing and low power sources) a seawater desalination unit, specially designed to suit local possibilities, had to be designed. SOGREAH (Société Grenobloise d'Etudes et d'Applications Hydrauliques) was chosen for the engineering and design of the unit, complete with evaporator.

Design of the Evaporator (Figure 3)

The desalination of seawater by evaporating under a vacuum is a technique of long standing, mainly used on ships. The main obstacle to its general use on land is its running cost, since sufficient heat recovery possibilities for the production required are not usually available. Indeed, using "noble" energy, the cost price per cubic metre of fresh water produced is still too high for small units.

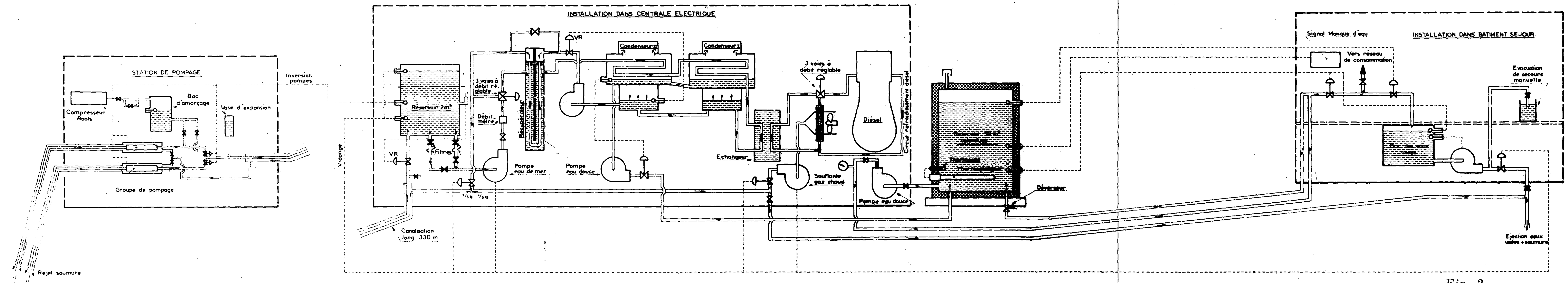
Although it is difficult in Adelie Land to base oneself on the economic standards accepted in this field, it is none the less clear that importation of gas-oil into the region is out of the question for this purpose. A heat recovery process was therefore needed, and the cooling water circuit of the electric power station diesels was used for the purpose.

Allowing for the installed electrical power, were a conventional boiler to be used, the maximum possible output would still be inadequate. Furthermore, part of the heat recovered would still be required to protect the circuits against freezing.

Only a technique employing expansion in stages enables low specific consumptions to be obtained, depending on the number of stages in series.

Allowing for the prevailing conditions, an evaporator with two stages only had to be chosen, whose operating diagram is shown in Figure 3.

The seawater, which arrives at the input to the electric power station at about 2^{o}C, is first of all heated in the recovery unit by the hot brine from the evaporator. Subsequently, the heated seawater flows in turn through the nest of tubes of the two condenser stages, thus receiving additional calories through condensation of the steam. Only when it arrives at the main heat exchanger is the water given heat energy from an external source, i.e. the cooling water of the diesel generator sets of the power station. Thus pre-heated, the seawater is fed into the first vessel and subjected to the vacuum corresponding to the extraction temperature. Partial evaporation takes place in this initial vessel and the steam condenses in a condenser at the top. The remaining brine goes on to vessel No. 2, subjected to a higher vacuum, corresponding to a temperature of 40^{o}C.



Station de pompage :	Pumping station
Eau de mer :	Sea water
Inversion pompe :	Inversion pump
Installation dans centrale électrique :	Installation in the power station
Vidange :	Emptying
Réservoir :	Reservoir
Filtres :	Filters
Vanne 3 voies á debit réglable	3 way valve with adjustable outflow
Débitmètre :	Flowmeter
Pompe eau de mer :	Sea water pump
Pompe eau douce :	Fresh water pump
Condenseur :	Condenser
Bouilleur :	Boiler

Soufflante gaz chaud :	Hot gas blower
Diesel :	Diesel
Circuit refroidissement diesel :	Diesel cooling circuit
Réservoir calorifugé :	Lagged reservoir
Thermostat :	Thermostat
Thermoplongeur :	Thermo-plunger
Déverseur :	Discharger
Habitation :	Living quarters
Signal manque d'eau :	Lack of water signal
Vers réseau de consommation :	To consumption network
Bac des eaux usées :	Waste water tank
Ejection eaux usées plus saumure :	Waste water and saline water discharge.

Fig. 2.
Dumont d'Urville Base
DRINKING WATER PRODUCTION AND DISTRIBUTION
BASIC DIAGRAM

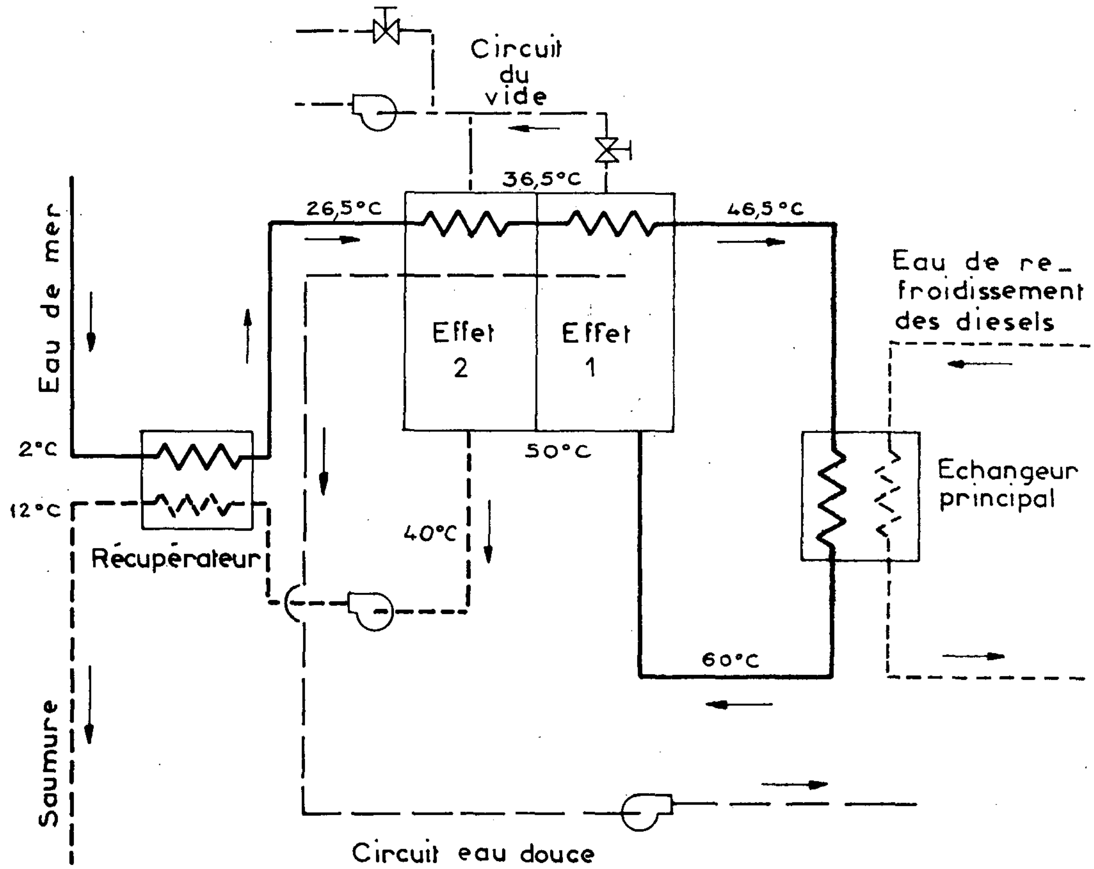


Fig. 3. Basic diagram of Evaporator.

Fau de mer :	Seawater
Saumure chaude :	Hot brine
Récupérateur :	Recovery unit
Effet 1 (et 2)	Condenser stage 1 (and 2)
Circuit du vide :	Vacum circuit
Circuit eau douce :	Fresh water circuit
Eau de refroidissement des diesels :	Cooling water of the diesel generator sets
Echangeur :	Heat exchanger

2.8 m³ ~ 620 gal/day

Under these conditions, and for an effective diesel load of 100 hp, the unit can produce up to 2.8 m^3 per day, instead of about 1 m^3 per day for a conventional boiler. In addition, a by no means negligible number of the calories given up help to protect the pump circuits. The unit as a whole only consumes 10 KW for pumping the seawater and distributing the fresh water.

A vacuum extraction pump sends the hot brine at 40°C into the recovery unit, from which it emerges at 12°C, to be discharged back to sea via discharge piping. Two discharge pipes are provided: the first, concentrical with the seawater inlet pipe, discharges towards the pumping station to provide protection against freezing up of the cold seawater inlet circuit and the second discharges the waste water.

Connection of the desalination plant to the electric power station circuits also calls for a number of adaptations. For instance, the desalination plant is connected in parallel to the present air cooling units. In addition, there is a device to ensure that should the power load fall, the necessary regulation by means of an auxiliary electric boiler prevents both the output and the operating stability of the evaporator from modified.

Design of the Pumping Set (Figure 4)

The pumping set, which is completely housed in a special building, lies on the shore (Figure 5, and picture thereafter). Submerged pumps could not be installed because of the thickness of ice that form in the winter. In addition, a special device had to be provided to prevent ice from forming in the suction pipes, operating as follows.

The seawater is taken in beneath the ice via a low pressure polyethylene pipe. Since the temperature of the seawater approaches freezing point (- 1.5° C), this pipe is thermally protected by the hot brine extracted from the plant, which circulates through an outer peripheral pipe, also in polyethylene. To protect the pipe as a whole from the mechnical loads caused by melting of the ice, the double concentrical piping is protected by a steel tube secured in a fissure in the rock.

Various causes interrupting flow in the circuit have to be provided for, the main one being clogging of the inlet strainer. This is why there are two parallel pump sets in the pumping station with automatic changeover in the event of clogging up. Lastly, the "off duty" inlet strainer is automatically cleaned by a compressed air jet.

Protection against Freezing

Protection against freeze-up between the pumping station and the power station is also provided by means of a double concentrical pipe 400 metres

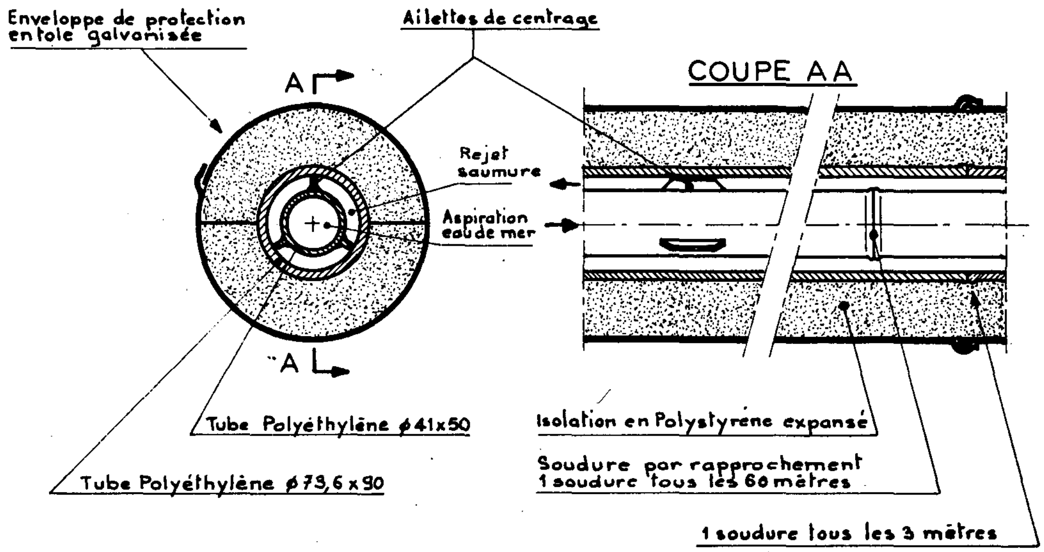


Fig. 4. Basic diagram of main pipe between the pumping station and the power station.

Tube polyethyléne :	Polyethyléne pipe
Isolation en polyethyléne expansé :	Expanded polyethyléne insulation
Soudure par rapprochement :	Welding by contact
1 soudure tous les 60 métres :	1 welding each 60 meters
Ailettes de centrage :	Support gill
Enveloppe de protection en tole galvanisée :	Galvanised steel-plate cover tor protection
Rejet saumure :	Hot brine discharge
Aspiration eau de mer :	Seawater pumping.

long, identical to the one described above, but lagged as well (See photo). Two-thirds of the flow of hot brine (12°C) extracted from the evaporator in the power station flows around the outside. Along the inside the cold (-1.5°C) sea-water is pumped towards the power station. The remaining third of the brine flow is used for protecting the waste water discharge circuit.

When the evaporator is shut down, purging by air pressure is automatic maintaining the water level below the ice. When starting, hot air from the air coolers of the power station is first of all discharged through the outer pipe for pre-heating.

Distribution $10 m^3 = 2200$ gal

An insulated, lagged storage tank is placed outside, near the power station. It allows the storage of 10 m^3 of fresh water, thus providing an independent reserve (Figure 5 and following photo).

A thermo-plunger keeps the temperature in this tank sufficiently high to avoid freezing. For the same purpose the water is distributed by a continuous circulation loop between the power station and the living quarters.

Waste Water Disposal

All the waste water of the living quarters is collected in a relay tank fitted under the false floor of the washroom. A take-up pump, controlled by a level indicator, periodically empties the tank and injects the waste water into the waste water piping where one-third of the saline output extracted from the evaporating apparatus is in permanent circulation. This piping follows the line of the refuse discharge monorail and is emptied into the sea (Figure 5 and following photo).

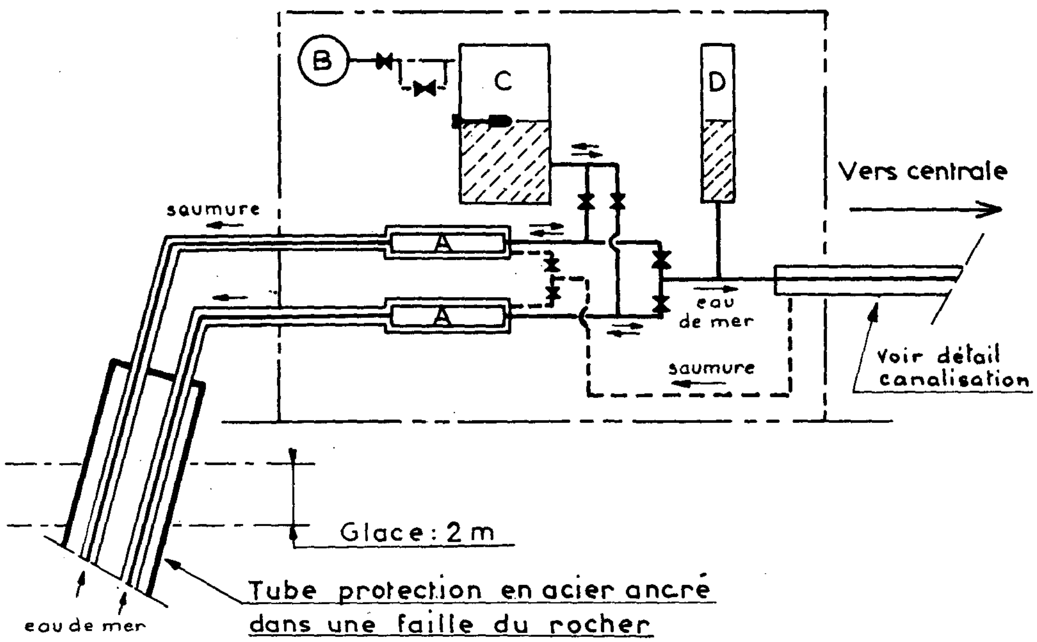
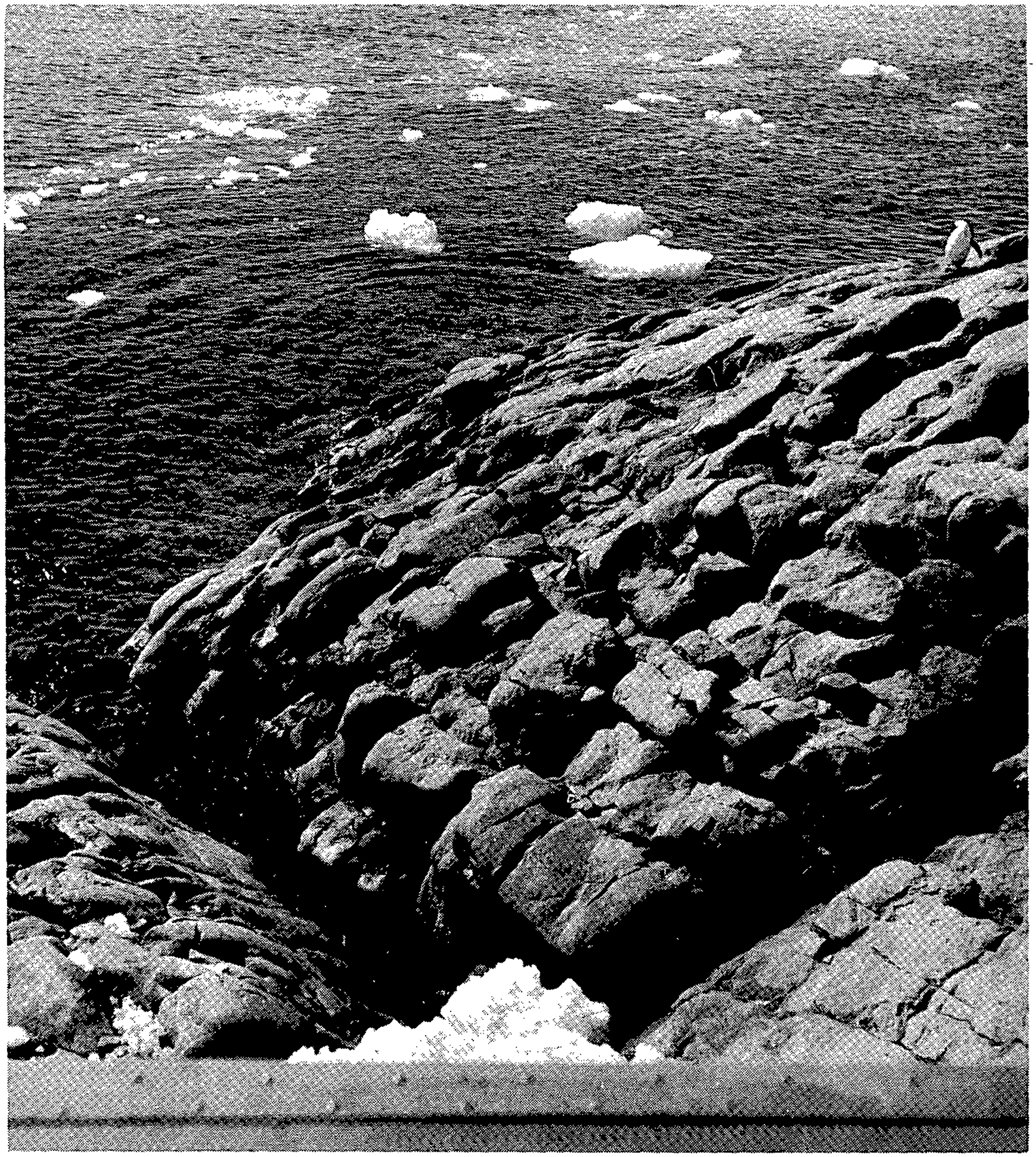
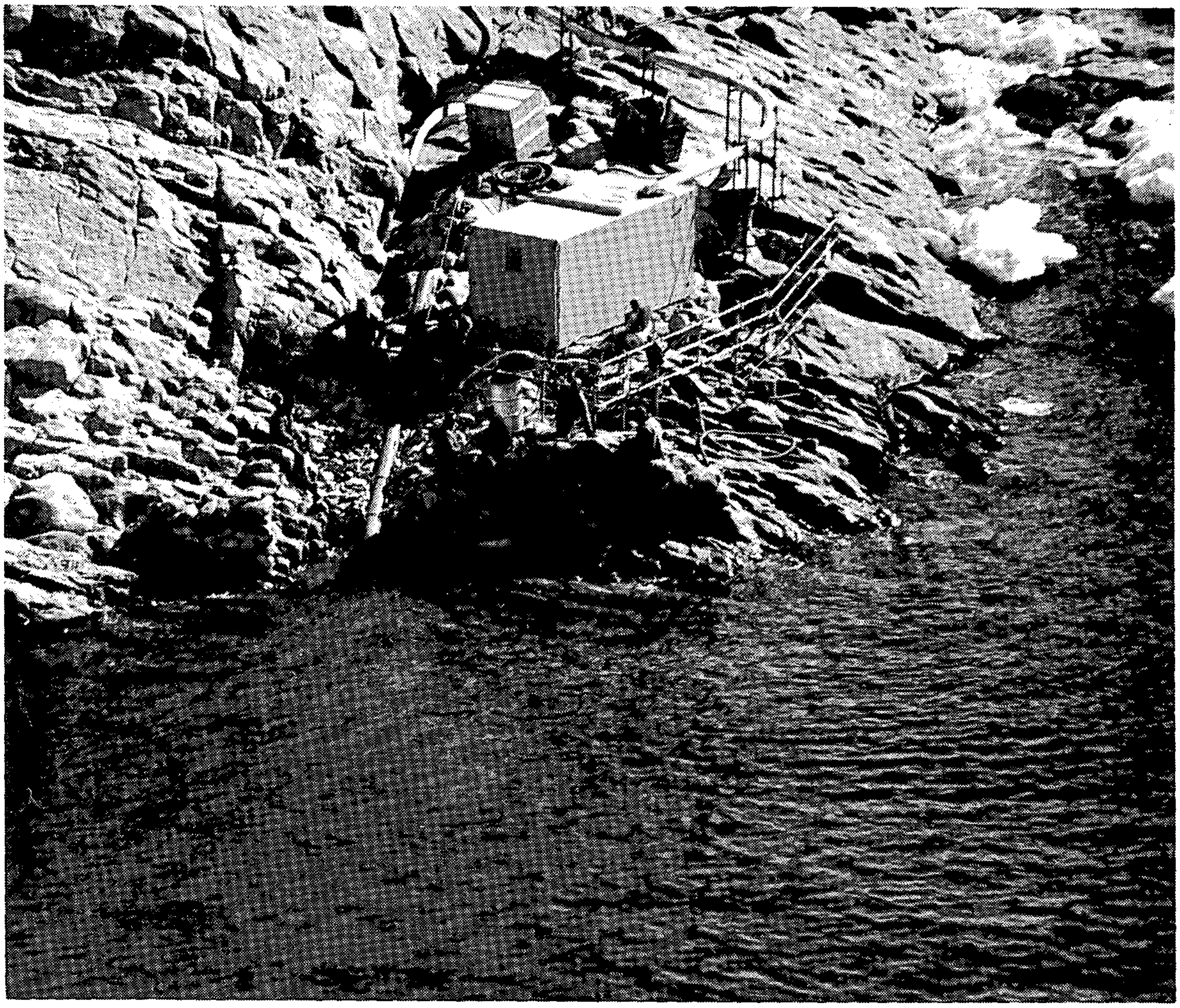


Fig. 5. Basic diagram of pumping station.

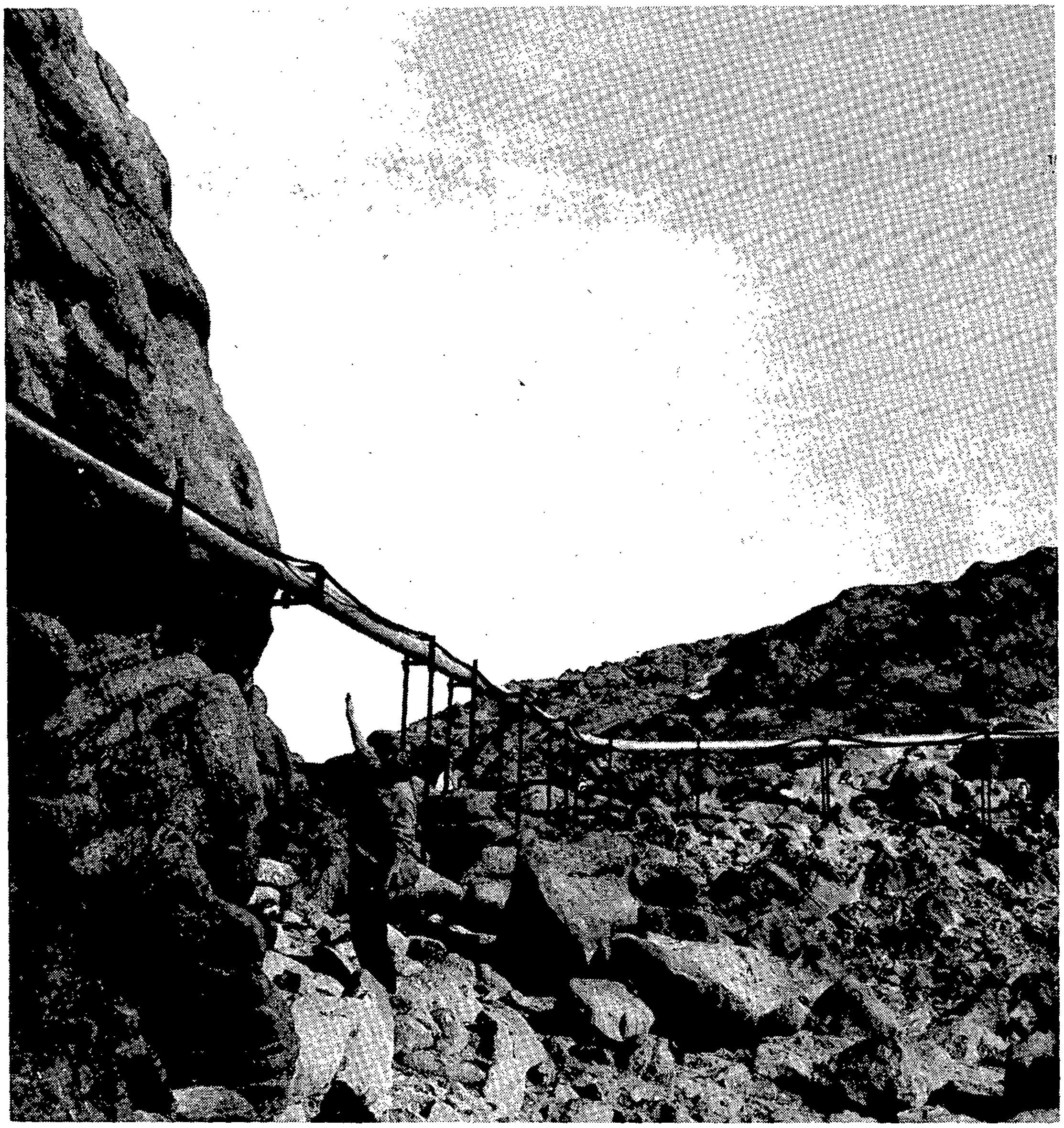
A. Pompes :	Pums
B. Compresseur d'air :	Air compressor
C. Bac d'amorçage :	Priming tank
D. Vase d'expansion :	Expansion tank
Eau de mer :	Seawater
Saumure chaude :	Hot brine
Glace :	Ice
Tube de protection en acier ancré : dans la faille du rocher :	Steel tube secured in a fissure in the rock.



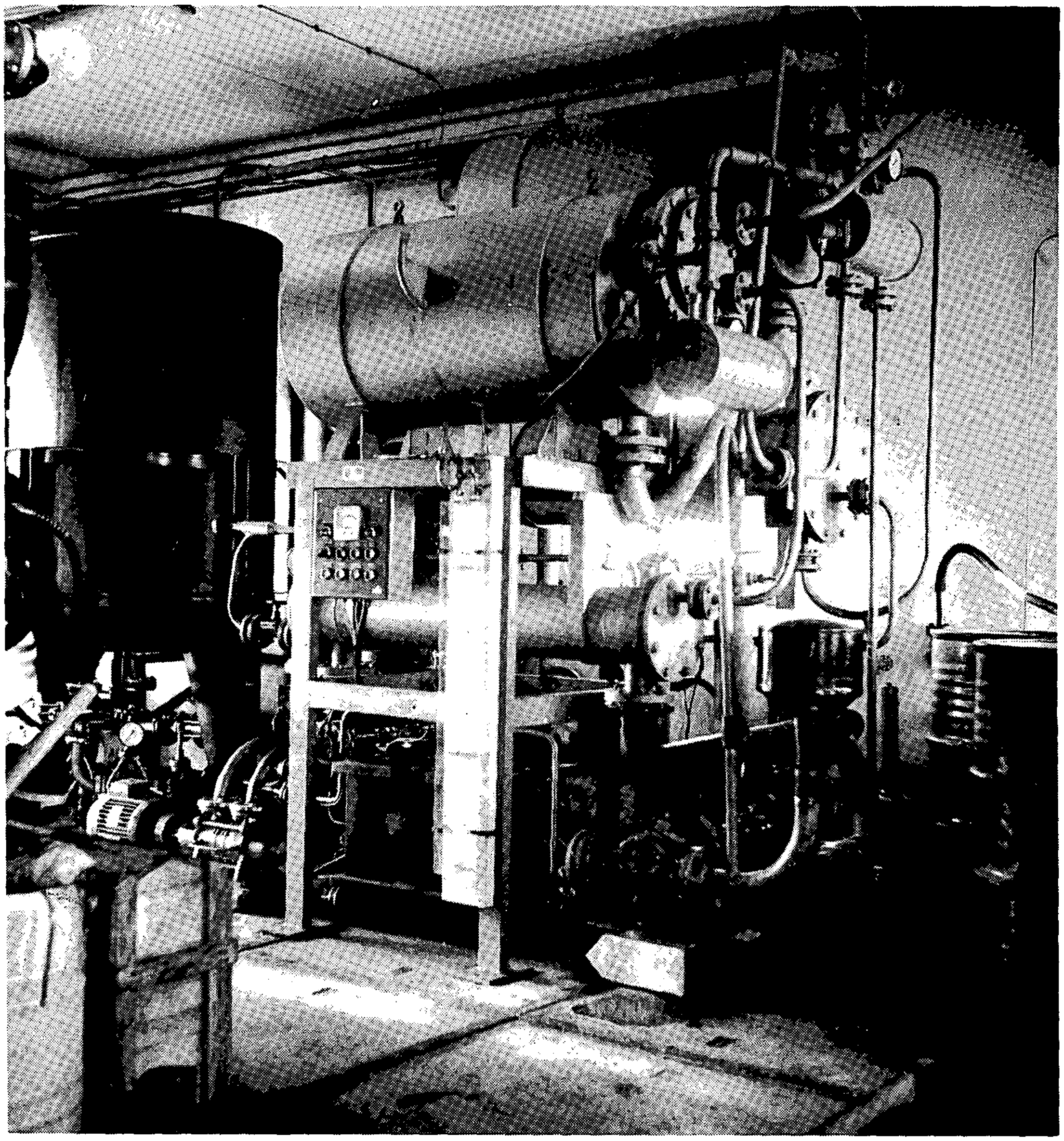
Rock fault used for passing the sea water pumping pipework.



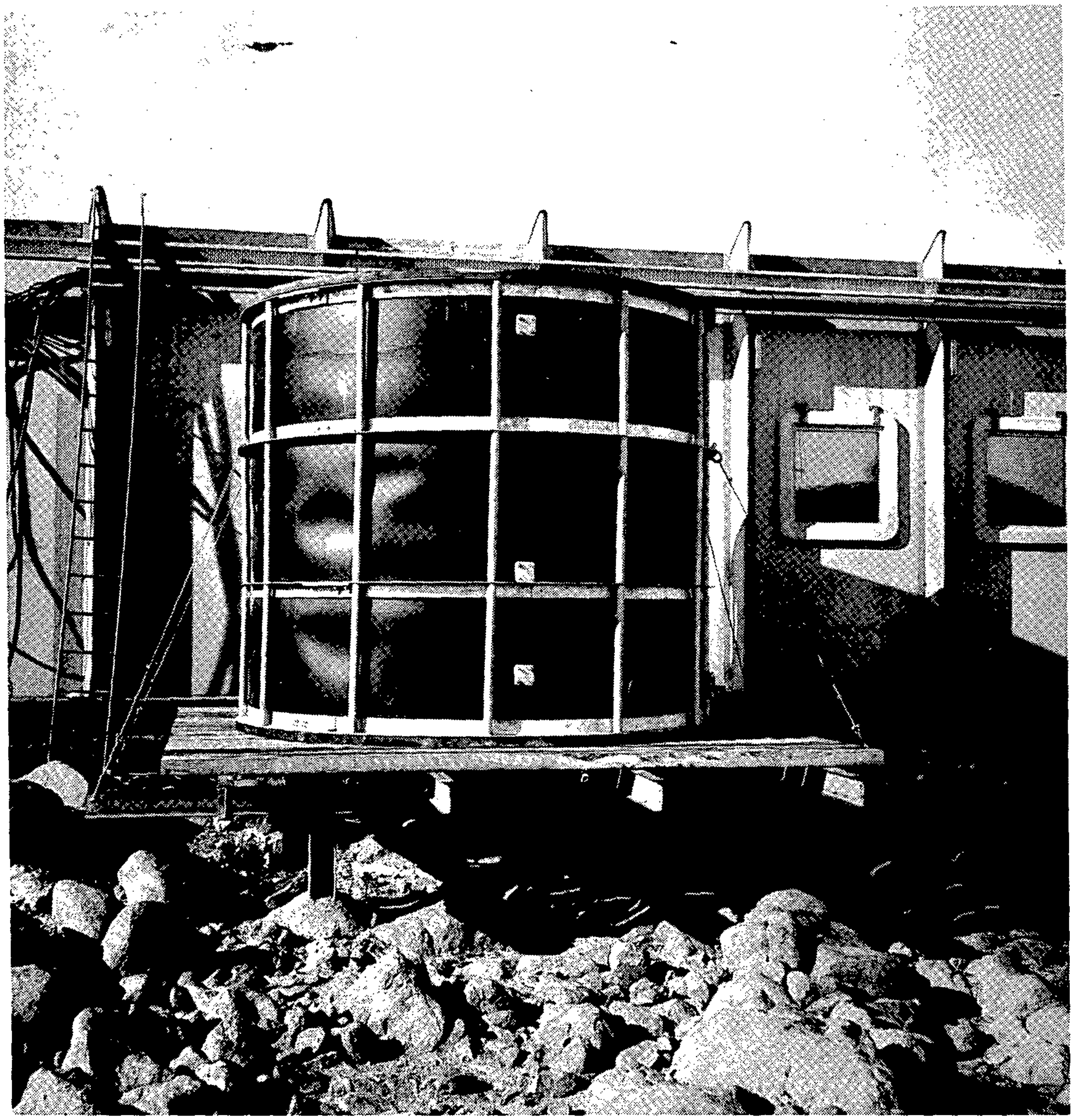
Sea water pumping station. Sea pumping pipework in the rock fault. Starting point of sea water conduction pipework and hot brine discharge, towards the electric plant.



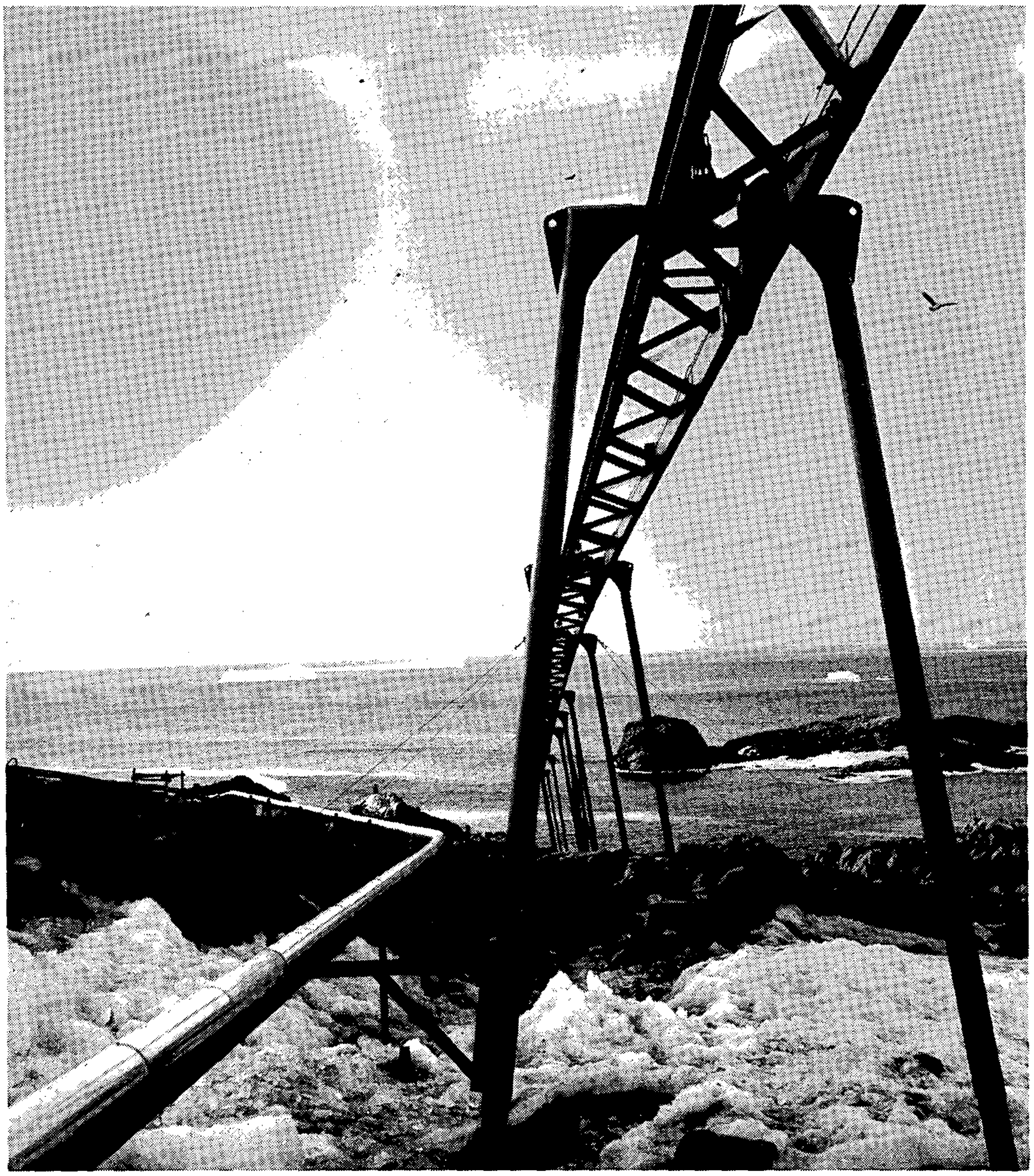
Seawater conduction pipework and hot brine discharge between pumping station and electric power plant.



View of the whole double-effect vacuum evaporation apparatus.



Lagged, insulated fresh water tank of 10 m^3 contents installed in front of electric power plant.



Discharge pipework for waste water and hot brine outlet following the course of the refuse monorail.

USE OF BITUMINOUS CEMENT AT THE DUMONT D'URVILLE BASE

Expéditions Polaires Francaises

Completion of the reconstruction and development plan of the Dumont d'Urville Base required the creation of a minimum infrastructure for the handing and unloading of equipment and building material unloaded from a ship. In particular, it was necessary to construct an unloading quay equipped with a gantry having a lifting capacity of five tons.

For the construction of this quay the simplest method was to create a submerged enrockment, but it was necessary to resolve the problem of the choice of the binder to be used to keep the blocks of rock in place.

The idea of using bituminous cement hot-poured results from the following considerations:

- the visco-elastic characteristics of bituminous mixes are such that for the low temperatures to which they would be continually exposed (between 0°C and - 40°C), structures so built would have the tendency to behave like an elastic material comparable to other traditional building materials.

- the setting of bituminous mixes only being obtained by temperature differences, they present a great advantage overconcrete and hydraulic cement whose setting is difficult in these low temperatures.

The bituminous cement to be used had, however, to fulfil special conditions:

- hold without noticeable deformation on a vertical wall;
- not crack at -40°C;
- penetrate sufficiently in the enrockment;
- maximum simplification of manufacture and use;
- ease of transport of material for a long sea voyage (two months).

Study of Cement and Choice of Bitumen

A special study was made by the Shell-Berre Company. So as to take into account the special conditions indicated above (and also the irregular sices of the enrockments, and thus the spaces to be filled), a special form of cement, rich in filler, was perfected:

river sand 0.5	= 80 parts in weight;
chalk filler	= 20 parts in weight;
bitumen	= 18.5 parts for 100 parts of aggregate.

Cements with the ingredients were manufactured with different types of bitumen. Comparative tests were made in the laboratory covering extrusion, holding on vertical walls, cracking at low temperature, depth of penetration in an enrockment. Finally, the 40/50 bitumen was chosen so as to obtain a bituminous cement which pours well under the working conditions while presenting good characteristics of stability.

Method of Use

So as to facilitate use on the worksite and to resolve the transport problems, the following arrangements were finally made:

- manufacture in France of cakes of under-dosed cement that was easily transportable;
- shipment of the cakes and of additional bitumen in packages of weight and size that facilitated their handling;
- manufacture on the spot, by re-melting the cakes with addition of bitumen by means of a melter-mixer of 600 litres capacity, specially lagged;
- use by pouring a complete mix.

The pre-manufacture of bituminous cement in cakes with an under-dosed formula enabled one to avoid the operation of drying the sand on the worksite, which would have been difficult in Adelie Land; on the worksite, it sufficed to melt the cakes and to add the necessary quantity of bitumen so as to obtain the required compound.

The cakes manufactured in France made use of 40/50 bitumen in a proportion of 9 parts of aggregate, instead of the 18.5 parts provided for in the above formula.

So as to avoid the risk of mass setting during the course of a long voyage by ship, the cakes were poured into four-layer paper bags, with a unit weight of 35 kg, so as to allow easy handling.

The 40/50 bitumen to be added was poured into small barrels of 50 kgs, net weight. All, these arrangements were designed, by means of the 600 litre melter-mixer, to allow production of mixes on the site by the following simple mixture:

- thirty cakes of 35 kg cement;
- two sall 50 kg barrels of 40/50 bitumen.

Completion of Work

The production and use of the bituminous cement took place according to forecast and without special difficulties. However, as the work took place during the winter of 1963, despite the lagging of the melter-mixer, cooling resulting from the violent winds of Adelie Land considerably lengthened the fusion time of the bituminous cement cakes; it therefore became necessary to fit the melter with a second burner. Pouring of 1,150 kg., of cement at 190°C could be effected every day. The progression of the cement in the enrockment provided no special problem, and the setting of each mix to the preceding one was shown to be perfect.

The section of the quay (following diagram) shows the arrangement used; checks confirm the good penetration of the cement through the whole thickness of the enrockment.

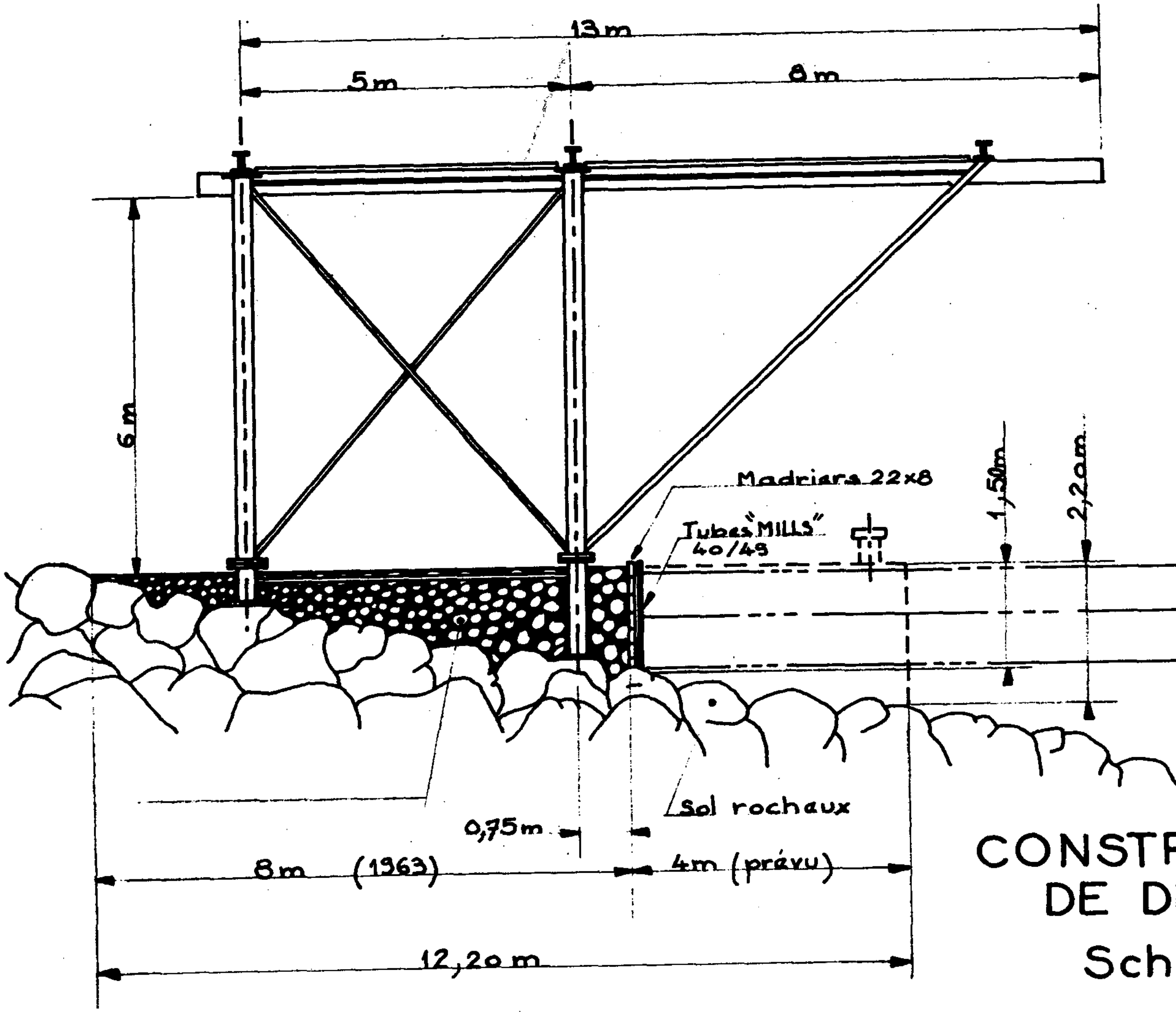
This quay, built in 1963, has been in service during each summer campaign since that date, and no incident has occured.

Apart from the construction of this quay the bituminous cement has been used in the improvement of the Dumont d'Urville Base, each time that it was necessary to consolidate and protect building foundations, or for certain work to effect tightness.

The main work performed is the following:

- consolidation and tightness of the platform of the electric power plant (1963);
- roofing, tightness and protection on the periphery of the seismological cellar (1964, following photo);
- construction of the ten by ten meter platform serving as a launching area for the firing of ionospheric rocket-sounds (1966, following photo). When firing, in January, 1967, the thermal protection of this platform was provided by a covering of steel plates.

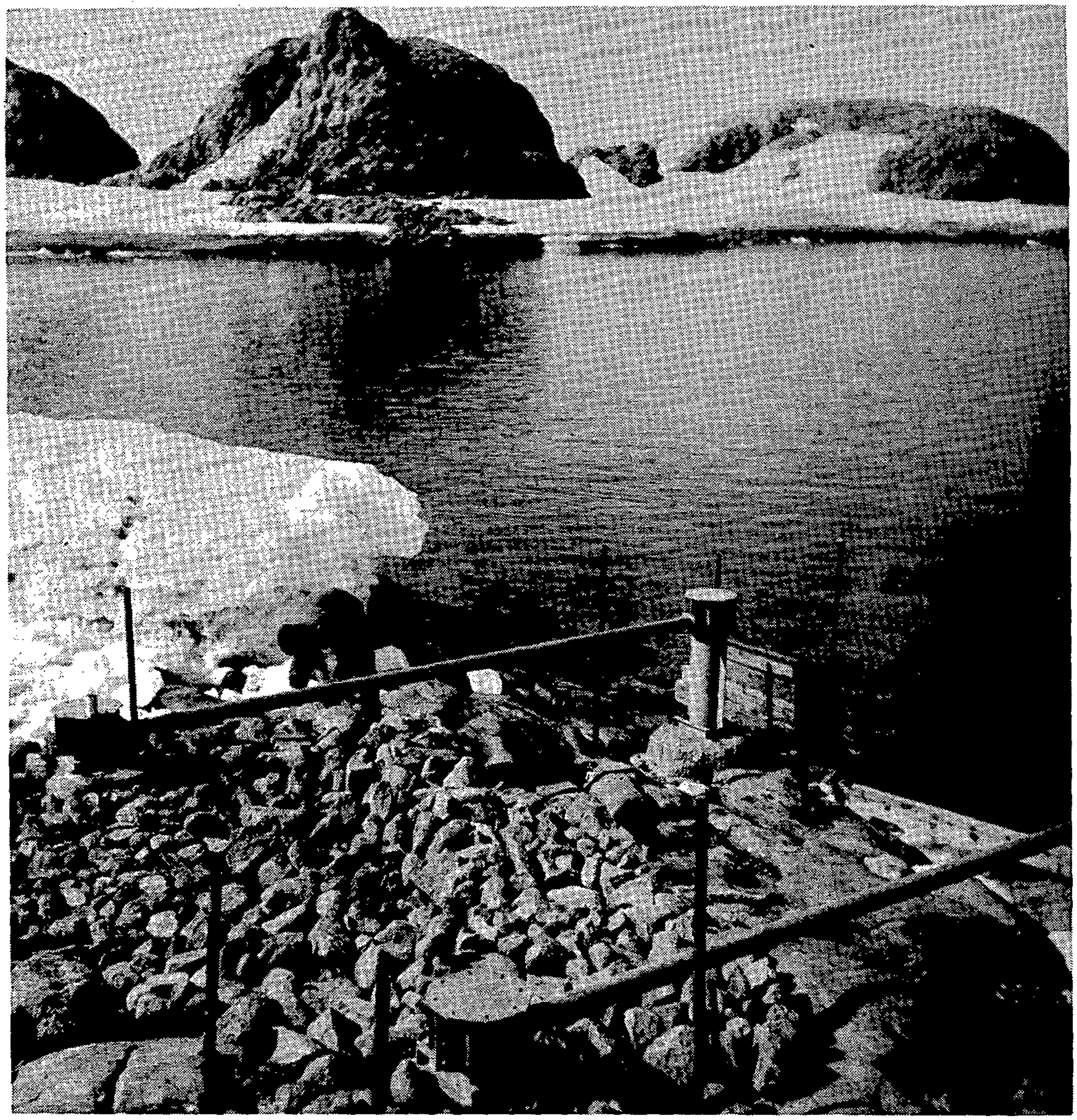
All the work constructed has given full satisfaction, and in the future, the unloading quay will be considerably lengthened, along the side of the island, by using the same method of submerged enrockment, set by penetration of bituminous cement hot-poured.



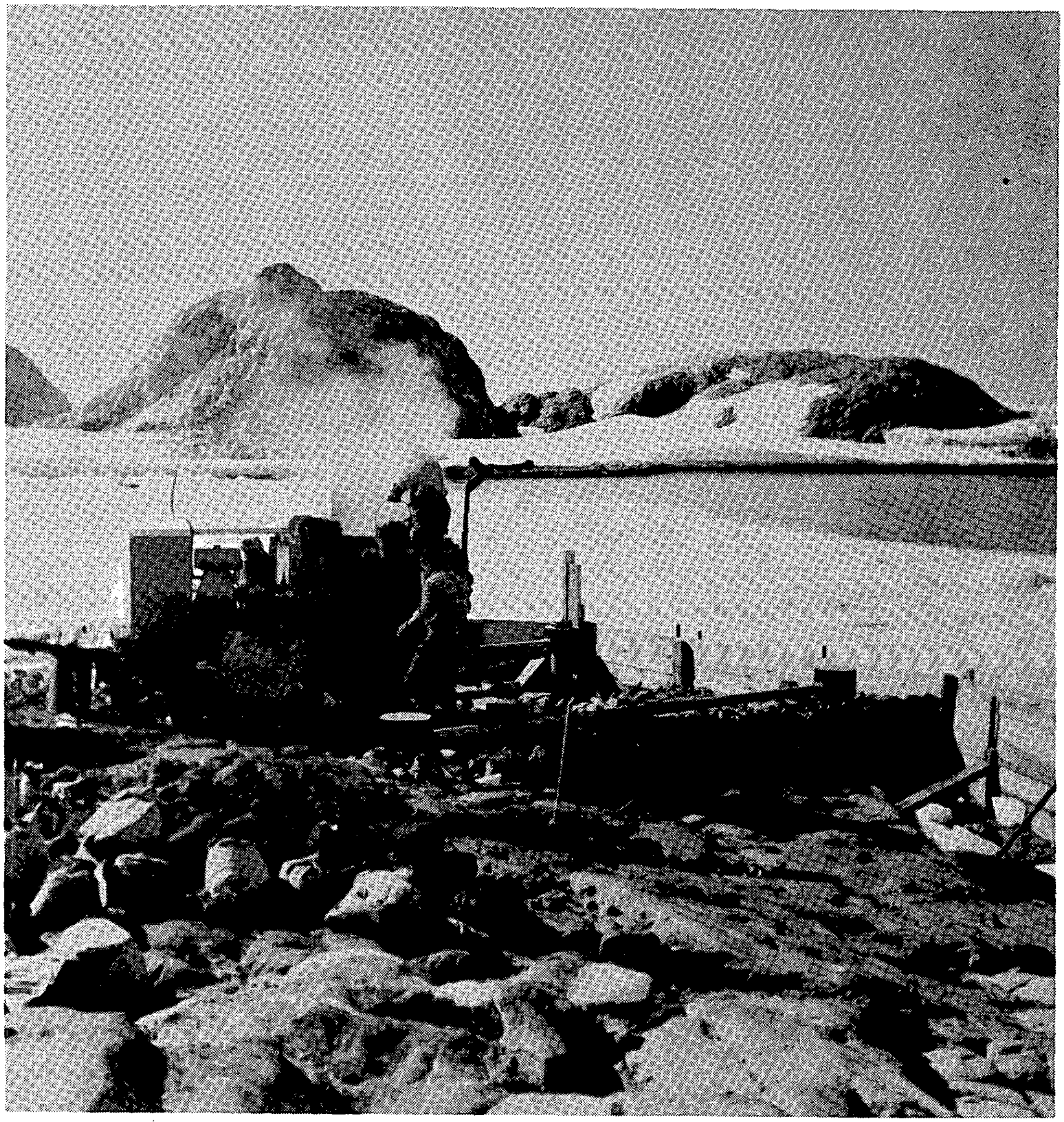
CONSTRUCTION DU QUAI DE DEBARQUEMENT

Schéma de principe

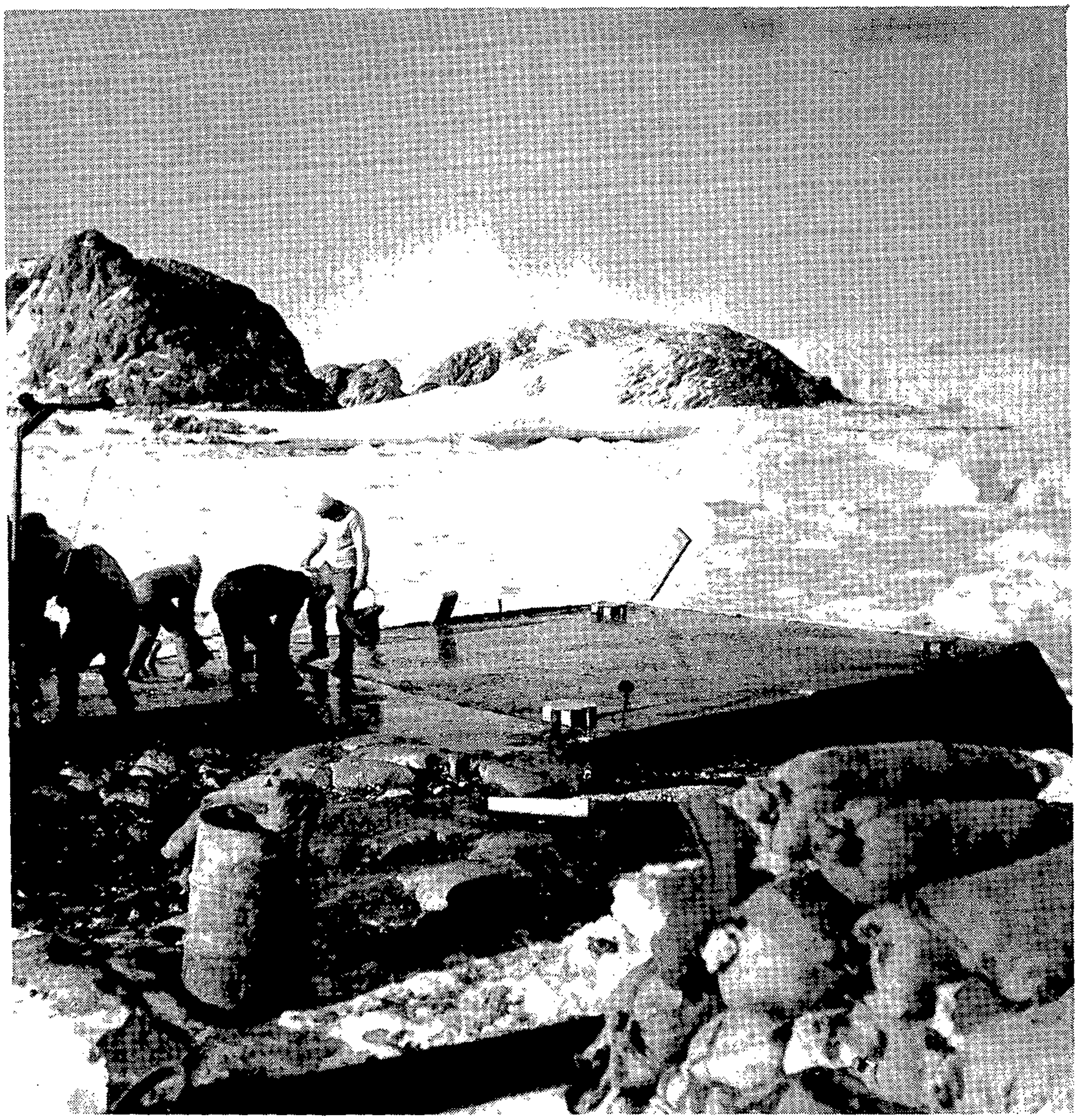
COUPE SUR VUE DE PROFIL



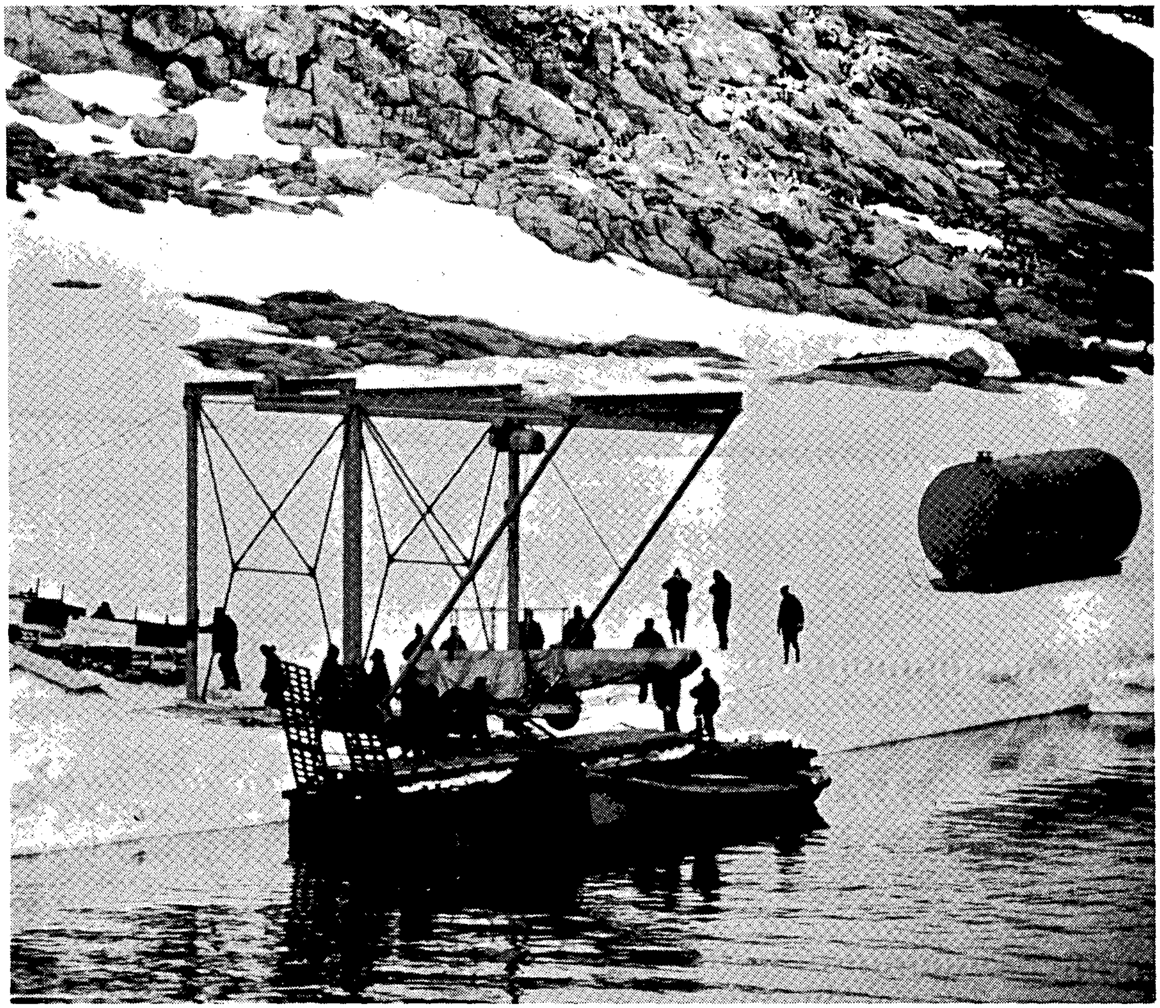
Construction of unloading quay: Laying of enrockment for bituminous cement pouring



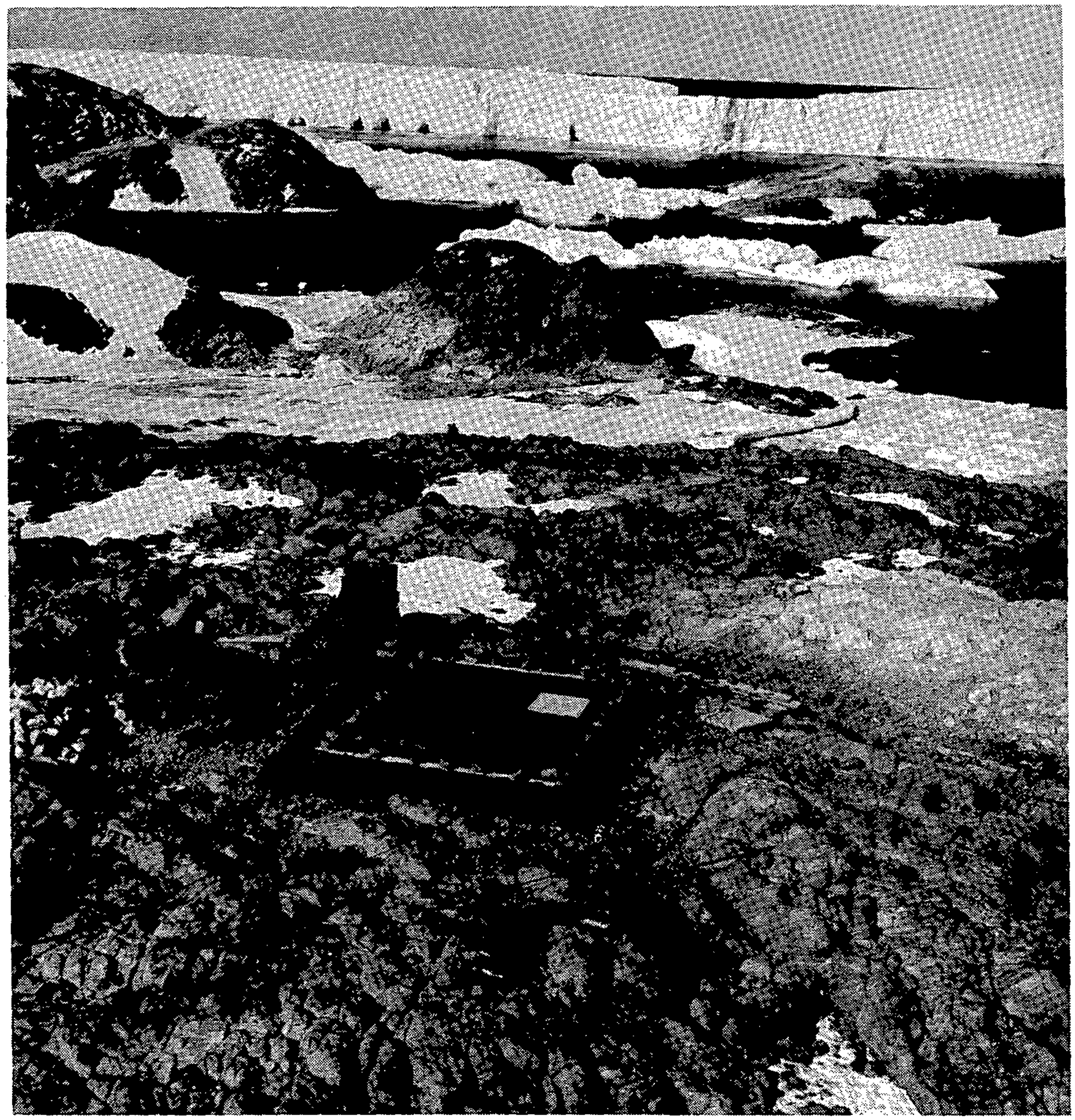
Construction of unloading quay: Preparation of the daily mix of 600 litres of bituminous cement.



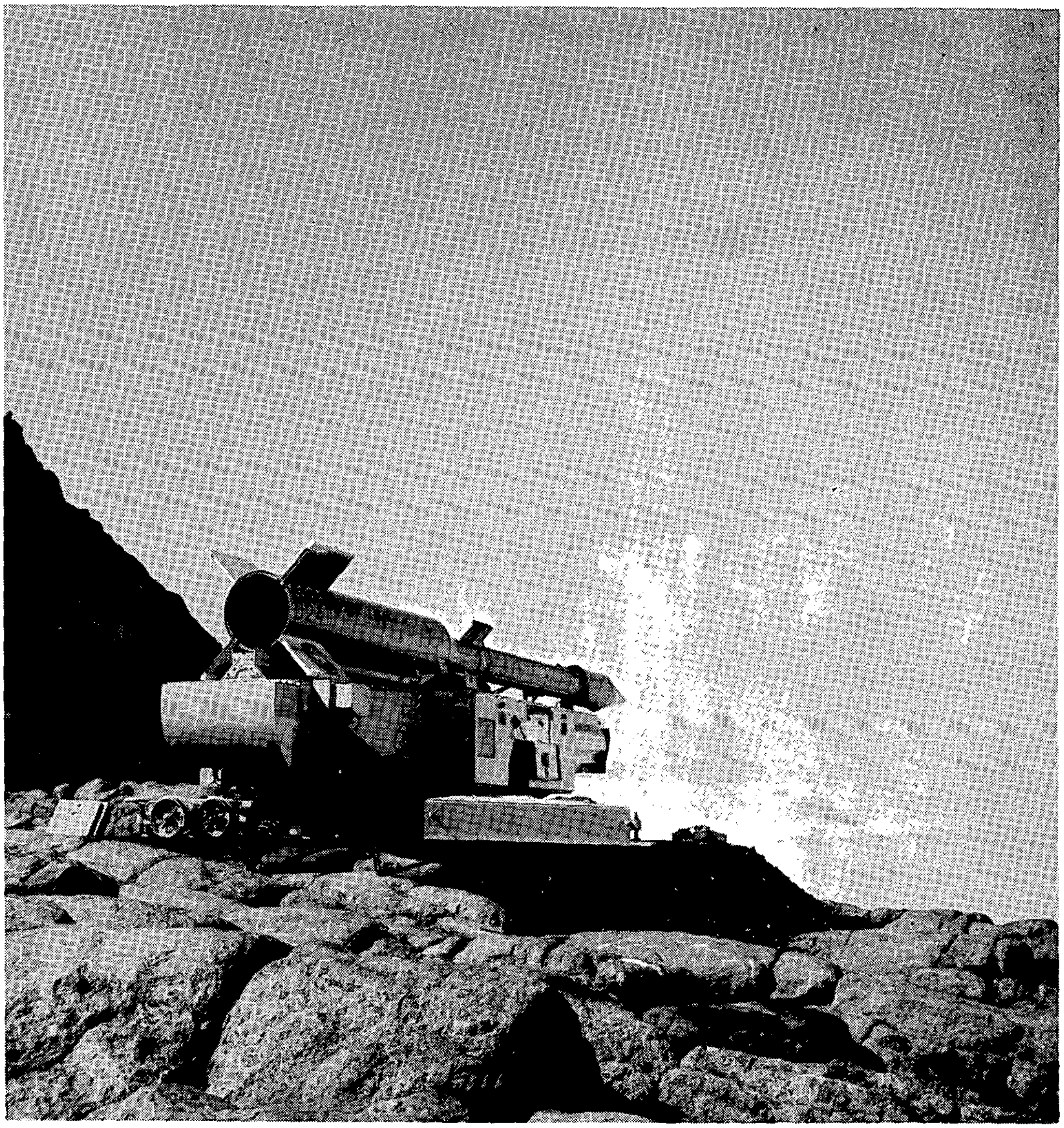
Construction of unloading quay : Pouring of bituminous cement for the finish.



Construction of unloading quay: Quay and unloading gantry completed, in use. (unloading of the rocket launching support.)



Seismological cellar: Capovering and tightness with bituminous cement.



Launching area of rocket-sounds: Platform constructed by enrockment set with bituminous cement.

RECONSTRUCTION AND DEVELOPMENT OF THE
DUMONT D'URVILLE BASE

Expéditions Polaires Françaises

1. History

The first French base on the Antarctic continent was that built by the French Polar Expéditions at Port Martin, in Adelie Land, in 1950 (Fig. 1).

A small connected base was built on Petrel Island in 1952 to study a large rookery of Emperor penguins. The main Port Martin Base having been destroyed by fire in January, 1952, the connected base on Petrel Island was closed in January, 1953. The buildings of that period still exist and are noticed as "Marret Base" on the attached drawings (Fig. 2).

To participate in the 1957-58 International Geophysic Year, the Petrel Island site was chosen for the building of the main base which was called as "Dumont d'Urville base". The reasons for choosing this site are described below.

The buildings and installations of this base were designed to answer the needs of a provisional base that was only to be occupied during three years: 1956 - 1957 - 1958.

At the end of the International Geophysical Year, the French Government decided to maintain the Dumont d'Urville Base on a permanent basis, and to continue the work of scientific research, also on a permanent basis, within the framework of the International Geophysic Cooperation.

On the one hand, this decision made it necessary to rebuilt the Dumont d'Urville Base to accord with a permanent base, and, on the other hand, to extend it so as to rapidly satisfy the growing needs of scientific research.

To provide for this re-building and development, a "Basic improvement plan" was studied during 1960 and 1961. Approved in 1962, it was completed in annual sections as from 1963, in the light of available credits.

This is the development that is recounted hereafter.

2. Position of the Dumont D'Urville Base

The Dumont d'Urville Base is built on Petrel Island in the "Pointe Geologie" Archipelego, on the edge of the Antarctic continent (Figs. 1 and 2).

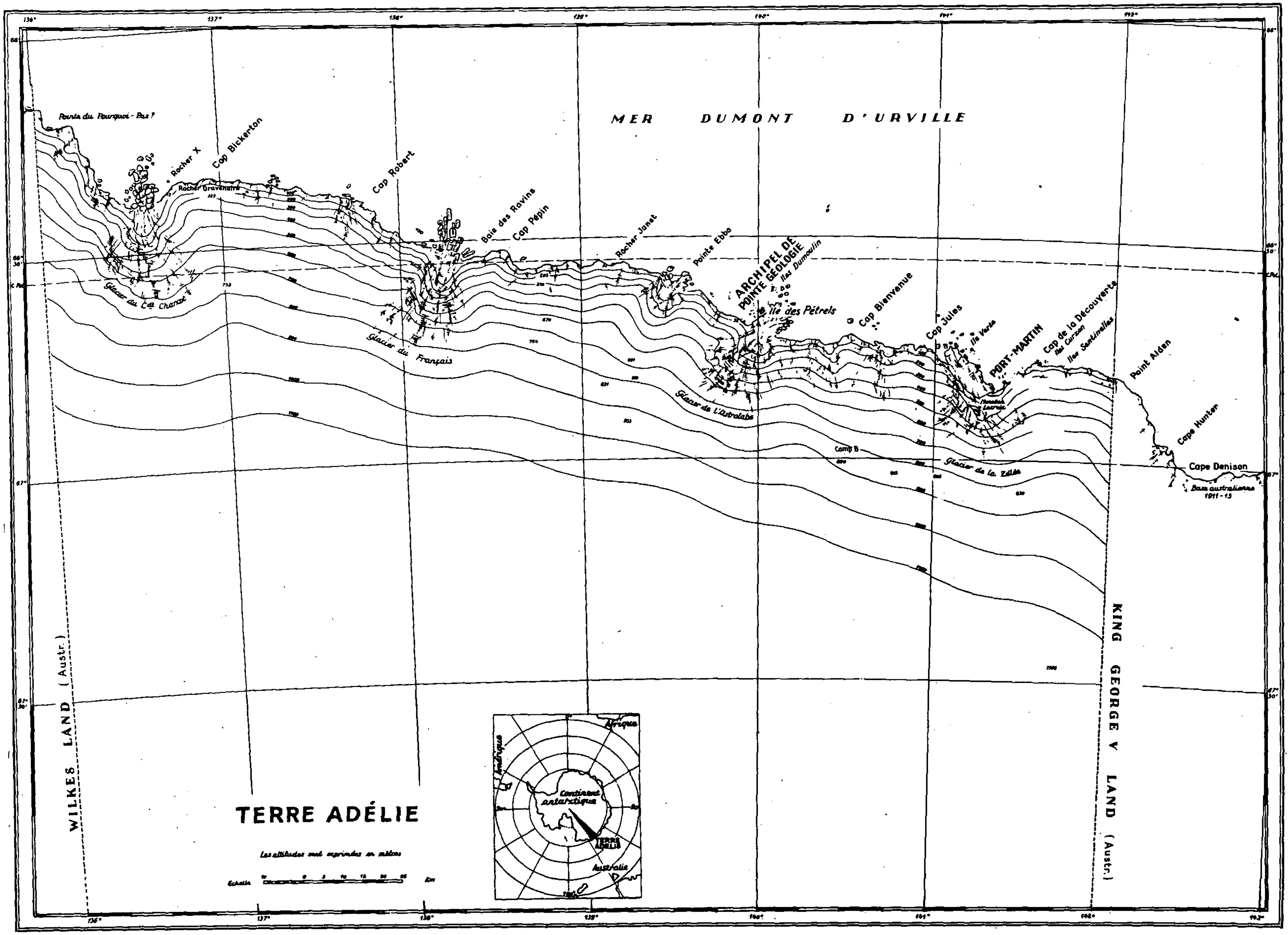
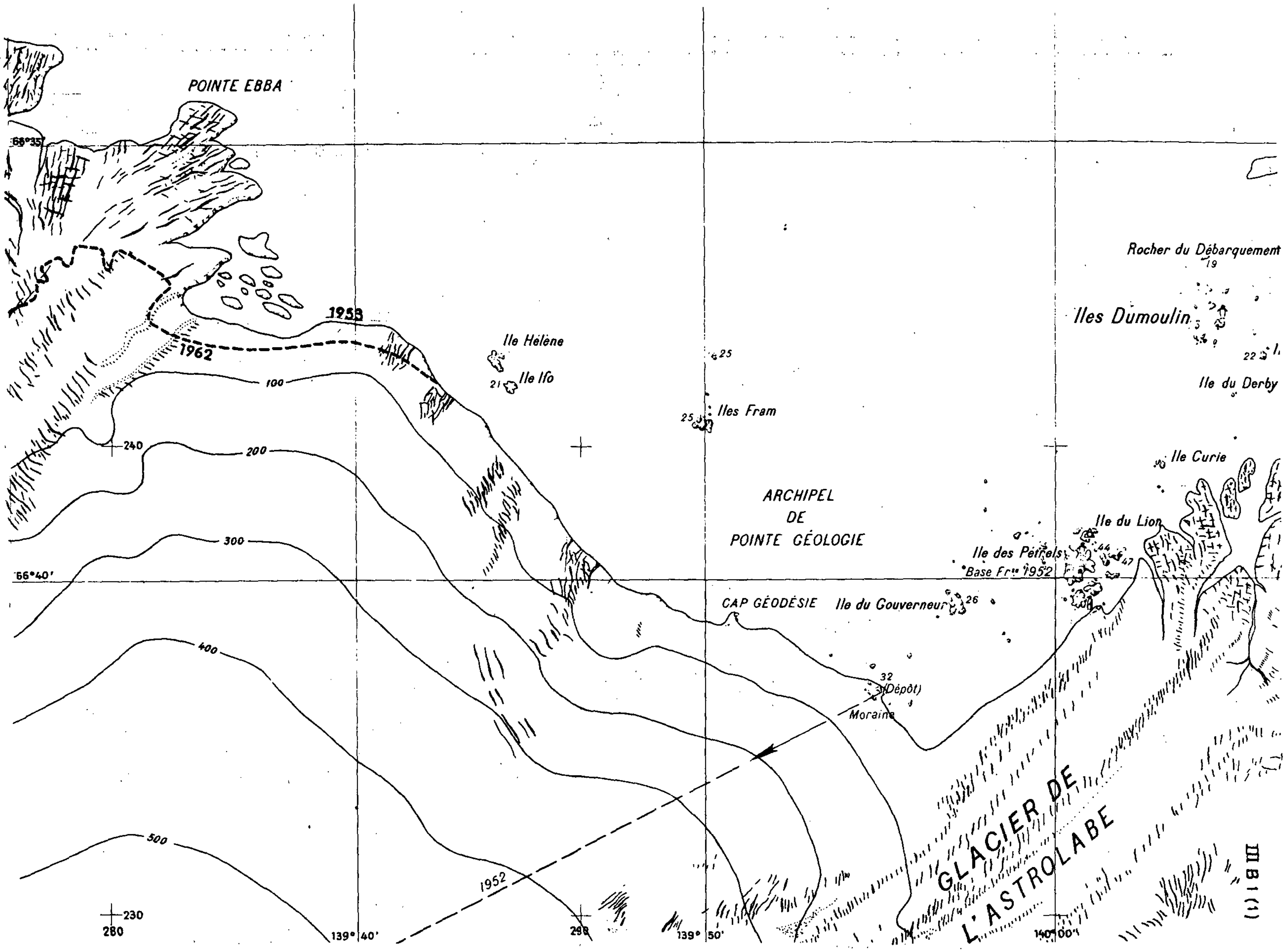

MER DUMONT D'URVILLE
Pointe du Pourquoi-Pas ?
Rocher X
Cap Bickerton
Rocher Dravenaire
Cap Robert
Baie des Ravins
Cap Pépin
Rocher Janet
Pointe Ebbo
ARCHIPEL DE POINTE GÉOLOGIE
Iles Dumoulin
Ile des Pétrels
Cap Bienvenue
Cap Jules
Ile Verte
PORT-MARTIN
Cap de la Découverte
Iles Curzon
Iles Sentinelles
Point Alden
Cape Hunter
Cape Denison
Base australienne 1911-13
Glacier du Cdt Charcot
Glacier du Français
Glacier de L'Astrolabe
Glacier de la Zélée
Camp B
WILKES LAND (Austr.)
KING GEORGE V LAND (Austr.)
TERRE ADÉLIE
Les altitudes sont exprimées en mètres
Echelle
Km
Afrique
Amérique
Continent antarctique
TERRE ADÉLIE
Australie

Fig. 1.



POINTE EBBA
66°35'
1958
1962
100
200
300
400
500
240
Ile Hélène
Ile Ifo
21
25
Iles Fram
25
ARCHIPEL
DE
POINTE GÉOLOGIE
CAP GÉODÉSIE
Ile du Gouverneur
26
32
(Dépôt)
Moraine
Rocher du Débarquement
19
Iles Dumoulin
22
Ile du Derby
Ile Curie
Ile du Lion
Ile des Pétrels
44
47
Base Fr.se 1952
66°40'
GLACIER DE
L'ASTROLABE
1952
230
280
290
139° 40'
139° 50'
140° 00'
III B 1 (1)

Fig. 2.

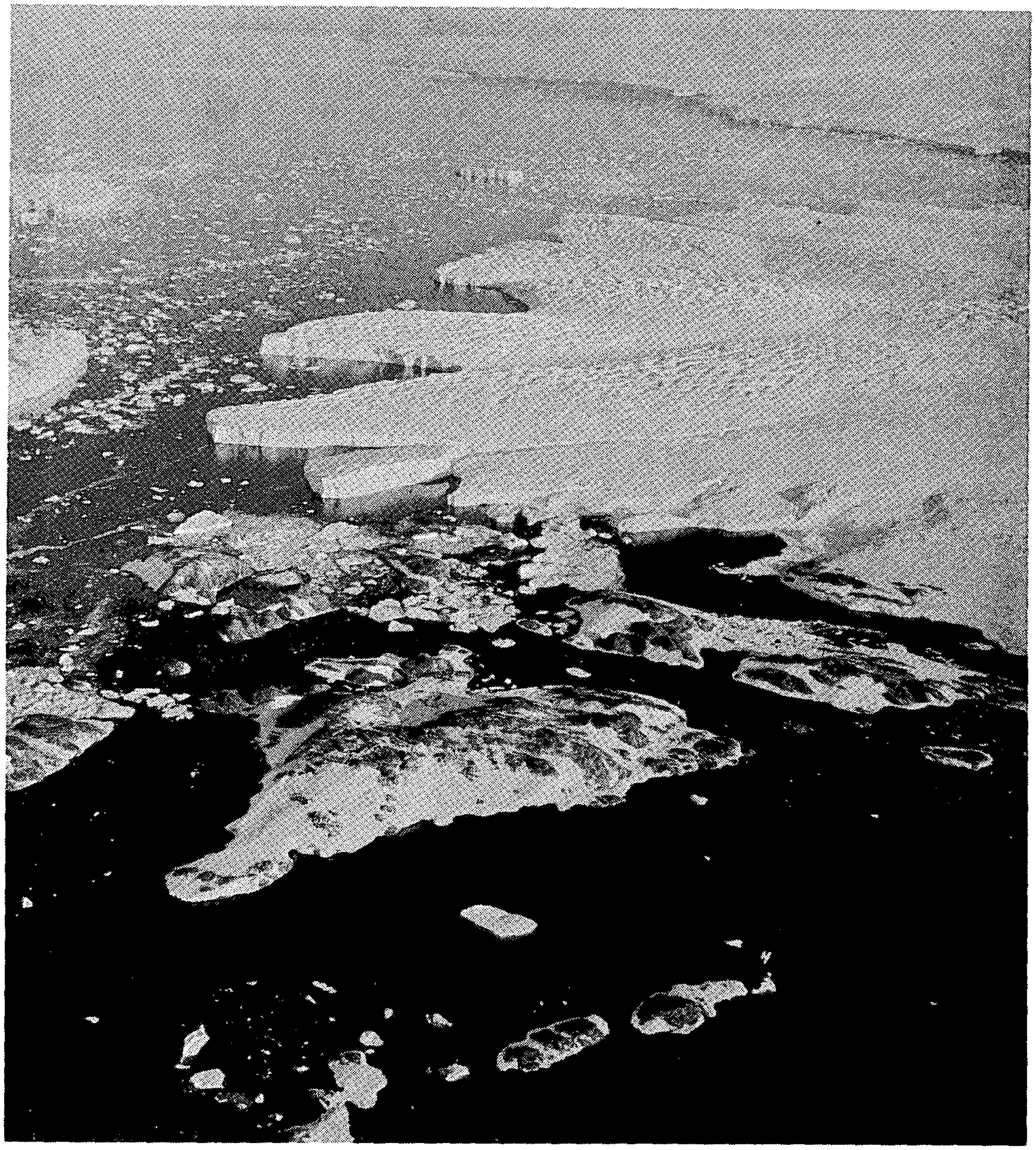


Fig. 3.

Position: Longitude : 140° 01' East
Latitude : 66° 40' South

In this region, the edge of the Continent consists of ice cliffs 15 to 25 m high. However, access to the continent is possible from André Prud'homme Cape, situated at about 4 km from Petrel Island.

Petrel Island consists of rock (gneiss), in a confused mass, with some perma-frost areas. About half of its surface is under ice (Fig. 3).

Its measurements are: 900 m at its greatest length, 550 m at its greatest width.

This island was chosen in 1956 for building the Dumont d'Urville Base for the following considerations:

- climatic conditions more favourable than at Port Martin; a less violent catabatic wind than that on the continent;less frequent blizzards; better visibility and clearer sky for scientific observations;

- the central part of the Island consists of a plateau with an average height of 40 m, providing good visibility in all directions for scientific observations;

- possibility of building on solid soil, on rock; existence of a landing beach that facilitates operations;

- possibility of access to the continent by the André Prud'homme Cape, for expeditions on the Antarctic plateau.

However, it must be noted that wind remains the characteristic phenomenon; the average wind (monthly average) observed over a 10-year period, is shown to be 11 m/sec (39.6 km /h). The maximum wind recorded reached 73 m/sec (262.8 km /h). Another characteristic, resulting from the wind is the absence of any accumulation of snow and almost total disappearance of the latter during summer.

The monthly average temperature is shown to be -11.04°C, the minimum monthly temperature -36.5°C in winter and -9°C in summer; the maximum monthly temperature is -0.7°C in winter and +6.1°C in summer.

3. Basic Installation Plan (Development Plan)

Aim

It was considered necessary to draw up such a plan so as to convert the temporary base into a permanent base; in fact, it was necessary to:

- avoid unorganized development, particularly in the siting of buildings that might require subsequent demolition or change of site;

- take into account the incompatibility of proximity of certain installations. The distances between them can be required, either for scientific installations among each other or of themselves (example: magnetism, seismology, Aurora), or between scientific and technical installations (example: ionosphere and radio; presence ozone or radioactivity and smoke from the electric power plant).

- Decide on a type of definitive building and a construction method, adapted to the climate and to the terrain, and, with necessary variations, likely to satisfy all needs.

- attempt to appreciate the development of scientific research needs, so as to decide on the technical installations to be built to satisfy these needs during a reasonable period of time (example: number of staff, power of the electric power plant).

- keep open all possibilities for the development by limiting the "reserved zones". These may be of different kinds; for example: separations between the wintertime activities and those of the summer campaign; zones reserved, on the one hand, to scientific installations and, on the other hand, to technical installations; zones reserved for projects planned in the more or less distant future;

- take into account the fact that completion of the plan will be spread over several years both for financial and operational considerations. Further, to respect the priority of scientific research, this could require an order of completion contrary to logic (example: priority construction of laboratory buildings ahead of new living buildings or water, sanitary and cooking installations). Thus former installations will remain operational, even though they no longer answer requirements. New buildings will be put to various successive provisional uses before serving final purpose (example: use of a garage as dormitary for the staff in the summer campaigns). The old buildings will only be able to serve their new purpose when the substitute buildings have been built (example: conversion into store-rooms). This spreading of the work over a period of time thus engenders inevitable management and organization difficulties during the temporary period.

History

Study of the "Basic installation plan of the Dumont d'Urville Base" started in 1960. Evaluation of the scientific needs and the decision as to the siting priorities to be maintained were made in 1961 in collaboration with those responsible for each scientific discipline. The first designs for the "Mass Plan" were drawn up at the same time and checked on the ground, by topographical surveys, during the course of the Antarctic summer campaigns of 1960/61 and 1961/62.

Simultaneously, the Technical Office of the French Polar Expeditions was making studies of new buildings (see Report: "The new buildings of the

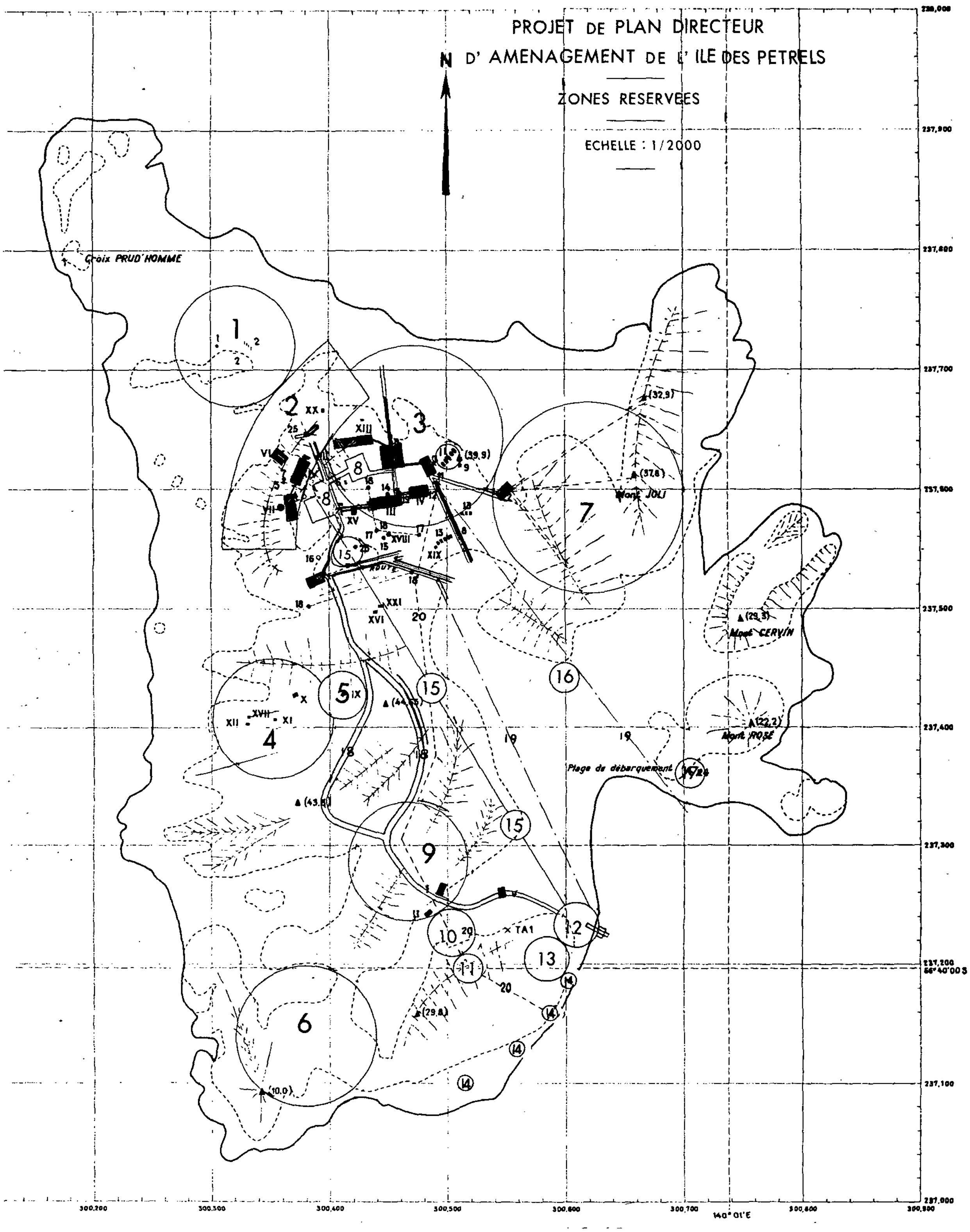


Fig. 4. General plan for installations of Petrel Island (1962).

Reserved areas (in red colour)

— for Wintering party :

1. Scientific area (magnetism)
2. Scientific area : 2 laboratory-buildings
3. Technical area : Dwelling building—Living quarters—Power plant
4. Scientific area (magnetism)
5. Scientific area (seismology)
6. Scientific area (ionospheric antenna)
7. Technical area (radio antenna)

— for Summer campaign :

9. For Summer dwelling building
10. Helicopter platform
11. Fuel-oil tanks
12. Unloading quay and gantry
13. Raw materials storage
14. Moorings for the ship
15. Project for a cable-car
17. Explosives storage

— Connection between summer and winter areas :

18. Planned roads
19. Helicopter channel
20. Fuel-oil piping and electrical cableway

Dumont d'Urville Base"), of the infrastructure (unloading, handling,), and the priority installations (electric power station and distribution network, storage and distribution of fuel oil, heating, etc.). The plan was finally approved in 1962 at which time the attached map was drawn up on which the planned installations are shown in red (Fig. 4).

General Design

As regards the foreseeable development of the Dumont d'Urville Base, two principles were laid down:

- winter-time: a permanent station, allowing constant development of scientific observations and work similar to that performed until then;

- summer campaign: a possible rapid and irregular increase of provisional experiment limited to one or several campaigns.

The basic installation plan thus differentiates between two main zones, one allocated to wintertime installations that can be set up in priority, the other, to summer campaign activities comprising certain priority installations, and allowing necessary room for later developments.

The winter-time zone is situated in the Northern part of Petrel Island, on the plateau most favourable for building, and having clear horizons for scientific observations. The Western part of this zone, consisting of an absolutely clear crest overlooking the sea (References 1 and 2 on the attached drawing) is reserved for scientific installations (laboratory buildings, the whole of the meteorological equipment). The Eastern part of this zone (Reference 3) is reserved for technical equipment (old buildings, new living-room building and winter housing building, new electric power plants, placed in the wind axis so as to avoid all atmospheric pollution).

The summer activities zone is situated to the South of the island near the unloading beach. Around the old Marret Base, it regroups the unloading equipment (quay and unloading gantry: Reference 12; ship mooring: Reference 14), materials store (Reference 13), fuel-oil store (Reference 11), helicopter landing area (Reference 19); it also comprises sites (Reference 9) designated for the construction of buildings (such as housing the staff during the summer campaigns).

Between these two zones, the central plateau of the Island is reserved for scientific installations requiring isolation: magnetism (Reference 4), seismology (Reference 5).

At the opposite ends of the island, two other sites have been reserved. One to the South (Reference 6) for the installation of ionospheric antennae; the other, to the north east, for the transmitting antennae of the future radio station.

A road system (Reference 18) between all these zones, and linking them together, is provided, with fuel-oil pipes and electric cable conduits (Reference 20).

The sites shown on the attached map could only be indicative in 1962, and were only finalized at the time of completing the work.

Installation Design:

It has been accepted that for a permanent base the design installation and winter-time buildings should attempt to recreate living and working conditions as close as possible to those at home.

Thus, the basic installation plan allows for a division between: collective life - private life - work.

The living-quarters building provides for all collective activities: dining room and kitchen, living room, library, record playing room, and, on account of technical requirements, all the water installations (laundry, lavatories, photographic laboratories).

Sleeping-quarters are provided in a separate building so as to provide silence, and consist of single rooms giving every opportunity for rest and privacy.

As regards work, the very different kinds of technical activities are necessarily performed in specialized quarters (electric power station, various workshops). For scientific tasks, each discipline is also provided with its own quarters; but, these quarters are concentrated in two laboratory-buildings, instead of being spread among the specialized shelters. This solution offers the advantage of simplifying the problems of heating, electrical distribution, fire prevention. The development of remote recording techniques and remote-control makes such concentration possible and permits other necessary apparatus (magnetometers, ionospheric or radio transmitters in relatively convenient standardized shelters; seismographs in a cellar, etc..) to be kept in separate exterior installations. Upkeep of these exterior installations does not normally require daily visits, which are often painful during the worst of the Antarctic climate.

Reconstruction Plan:

The extent of such a programme is governed by the available logistic means. In last analysis, at the present time it is the shipping capacity of the relief ship that is the determining factor, both as regards the number of staff (winter-time and summer campaign), as well as the power available (linked to the shipping capacity for bulk fuel-oil). The development of a permanent base in the Antarctic is thus effected in successive stages, the move to a higher stage requiring new shipping facilities to be available, thus an increase, that is often substantial, of the operating expenses.

The first stage in the development of the Dumont d'Urville Base, thus governing the reconstruction plan, has been laid down as follows:

- fuel-oil availability (electricity and heating); 400m^3/year (in 1962; 70 m^3).

- electric power available: 4 electric generator units of 115 KVA (in 1962: 4 units of 20 KVA).

- handling capacity: 1000 tons in 10 days for unloading.

- winter-time staff: 40 men (in 1962 : 20 men).

- total staff for summer campaign: 100 men (in 1962 : 40 men).

The reconstruction plan decided on maintains all the potential for future development, as well as that covering the winter-time buildings as well as that covering the winter-time buildings as well as the summer campaign installations (reserved zones), so as to allow a move to a second stage if the need is felt and the means are available.

Completion of the reconstruction plan itself, in hand since 1963, is described chronologically hereafter:

4. Completion of Reconstruction Plan

After approval by the Administration of the French Austral and Antarctic Lands Territory, completion of this plan has been carried out year by year, subject to the available credits, since the summer campaign of 1962/63.

As a general rule, infrastructure and construction work is only undertaken during the summer campaign. There are two exceptions to be noted: completion of the first priority infrastructure work during the winter period of 1963; the construction of two buildings during the winter period of 1966, so as to make possible the ionospheric rocket-probe firing campaign during the Antarctic summer of 1966/67.

Progress of the work is described hereafter in the following form, year by year, giving the state at the end of each summer campaign:

- plan of completed installations, also providing indications of projects finally selected.

- aerial photograph of the winter-time area (all the photographs were taken from points situated over the sea, to the north of the island. The winter-time zone is thus always seen approximately from the same angle).

- list of work performed during the corresponding summer campaign and the following winter period.

However, work during the 1962/63 and 1963/64 summer campaigns have been collated with those of the 1963 winter period, since they form a whole that indicates the start of completion work.

So as to allow for comparison, the state of the installations at the Dumont d'Urville Base is described in the same manner, as of the date of January 1, 1962, before the beginning of reconstruction.

State of Installations at the Dumont d'Urville Base on January 1, 1962

Map of installations on January 1, 1962 (Fig. 5):

The installations are virtually those of the International Geophysical Year, with the exception of the start of the road in course of construction.

The numerous, dispersed shelters and scientific installations are to be noticed on the plateau to the north of the island.

Aerial photographs Figs. 6 and 7:

Fig. 6, taken in 1957, shows the main installations completed for the A.G.I.

Fig. 7 shows the first section of the road leading to the winter-time buildings built in January, 1962.

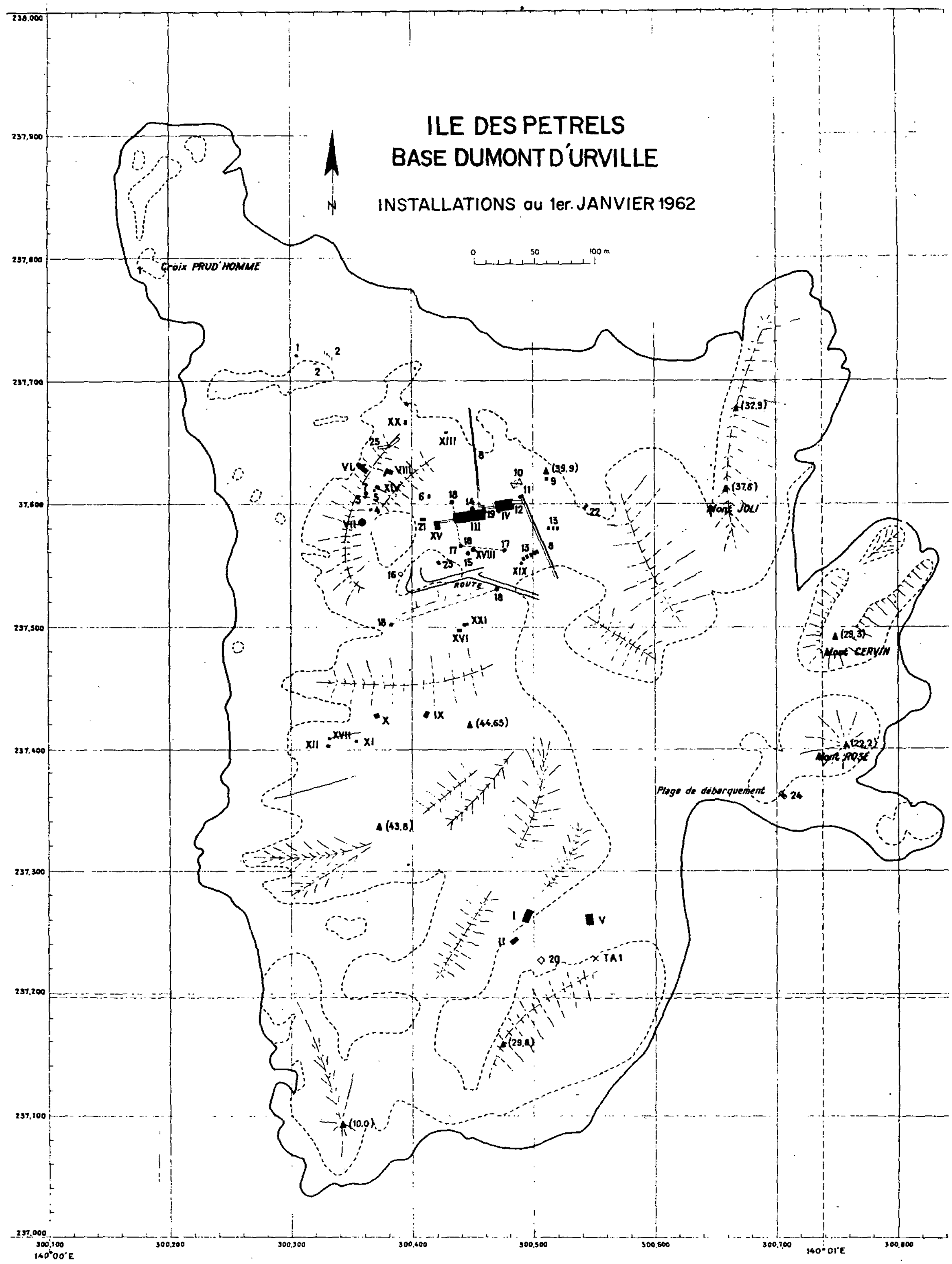


Fig. 5. Map of installations on January 1, 1962.

I — Base Marret
II — Atelier Marret
III — Bâtiment d'habitation
IV — Centrale — Entrepot
V — Garage
VI — Abri de lancement des radiosondes
VII — Abri du radiothéodolite
VIII — Abri d'optique atmosphérique
IX — Abri de séismologie
X — Abri du magnétographe Lacour
XI — Abri de magnétisme (étalonnage Lacour)
XII — Abri pour mesures magnétiques absolues
XIII — Abri du magnétographe à plume Lebeau
XIV — Abri d'observations des aurores
XV — Abri vivres
XVI — Abri CEA — ozone
XVII — Abri pour mesures magnétiques absolues
XVIII — Abri météo
XIX — Abri motopompe
XX — Abri caméra panoramique
XXI — Abri Rayonnement cosmique

1 — Barre fluxmêtre verticale
2 — Barres fluxmêtres horizontales
3 — Théodolite
4 — Héliographe
5 — Caméras
6 — Antenne du radar à aurores
7 — Phare néphoscopique
8 — Voie ferrée
9 — Solarigraphe Volochine
10 — Cuves à gas oil 2 m^3
11 — Treuil
12 — Plan incliné
13 — Cuves à gas oil 8 m^3
14 — Tour météo
15 — Abri météo
16 — Prises de terre des lignes telluriques
17 — Pylones d'antennes radio
18 — Pylones d'antennes du sondeur ionosphérique
19 — Couloir reliant les bâtiments III et IV
20 — Plateforme hélicoptère
21 — Caravane (n°6) Biolgie
22 — Caravane (n°13) glaciologie
23 — Anémomètre EDF
24 — Dépots explosifs
25 — Radier pour bouteilles d'hydrogène

Fig. 6.

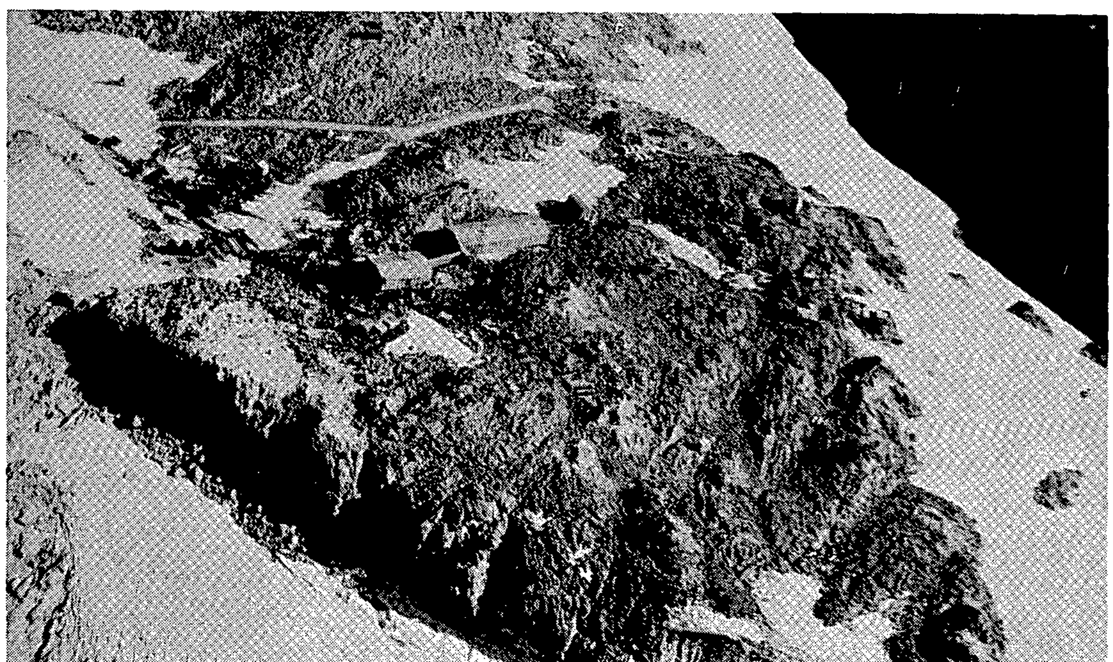


Fig. 7.

State of Installations at the Dumont d'Urville Base in February, 1964.

Map of Installations in February, 1964 (Fig. 8):

This shows the infrastructure work completed during the 1962/63 summer campaign and the 1963 winter period, as well as construction completed during the course of the 1963/64 summer campaign of which the list is given below.

List of Work completed:

1962/63 summer campaign and 1963 winter period:

- Extension of the road to the northern crest of the island;
- Construction of a dock and an unloading gantry (see Report, Use of Bituminous cement at the Dumont d'Urville Base);
- Levelling on the site for fuel-oil 50 m^3 tanks.
  Installation of the first tank;
- Construction of a pipeline connecting these tanks to the future electric power station;
- Building of mooring stanchions for the ships on Petrel Island and Jean Rostand Island;
- Levelling of site for future electric power station;
- Construction of metal platforms to take : the first laboratory building, (see Report : "The new building of the Dumont d'Urville Base"), a garage;
- Excavation for the seismological cellar.

1963/64 summer campaign:

- Construction of building for the new electric power station and the first laboratory building;
- Construction of the metal platform for the second laboratory building;
- Construction of the garage;
- Construction of the first network of conduits for electric cables;
- Installation of the second 50 m^3 fuel-oil tank.

The internal installation work on the first laboratory building was finished during the 1964 winter period, as well as installation of the first two electric generating units of the electric power station (which started operating at the end of April, 1964). Extension of the network of conduits for electric cables was also carried forward during this winter period.

Aerial photograph Fig. 9:

Taken in January, 1964, during the summer campaign, there can be seen from left to right:

The new electric power station under construction, the buildings of the old base, the extended road, the new garage, the first laboratory building under construction.

In the background: The "Thala Dan" at moorings and the unloading gantry.

State of Installations at Dumont d'Urville Base in March, 1965

Map of Installations in March, 1965 (Fig. 10):

The installations built at this date are shown in black on the map, and in grey, the projects finally selected:

On an isthmus of the island to the east, there is shown a project, which is not shown on the "Basic Installation Plan". This refer to the assembly hall for the ionospheric rocket-probes for the 1966/67 firing campaign. Thus, the first important scientific experiement of the summer campaign, whose likelihood had been accepted in principle in the general design of the installation plan was completed. To fire these rockets, it became necessary to construct the first building to house the summer campaign staff which is shown under reference P.7 in Fig. 10, in the area reserved for this purpose (Reference 9 of the map of the "Basic Installation Plan" above).

Also shown are the following projects:

p.3 - Pumping station and water piping (see Report: Dumont d'Urville Base Drinking Water Supply").

p.6 - Mast and antenna of the ionospheric probe in the area reserved for this purpose (Reference 6 on the map on the "Basic Installation Plan" above).

p.8 - Refuse monorail.

List of work completed (1964/65 summer campaign)

- Construction of the second laboratory building;

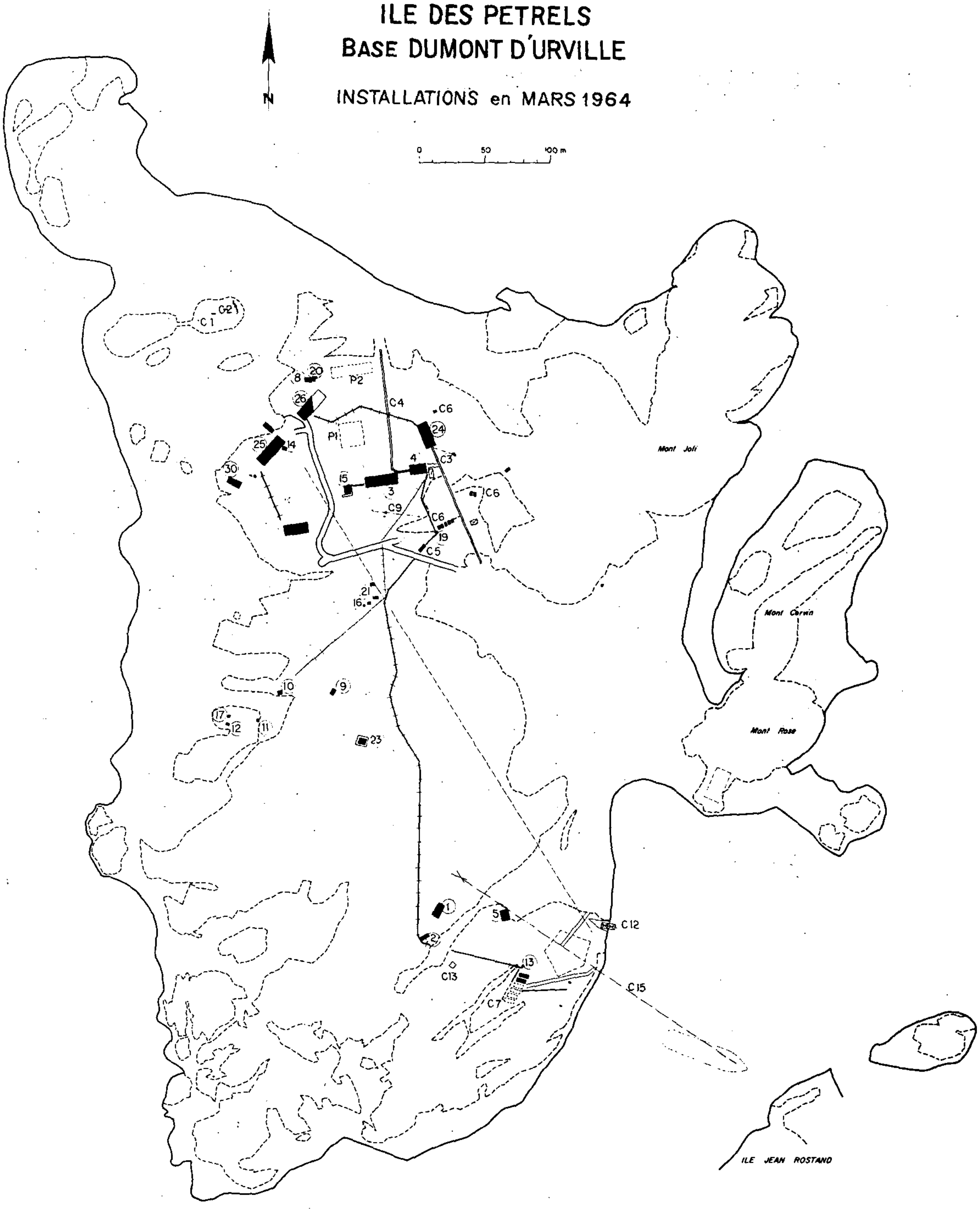


Fig. 8. Map of installations in February, 1964.

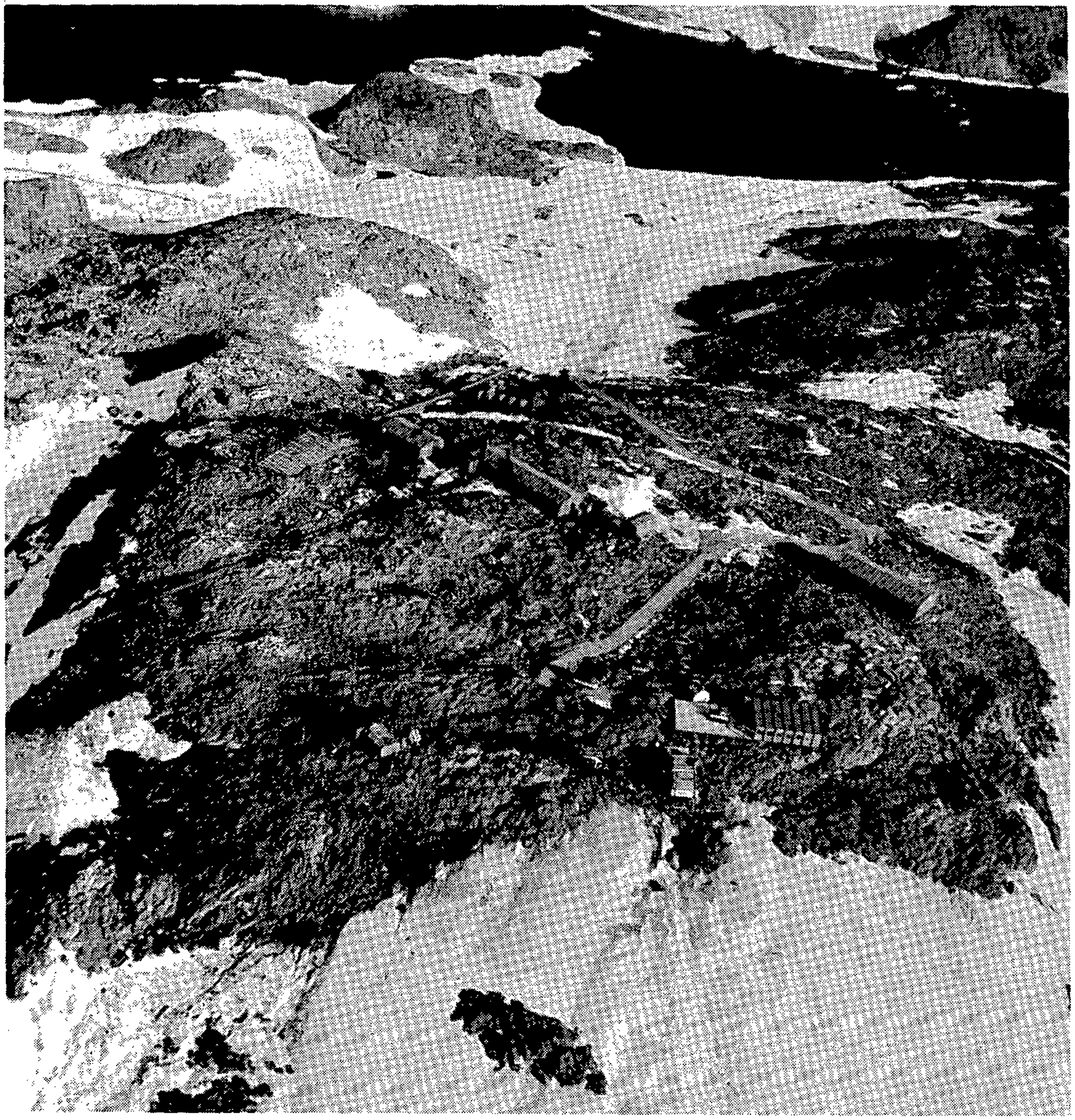


Fig. 9.

- Construction of the platform of the launching shelter for balloon-probes;

- Construction of supporting posts for the platform of the future living building;

- Installation of the third 115 KVA electric generating unit;

- Construction of a 25 m^3 cold room;

- Installation of the third 50 m^3 fuel-oil tank:

- Transfer to the laboratory buildings of the magnetism, seismology, cosmic rays, radioactivity, meteorology, aurora and biology installations.

- Complete renovation of the magnetism station, partial renovation of the seismological station (short periods);

- Balance of installations for electric cable conduits.

All the work, in particular the installation of scientific equipment, was continued and completed during the 1965 winter period, as well as the construction of the launching shelter for the balloon-probes.

Aerial photograph Fig. 11:

This photograph shows, on the left, the second laboratory building, and at the bottom right, the platform of the launching building for the balloon-probes.

State of Installations of the Dumont d'Urville Base in March 1966

Map of installations in March, 1966 (Fig. 12):

The installations built to this date are shown on the map in black, in black-and-white the installations under construction and in grey the projects finally selected.

This map does not include any new projects on account of preparations for the rocket firing campaign.

List of work completed (1965/66 campaign and 1966 winter period)

1965/66 Summer campaign:

- Construction of living quarters building;

- Construction of building platforms; assembly hall for rockets and staff

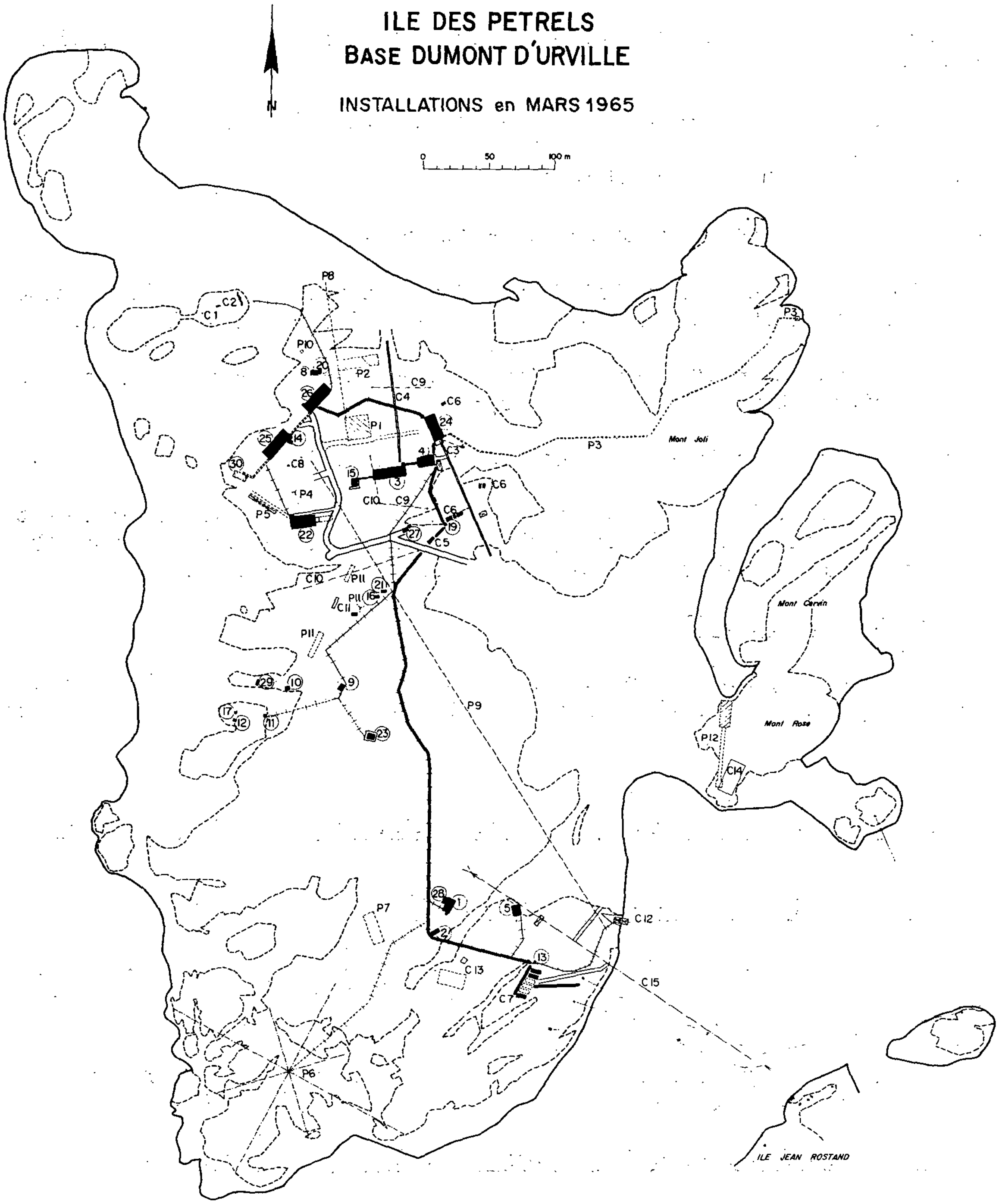


Fig. 10. Map of installations in March, 1965.

Fig. 11.

housing for summer campaign;

- Construction of 73m high mast for ionospheric antennae;
- Construction of refuse monorail;
- Construction of the new helicopter landing area (see Report : "Dumont d'Urville Base Helicopter Wind-break Wall".);
- Installation of the fourth 50 m^3 fuel-oil tank;
- Installation of conduit for additional electric cables;
- Completion of sea-water pumping shelter.

1966 winter period:

Construction work was continued exceptionally during this winter period, by a specialized team, so as to complete the indispensable installations for the rocket firing campaign of the following summer;

- Construction of rocket assembly hall, the launching area and the connecting railed track;
- Construction of the building for housing the summer campaign staff;
- Construction of the conduit for sea-water conduction;
- Installation of a frequency switchboard (quartz clock) for time determination to scientific apparatus, (hourly pips and 50-period current);
- Installation of an automatic telephone network between the different buildings and shelters (60 extensions);
- Complete re-building of the ionospheric station (vertical probe and absorption probe, revertical riometers, 1 revolving riometer, remote-control and centralization of measurements for the unit in a laboratory building);
- Main internal improvements to the living building.

Aerial photograph Fig. 13:

Taken in February, 1966, this photograph shows in the middle the new living building, which is of square shape, but the refuse monorail has not yet been built. At bottom right : the launching building for the balloon-probes with its sliding door.

In the background, at the foot of a rocky mass, there can also be seen a platform for the future rocket-assembly hall.

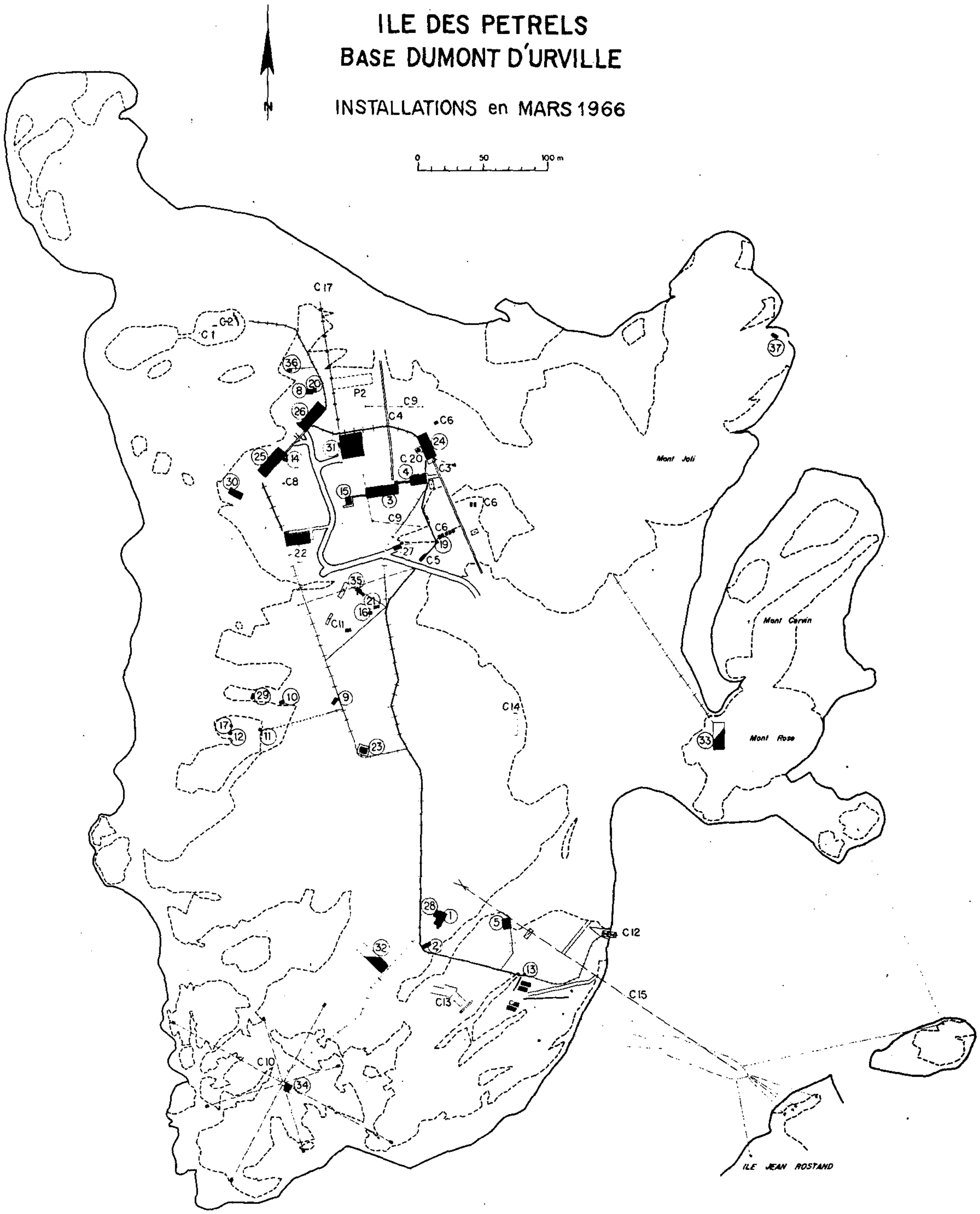


Fig. 12. Map of installations in March, 1966.

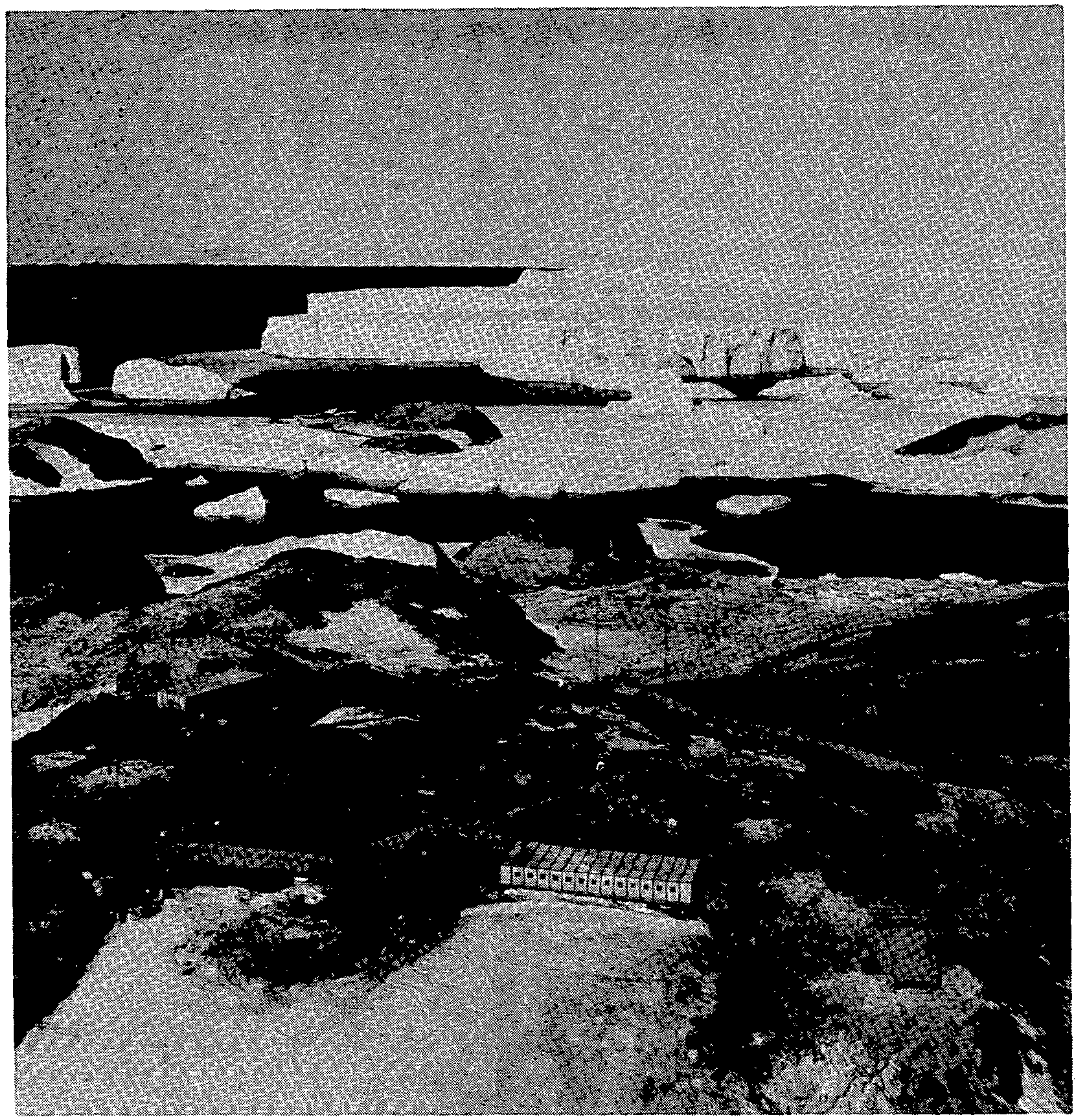


Fig. 13.

State of Installations of Dumont d'Urville Base in March, 1967

Map of Installations in March, 1967 (Fig. 14):

The installations completed to this date are shown on this map in black and, in grey, the project finally selected.

A new project is shown under reference p.32, on the central plateau of the island reserved for scientific research. This is a new building for cosmic rays and radioactivity, made necessary by the installation of a neutron battery with a weight of 20 tons.

List of work completed (1966/67 campaign).

Although this campaign was mainly concerned with the firing of ionospheric rocket-probes, the following work was completed:

- End of internal improvements to the building housing the summer campaign staff;

- Continuation of internal improvements to the living building;

- Starting up of the installation for production and distribution of fresh-water (evaporator, piping for fresh water distribution and waste-water discharge);

- Installation of a DECCA radar for wind-probes and construction of a protective radome;

- Installation of the fifth 50 m^3 fuel-oil tank;

- Construction of conduits for additional electric cables, and foot-bridges between buildings.

Aerial Photograph Fig. 15:

In the foreground : in the middle, the refuse monorail built the preceding summer, showing its departure point on the northern facade of the living building ; on the left, the layout of the water piping.

In the background : on the extreme left, the rocket assembly hall : on the right, the new building for housing summer campaign staff, and the ionospheric antennae mast.

This photograph was taken in February and the meteorological radome was under construction and is not shown.

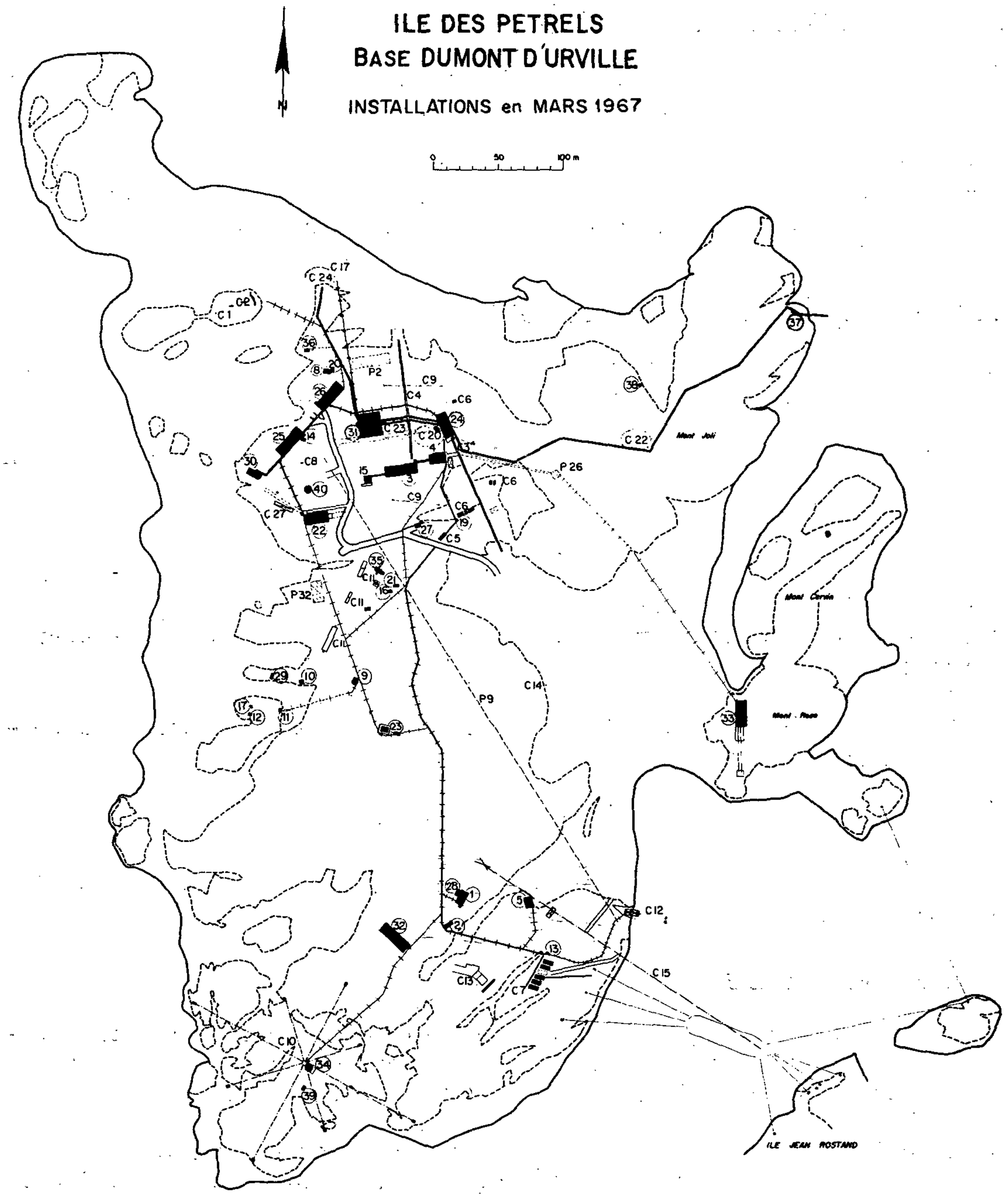


Fig. 14. Map of installations in March, 1967.

Base Dumont d'Urville

Installations on March 1, 1967

Buildings and shelters

1 — "Marret" Base
2 — Shelter for helicopter accessories
3 — Dwelling building
4 — Storehouse(formerly electric plant)
5 — Garage
10 — Magnetism shelter (magnetograph)
11 — Magnetism shelter (gauging)
12 — Magnetism shelter (absolute measurements)
13 — Fuel-oil pump shelter
15 — Food storehouse
16 — Radioactivity shelter
17 — Magnetism shelter (absolute measurements)
19 — Fuel-oil pump shelter
21 — Radioactivity shelter
22 — Mechanical workshop
23 — Seismological cellar
24 — Electrical power plant
25 — Laboratory building n°1
26 — Laboratory building n°2
27 — Cold room
29 — Magnetism shelter (magnetometer)
30 — Launching shelter for sounding balloons
31 — Living quarters
32 — Summer dwelling building
33 — Rocket assembly building
34 — Ionospheric shelter-transmitters
35 — Ionospheric shelter-riometers
36 — Ionospheric shelter-absorption
37 — Seawater pumping shelter
38 — Biology shelter
39 — Shelter for ionospheric spareparts
40 — Meteorological radome

Various constructions

C 1 — Magnetism (quick variations)
C 2 — Magnetism (quick variations)
C 3 — Winch railway
C 4 — Old refuse disposal railway
C 5 — 2 m³ fuel-oil tanks
C 6 — 8 m³ fuel-oil tanks
C 7 — 50 m³ fuel-oil tanks
C 9 — Radio antenna
C 10 — Ionospheric antenna
C 11 — Riometers
C 12 — Unloading quay and gantry
C 13 — Helicopter platform and wind-break wall
C 14 — Explosives depot
C 15 — Mobil cableway
C 17 — Refuse-disposal monorail
C 20 — 10 m fresh water tank
C 22 — Seawater intake pipework and hot brine outflow
C 23 — Fresh water pipework and hot brine outflow
C 24 — Waste water and hot brine discharge pipework
C 27 — Floor for hydrogen bottles.

Projected buildings and constructions

P 2 — Winter dwelling building
P 9 — Planned cableway
P 26 — Radio station
P 32 — Cosmic rays and radioactivity laboratory

- - - - - - Rock/ice limit
Projected buildings
Cableway and fuel-oil piping
Floor serving as depot.

Fig. 15.

State of Installations at Dumont d'Urville Base in March, 1968.

List of Work completed (1967/68 campaign).

- Construction of cosmic ray/radioactivity building;
- Construction of the metal frame for the two-floor winter housing building;
- Installation of the fourth electric generating unit in the electric power station (power per unit increased to 170 KVA);
- Installation of the sixth 50 m^3 fuel-oil tank;
- End of internal improvement to the living building;
- Installation of photographic laboratories;
- End of renovation of seismological installations (long periods);
- Balance of installation for production and distribution of fresh water, now in operation;
- Transfer and concentration of the 8 old 8 m^3 fuel-oil tanks behind the electric power station.

Aerial photograph Fig. 16:

In the foreground ; on the extreme left, the refuse monorail and the metal framework under construction for the winter housing building..

In the middle ; the radome (white) of the meteorological radar built during the preceding summer.

On the right : the new cosmic ray/radioactivity building.

Fig. 16.

Scientific Installations (Figs. 17~23)

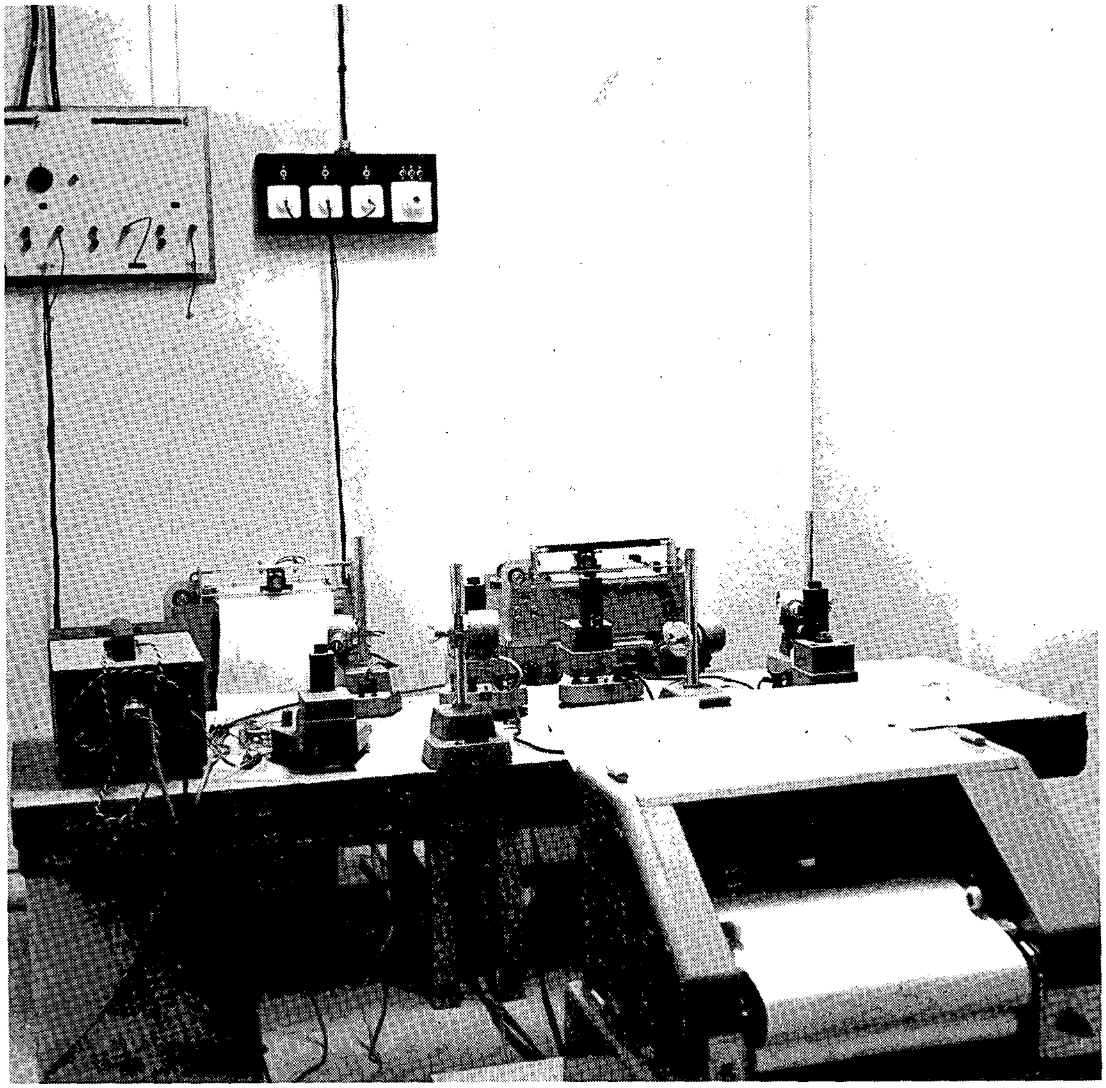


Fig. 17. Magnetism room (1965), in the laboratory building.
In right foreground, double-track spot follower for X and Y pulses can be seen. The galvanometers and the amplifiers are in the centre, on pillars and concrete table. In the background, the spot followers for Z pulses and X micro-pulses can be seen.

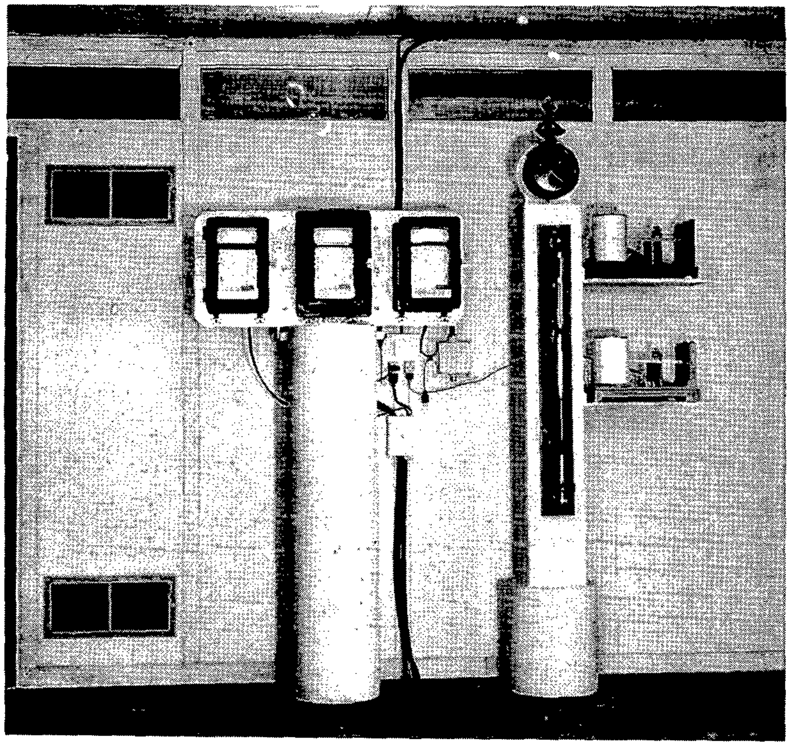


Fig. 18. Meteorological room (1965), in the laboratory building. Recorders connected to solarmeter and thermo-probes; barometers. All these instruments are set on concrete pillars, going through the floor and anchored to the rock.

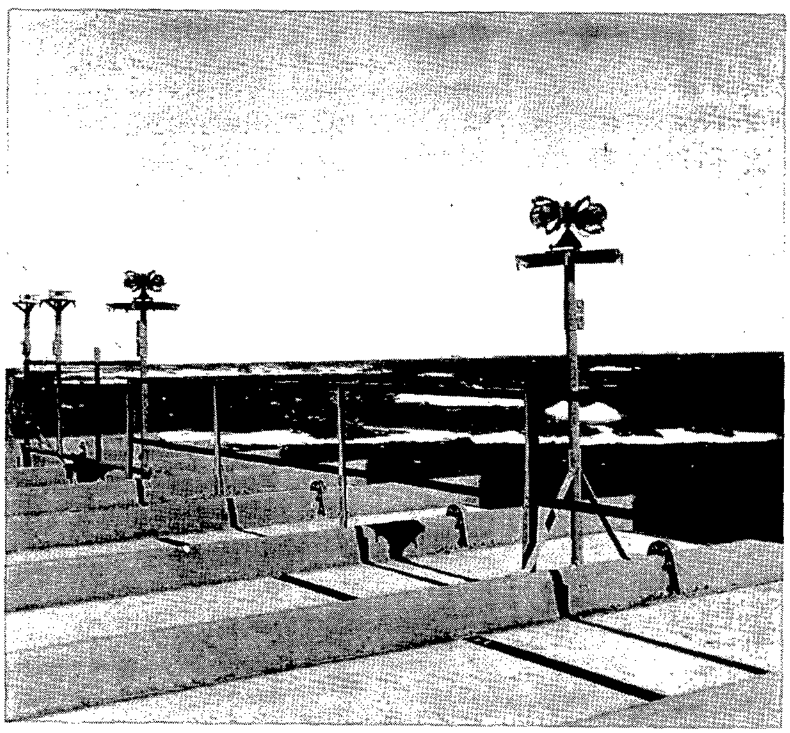


Fig. 19. Laboratory building roof (1965).
2 heliographs and one solarmeter connected to recorders placed in the meteorological room.

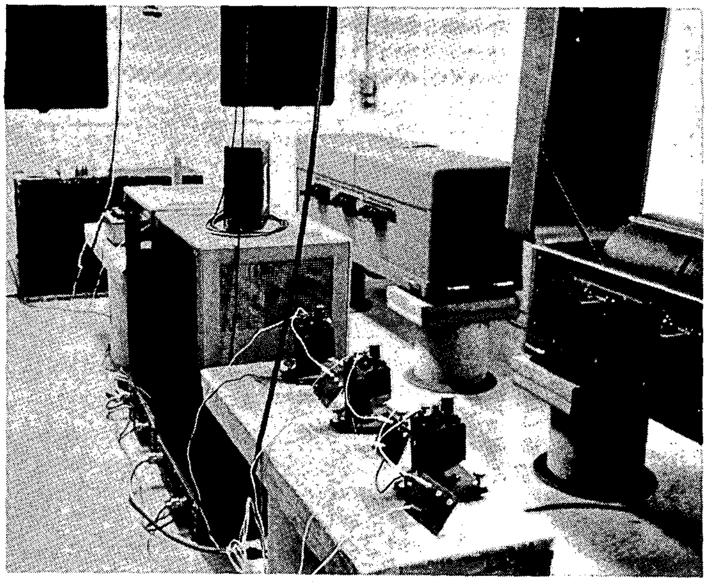


Fig. 20. Meteorological room (1965 and 1966), in the laboratory building.
Galvanometers, short and long periods (on concrete pillars in the centre), connected to seismographs set in the cellar, separated by the recorder control cupboards. On the right, photographic recorders short and long periods can be seen on concrete pillars.

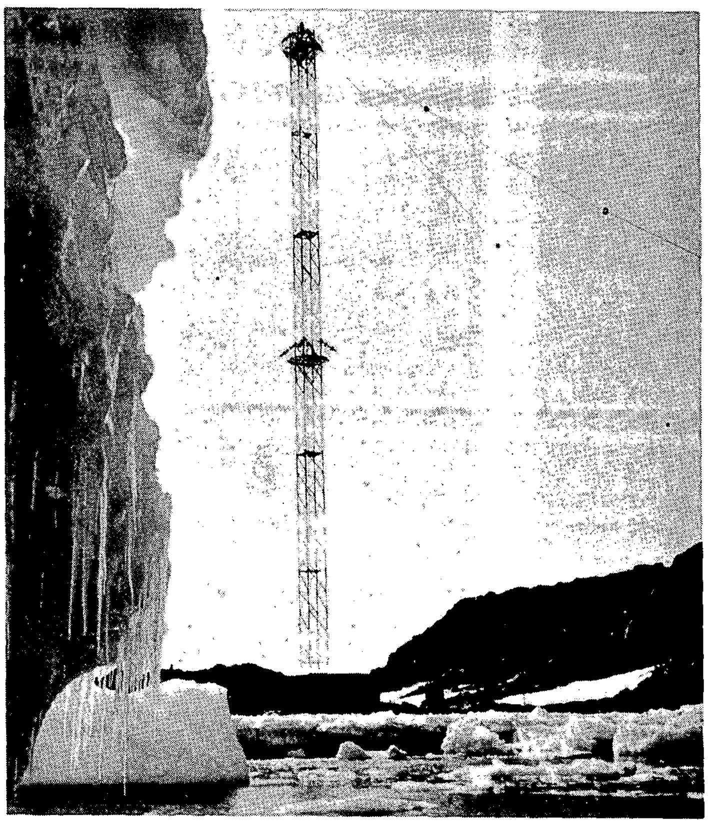


Fig. 21. Pylon 72.8 m high, carrying the antennae of the vertical probe. 4 of the 8 stays act as antennae forming a 200 m delta, and another of 100 m (1966). Recorders and remote-control are set in the Ionospheric room of laboratory building.

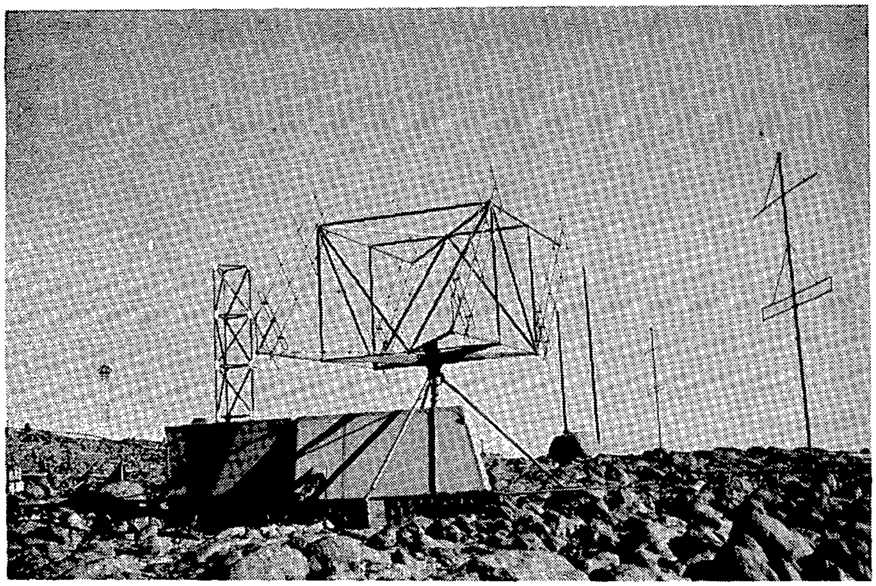


Fig. 22. Riometer zone. From left to right ; 75 MH helicoidal antenna, 75 MHz revolving antenna and the selter housing the revolving mechanism and the receivers, 2 supporting masts for the 13.7 MHz antenna, 30.1 MHz antenna, 20.0 MHz an t-enna. Recorders are located in the Ionospheric room of laboratory building.

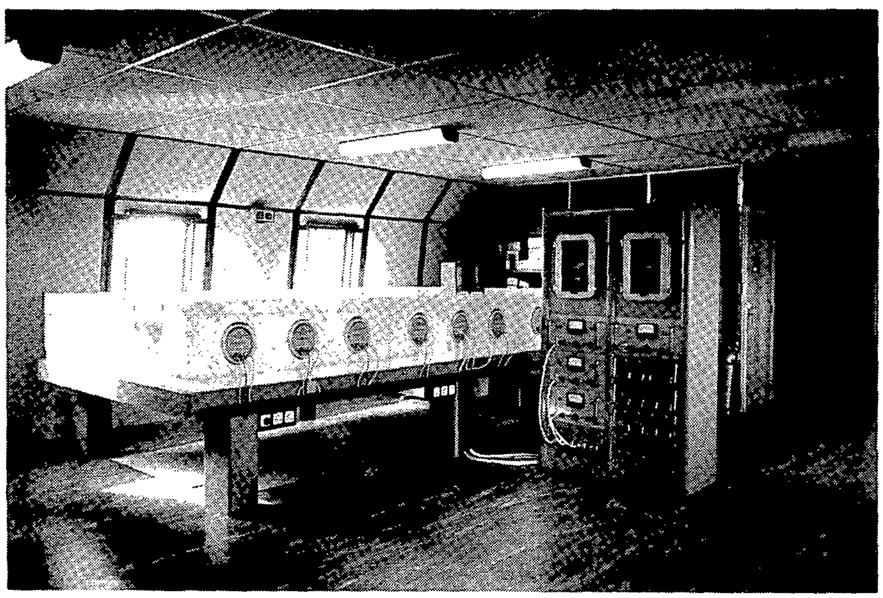


Fig. 23. Cosmic ray building (1968).
Neutron battery consisting of 9 neutron counters under polyethylene cover and lead brick housing.
Cupboard for electronic counting and recording racks.

Technical Installations (Figs. 24~33)

The whole technical installations of the Dumont d'Urville Base are conceived, or look into by collatoration with the suppliers, on the responsibility of Technical Office of Expéditons Polaires Françaises (Engineer; Miss Christiane Gillet).

The following pictures show some of these installations.

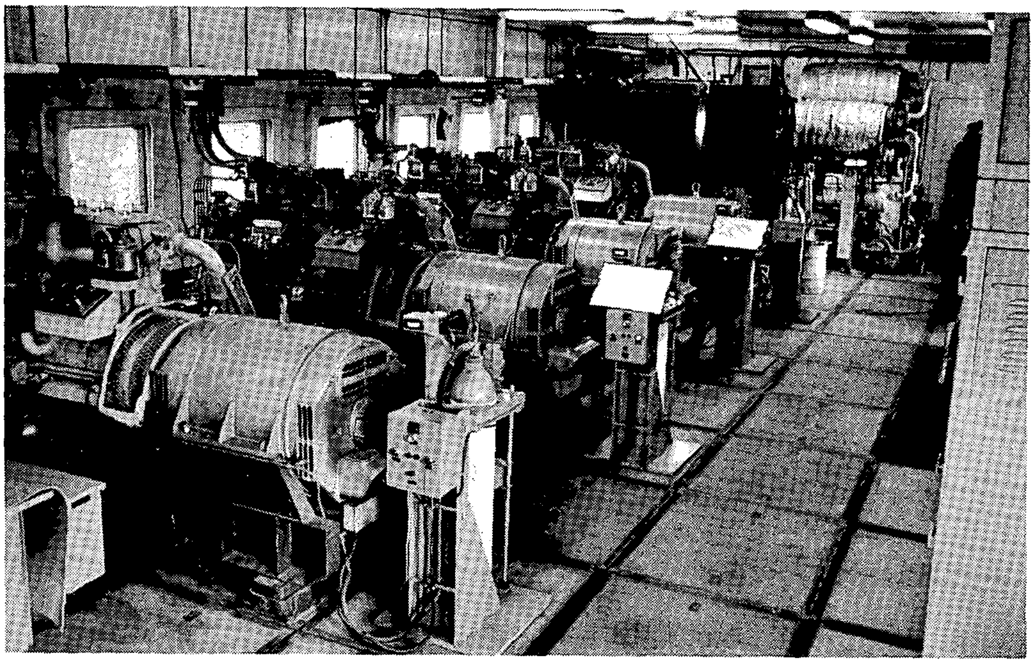


Fig. 24. Electric power station (1968).
Three 115 KVA electric generating units and one 170 KVA electric generating unit. In the background, vacuum evaporator for desalination of seawater can be seen. Control cupboards for the units and electrical distributions are on the right.

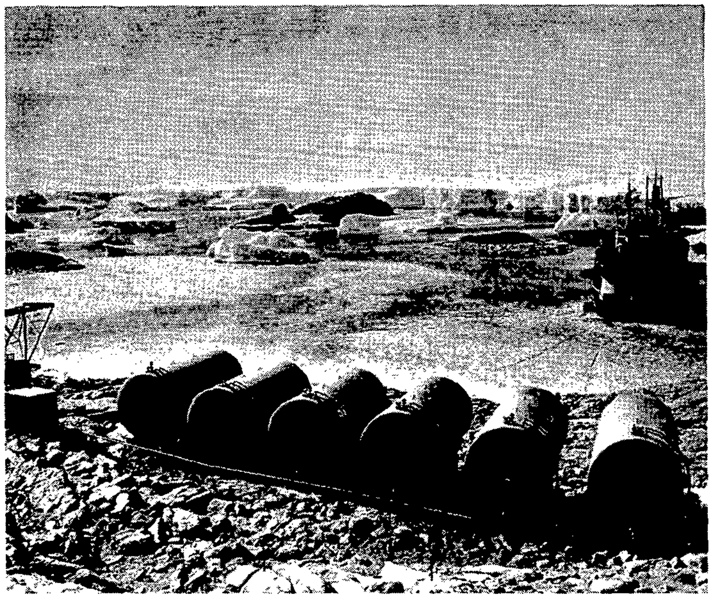


Fig. 25. Fuel-oil storaga (1963～1968).
The six 50 m^3 fuel-oil tanks; the delivery incline in the pipeline towards the electric power station. Unloading gantry can be seen on the left and the ship at her moorings is in the background.

Fig. 26. Fuel-oil piping and electric cable-ways (1964).
Set on tubular support to avoid being snowed up and iced.

Fig. 27. Living quarters (1966~68).
Plant box (in the centre), dining room (on the right), bar (in the background) and library and living room (on the left).

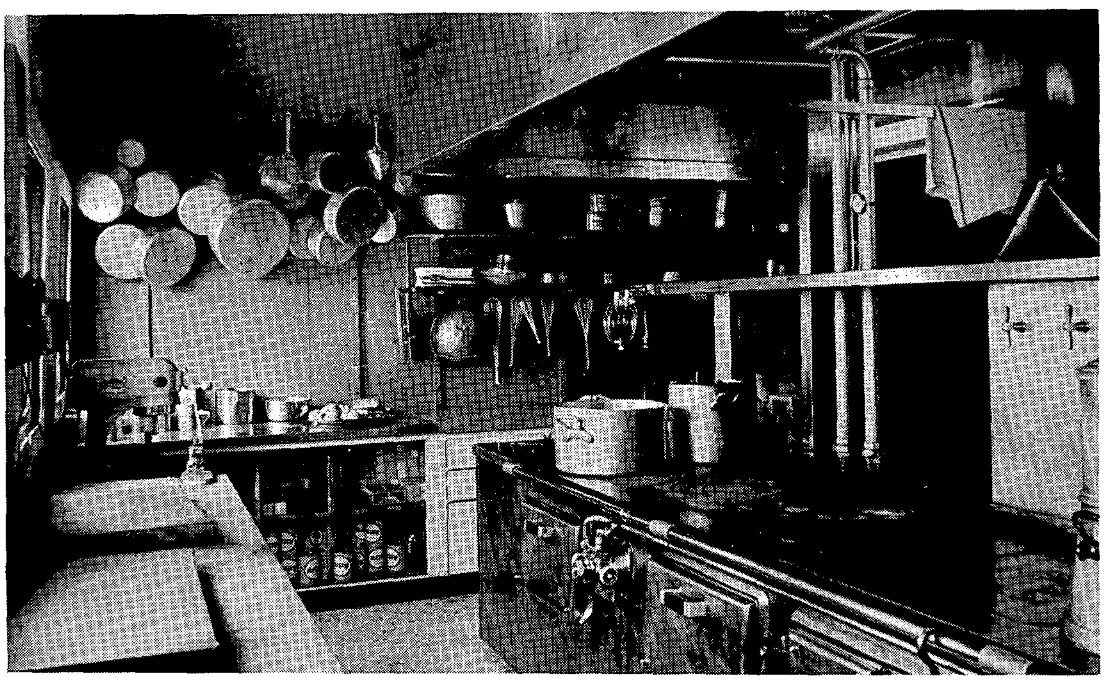


Fig. 28. Living quarters. Kitchen (1967).
Fuel-oil cooking stove can be seen in the centre, and vapour exhaust canopy with fat filters is above.

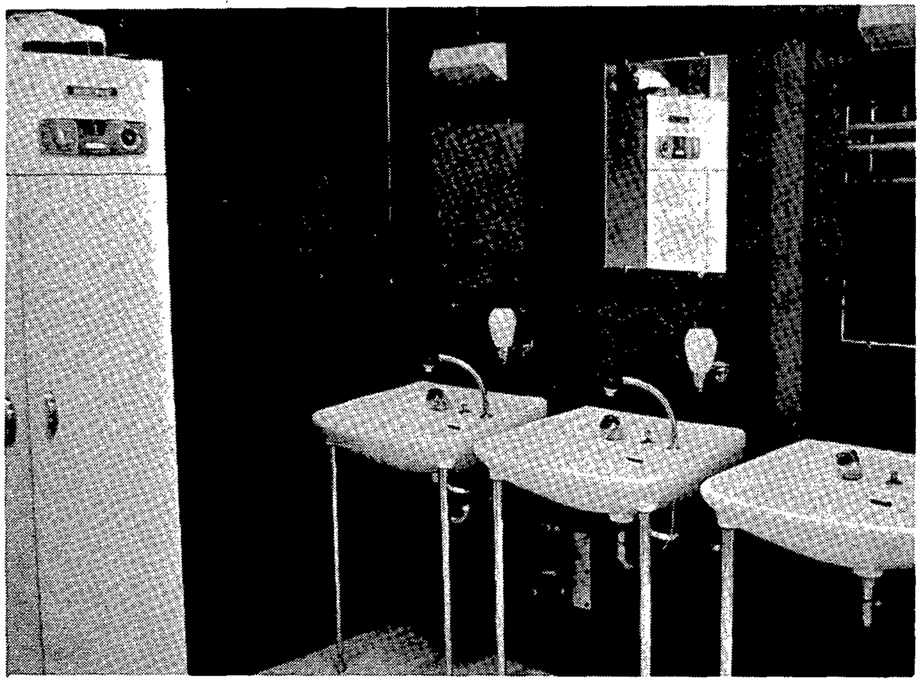


Fig. 29. Washroom (1967) in the living quarters.
The hand-basins and the electric drying-cupboard.

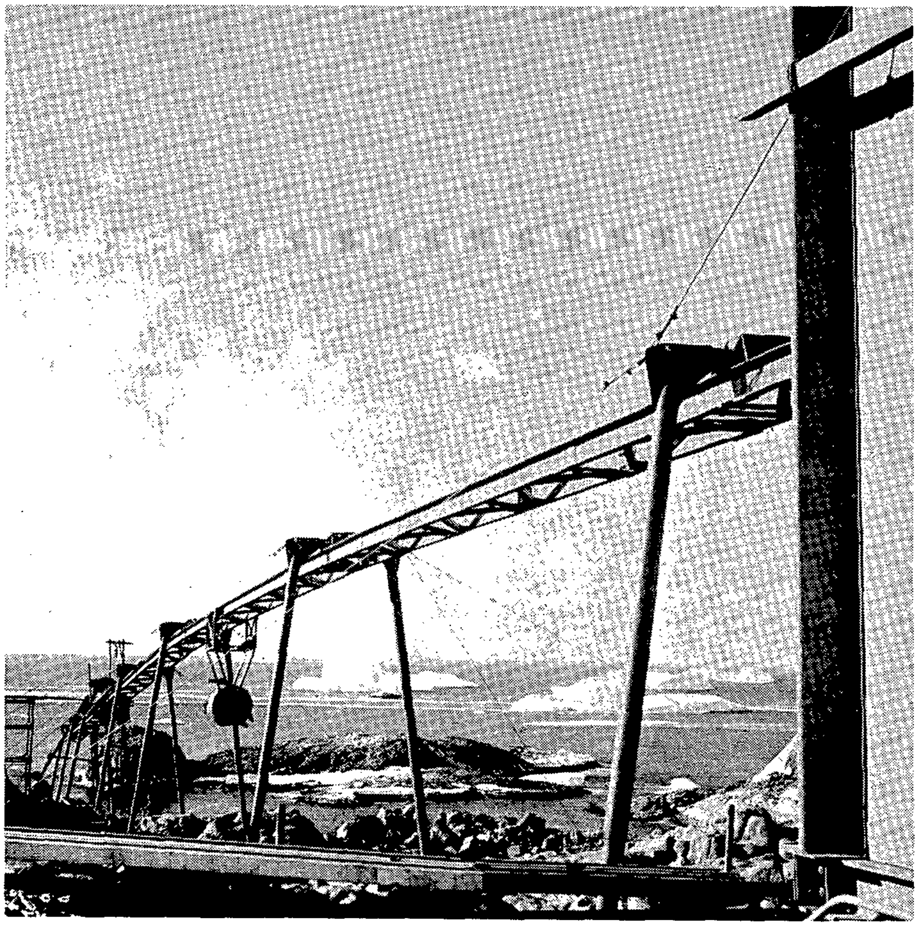


Fig. 30. Refuse monorail (1966).
The suspension archs of the rail allow the movement of the automatic-tilting bucket (lengh of haul : 100 m).

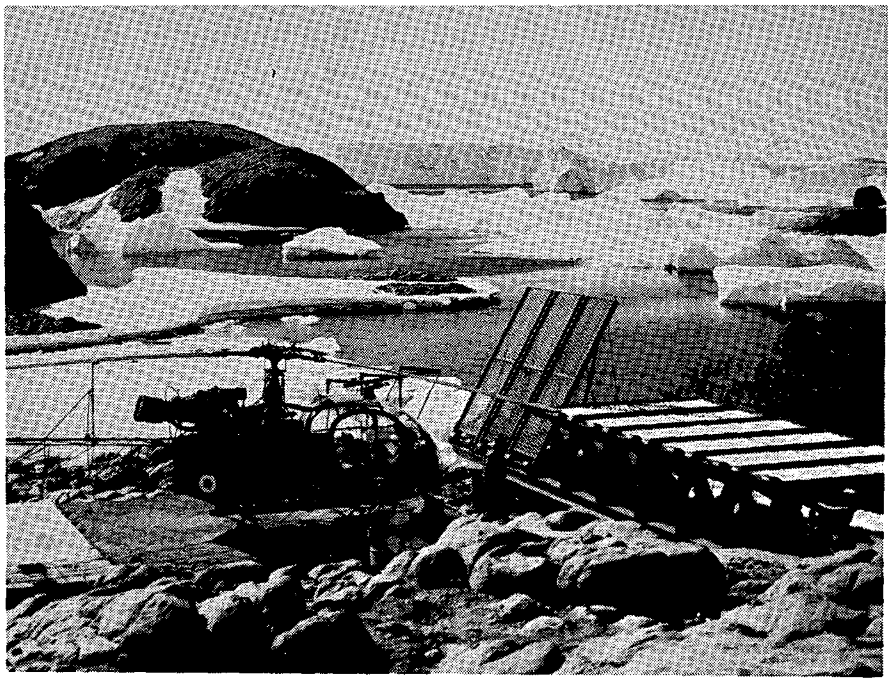


Fig. 31. Helicopter landing area (1966).
Protection by wind-break wall consisting of elements that can be raised and lowered to prevent formation of snow-drifts in winter. Reduction ratio of wind velocity = 5 (250 km /h up wind = 50 km /h down wind).

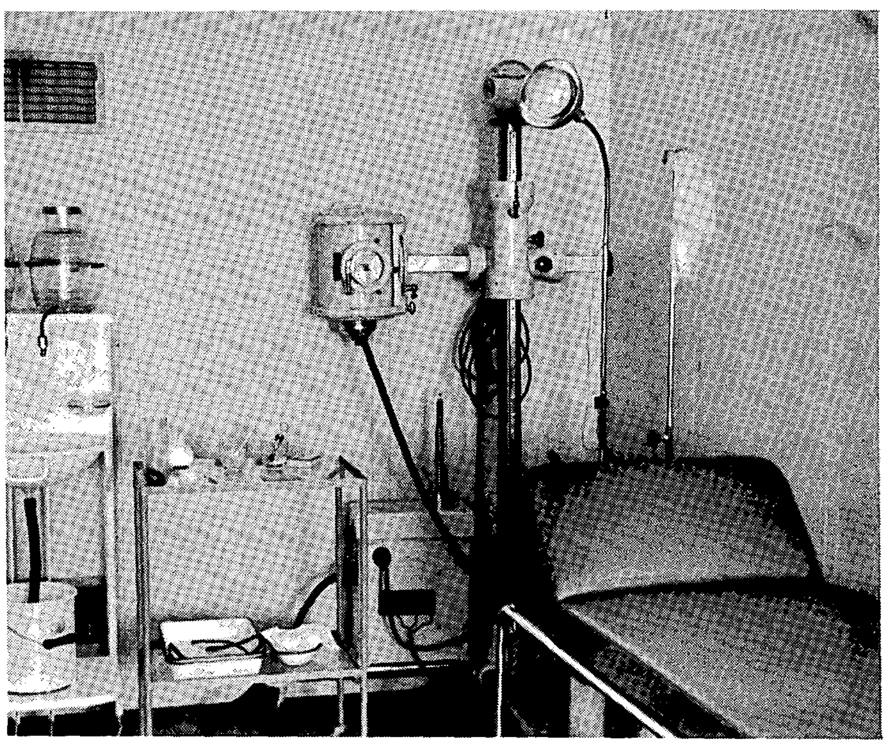


Fig. 32. Infirmary (1966).
Partial view of the X-rays spparatus and the examination couch.

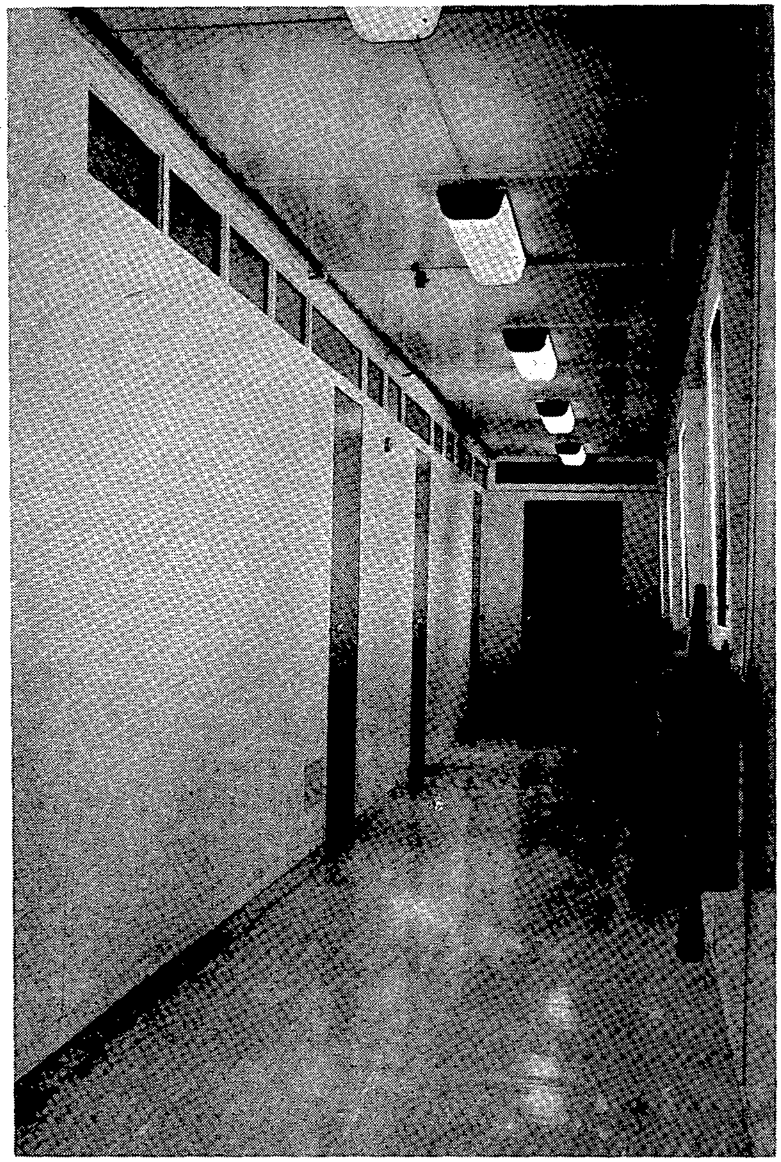


Fig. 33. Laboratory building's corridor.

THE NEW BUILDINGS AT THE DUMONT D'URVILLE BASE

Expeditions Polaires Francaises

In 1958, the French Government decided that France would take part in International Geophysical Cooperation in the Antarctic and signed the Antarctic Treaty in 1959. The Dumont d'Urville Base in Adelie Land then became a permanent base.

Since the existing buildings and installations were built on a temporary basis to take part in the 1957-58 International Geophysical Year, it became necessary to reconstruct them with a view to installing a permanent base with possibilities of extention. (Refer to the Report concerning the "Reconstruction and Development of the Dumont d'Urville Base").

1. Basic Description of Buildings

The description of the final new buildings at the Dumont d'Urville Base was drawn up by the French Polar Expeditions in 1961. They must meet the following specifications which are a result, at one and the same time, of the climate, the configuration of the ground, means placed into service and various utilisations, they must, therefore:

- withstand wind speeds of 250km/hours,
- they must be built on piles, firstly to prevent accumulation of snow and icying from the ground, secondly to facilitate building on very broken and rocky ground so as to avoid heavy earth removal works (systematic use of explosives can hinder any scientific observations taking place during the period of works);
- to enable rapid assembly to complete construction during a single summer campaign; the solution retained is that of a metal framework receiving covering panels ;
- to offer excellent heat insulation without any heat bridge within a minimum prefabricated volume ; the solution retained is that of plastic sandwich panels offering both the necessary mechanical strength and heat insulation ;
- to offer complete wind, snow, blizzard and melted snow proofing;
- to consist of light components easy to handle on the terrain (particularly for those components that must be lifted : framework, panels) and easy to assemble with bolts ;
- to seek out maximum standardization and interchangeability of components;
- to offer, within each building, a "free surface" to enable all types of layout with removable and prefabricated partitions ;
- to provide for the possibility of alternatives to enable construction of various types of buildings, of different dimensions and, possibly, with an upper floor.

2. General Study and Design of Buildings

This study has been conducted in association wit- the French Polar Expeditions Technical Bureau, by the A.T.B.A.T. (Atelier de Bâtissours; Engineer : Wladimir BODIANSKY (+) who, in 1957, designed the fiberglass/ polyester resin stratified "Igloo" for the International Greenland Glaciological Expedition wintering station). The study and the supply of the metal frameworks were conducted by the Compagnie Françaises d'Entreprices Métalliques (C.F.E.M.). The type of panel selected is the "box-panel" patented by the S.P.A.I.R. (Société pour l'Application Industrielle des Résines de Synthése).

In order to fulfill the required characteristics, given hereabove, the construction principles adopted were the following :

- breakdown of buildings into 2 distinct components : the platform on piles, the building, as such. This design enables definition of heavy type platform forming a veritable artificial floor capable of receiving both new buildings and conventional type buildings (such as worksite shacks for garage or storage purposes) and capable of supporting, according to the model, various types of floors, whether these be light (made out of SPAIR panels for the new buildings), or heavy floors (such as concrete slabs for the garage).

In order to facilitate construction on very broken ground, this platform rests on posts with heights that can vary by $\pm$ 0.90 m relative to the theoretical horizontal axis. These posts consist of components that can be lengthened or shortened in increments of 25 cm, thereby enabling all possible heights to make allowances for great differences in ground level.

- the metal framework of the buildings is external, the panels (floor, ceiling and side panels), are, therefore, supported by this framework without members passing through them ; any heat bridge is thus completely avoided. The assembly of panels on the metal framework is, itself, obtained without passing though the panels by means of screws passing into metal fitting buried within the panels.

In the case of special buildings that are more than 8 m wide (or with two floors), it is necessary to reinforce this framework with an interior longitudinal framework and posts passing through the floor which must, therefore, receive an insulated covering ; these posts, however, are limited in quantity (8 for a 18 m x 18 m building) and the constraint resulting therefrom is, therefore, acceptable.

3. Description of Platforms (refer to attached drawing)

Platforms consist of a metal floor resting on templet, supported by variable height posts.

The metal floor consists of a conventional orthogonal framework of joists and girders made out of Adx steel clamped down onto the templots.

The templets consist of an H section horizontally stiffened by a welded U section.

These templets are attached, at each extremity, to the top of post by means of 2 bolts. The oval O bolts allow a tolerance of 5 cm. Under these conditions, the longitudinal installation of posts spaced at 4.40 m, can attain 4.50 m and transversal installation can vary by ± 0.90 m relative to the theoretical axis (refer to drawing attached hereto). This solution enables selection of the most suitable ground to seat the pile.

The posts consist of tubular components (dia. 356 mm, thickness 6mm) assembled by means of flanges. Three standard components measuring 0.25, 0.50 and 1 m, make it possible to obtain piles of variable height according to the differences in ground level.

Since the tear-out force applied to a post as a result of wind is 3 tons for a laboratory type building, the piles are anchored to the ground. Up to a height of 0.75 m, each post is attached to the rock by means of 6 self-expanding anchoring bolts. In the case of heights of 1 m and more, each post is attached by means of 3 bolts and 3 guy cables at an angle of 45° so as to take up the horizontal forces due to the effects of wind on the building.

Finally, at half the span of the floor girders, H section supports cancel out the bend due to vertical loads. These supports, which are of variable height, withstand no anchoring force. Linkage between these components and the girders is obtained by means of bolts with interposed neoprene sheets to prevent possible hammering noises due to wind effects.

4. Description of Metal Framework of Buildings

(refer to attached drawings : Laboratory buildings - Living quarters - Living quarters joint).

The framework of the buildings consists of visible spans spaced at 1.60 m.

The use of H sections was not retained to obtain these spans for reasons of weight and corner assembly difficulties.

The spans are made out of folded steel platework 6 mm thick and welded throughout onto a flat sheet of similar thickness. The profile is, therefore, an "omega". These spans assure the lateral stability of the buildings. Each span can be considered as an arch with 2 ball joints.

Attachment of the span base on the platform girders can take place simply by bolting down. On the other hand, the two upper corners, which withstand the heavier stress, must be carefully assembled. The following solution has been adopted :

- each span is broken down into 3 components : 2 brackets and a central part.
- the corner assembly of each bracket is obtained by welding in the shop (welding on the spot being quite out of the question as a result of the climate and the impossibility of quality control).
- assembly of the central part and the 2 brackets is obtained, when mounting, by means of clamps retained by 6 bolts. Continuity of the omega flange is assured by means of a plate attached with 12 bolts (refer to Laboratory Building drawing - detail B and section CC).

When mounting, the 3 span components are assembled on the platform, the span is raised in a single unit (total weight : 600 kg), and its two legs are attached by means of bolts to the platform girders, temporary wind bracing assures the proper spacing between two adjacent spans until the ceiling and side panels are installed.

At the end of the building, the paneling is maintained in place by folded platework uprights of similar section to that of the spans.

The longitudinal stability of the buildings is assured solely by the roof and side paneling with no other wind bracing system.

According to the type of building, spans of different heights have been obtained as a function of the desired height under the ceiling for each building : 2.50 m for the Laboratory Buildings : 3.20 m for the electric power station ; 3.20 m for the living quarters (with interior framework) ; 5 m for the meteorological balloon probe launching shelter ; 2.50 m x 2 for the winter housing building with an upper floor (with interior framework).

5. Description of Panels

The panels used are plastic box panels manufactured by the S.P.A.I.R.; they are monolithic sandwich construction and consist of a hardened expanded polyvinyl chloride core with all surfaces covered with fiberglass/polyester resin stratified material.

The patented method of manufacture makes it possible to obtain great rigidity through close adherence of the stratified material onto the core which is obtained without gluing. This material is classified as being noninflammable in the buildings materials classification (does not transmit a flame).

The thickness of the panels is 84 mm (80 mm of expanded PVC, 2 mm for each surface of stratified material). The weight is 22 kg/m^2. The heat loss coefficient is K = 0.4.

The perimeter of each panel carries buried metal fittings made out of 12 mm thick steel platework located under the stratified material. These fittings carry tapped holes enabling attachment onto the metal framework with bolts. These bolts, spaced at 40 cm, are attached from the outside and do not pass through the panel and, therefore, engender no heat bridge. Laboratory tests prove that the tear-out strength is 3 tons per fitting. The dynamic pressure on the panels, calculated for a wind speed of 250 km/hour, attains 300 kg/m^2 and there is, therefore, a more than sufficient safety factor for the standard panels adopted that have a surface area of approximately 4 m^2.

Since the building module adopted for all the new buildings is 0.80 m, all the panels have a width of 0.80 x 2 = 1.60 m. In all the new buildings, these panels are used not only for the roof and the side paneling, but also for the floor (with the exception of the electrical power station in which the floor consists of prefabricated concrete slabs). Two facade panel heights have been adopted : 2.50 and 3.20 m.

There is a total of 5 panel models for a single type of building including, for the facades, the window panels and the door panels (the doors are also box panels ; door and window frames are made out of stratified materials).

Assembly of a building takes place in the following order : Laying of floor panels attached to the metal platform, laying of roof panels attached to the metal framework spans, installation of side panels attached to the vertical span uprights.

As described hereabove, the longitudinal stability of buildings is obtained solely by the panels and without any wind bracing system for the metal spans. To assure proper transmission and distribution of stress, particularly diagonal strains in the case of roof panels, it is necessary to obtain a proper junction between these panels, The row consisting of 2 consecutive spans is formed by three panels in the case of the roof. These panels are made to adhere together on assembly, by interposing a fiberglass mat covered with polyester resin. The resin used contains appropriate catalyzers and accelerators to obtain sufficiently rapid and good quality polymerization for utilisation temperatures of between 0 and + 5°C, during the Antarctic summer.

6. Weatherproofing of Buildings

Since a 5 mm tolerance exists between panels for assembly purposes, weatherproofing is assured by filling this joint with a cement that withstands low temperatures (depolymorized rubber). Within the building, this joint is covered with a joint cover made out of platework reveted onto the stratified material. A cement bead is also laid, prior to assembly, between the ceiling panels and the horizontal span plate to increase weatherproofing of the roof.

In the case of buildings that are wider than 8 m (such as the living quarters : 18 m), weatherproofing of the roof is obtained as shown on the attached drawing (refer to "joint for Living Quarters") : Each panel is edged with a stratified material bead adhering to the external surface and on both the sides that are attached under the spans. This edging carries a housing to receive a hollow seal ring (silicon pipe), crushed by 25 % when the panels are tightened on the spans. Furthermore, a cement bead is installed outside along the entire length of the spans. This arrangement makes it possible, at the joint of the spans, to obtain perfect weatherproofing for the roof against melted snow, which can stagnate on the roof and then can be blown away at a high pressure by 250 k.p.h. winds.

The three roof panels form a row between two spans and adhere together as described hereabove, therefore offering perfect weatherproofing of these joints by the adherence itself.

7. New Buildings Constructed or Under Construction

Six buildings of this type have been raised, one of which is under construction.

- Electric power station : Building measuring 19.20 x 8 m (12 - 1.60 m spans) ; height, 3.20 m ; built on metal raft resting on ground ; prefabricated concrete slab floor. Built during the 1963/64 Antarctic summer compaign.

- Two laboratory buildings : Building measuring 24 x 8 m (15 - 1.60 m spans) ; height, 2.50 m ; built on metal platform resting on piles. Construction : One during the 1963/64 summer campaign, the other in 1964/65.

- One meteorological probe balloon launching building : Building measuring 11.20 x 5 m (7 - 1.60 spans) of trapezoidal shape with a sliding door offering sufficient space to release the balloons ; maximum height : 5 m ; built on a metal platform resting on piles. Construction during 1964:65 summer campaign.

- 1 Living Quarters Building : Building measuring 17.60 x 17.80 m (11 - 1.60 m spans), with approximately square floor space, with inner framework ; height, 3.20 m ; built on a metal platform resing on piles. Construction during the 1965/66 summer campaign.

- 1 winter dwelling building : Building measuring 32 x 8 m (20 - 1.60 m spans), with 1 upper floor, with an inner framework also supporting the first floor ; built on a metal platform resting on piles. Start of construction during the 1967/68 summer campaign.

The main construction principles of these buildings are shown on the general drawings and diagrams attached hereto :

- Building metal support platform. (Laboratory Building type ; slight modifications have been made for future platforms)

- Laboratory buildings (identical to the electrical power station)

- Living quarters building, with inner framework

- Joint for living quarters building showing the weatherproofing system adopted for the roof.

- Inner layout of living quarters building (the inner layout of laboratory buildings consists, simply, of rooms obtained by standard model removable and prefabricated metal partitions).

The attached photographs show : Various types of building ; stages in the assembly of platforms, metal framework, panels ; various types of floor ; weatherproofing joints ; outflow of snow under plateforms. (For the inner layouts of buildings, refer to the report : "Reconstruction and Development of the Dumont d'Urville Base).

* * *

Amenagement Interieur du Batiment Sejour (See P. 269)

Salle à manger

1. Tableau général de distribution électrique

Laboratoire photographique

1. Bacs

Chaufferie

1. Chauffe-eau
2. Groupe d'alimentation en gas oil des fourneaux
3. Généra teur d'air chaud

Salle d'eau

1. Urinoirs
2. Lave-mains
3. W. C.
4. Cabines de douche
5. Ballon d'eau chaude
6. Machines à laver
7. Essoreuse
8. Table
9. Lavabos

Sas Nord

1. Départ monorail pour évacuation des ordures
2. Pompe pour l'évacuation des eaux usées

Cuisine

1. Cuisinière avec hotte de ventilation.
2. Armoire frigorifique
3. Ensemble de plonge
4. Bacs à légumes
5. Eplucheuse
6. Table de travail et étal
7. Batteur mélangeur
8. Placard bas et barres de casseroles
9. Four à pain et armoire de commande
10. Tour à patisserie
11. Coffre à farine
12. Pétrin

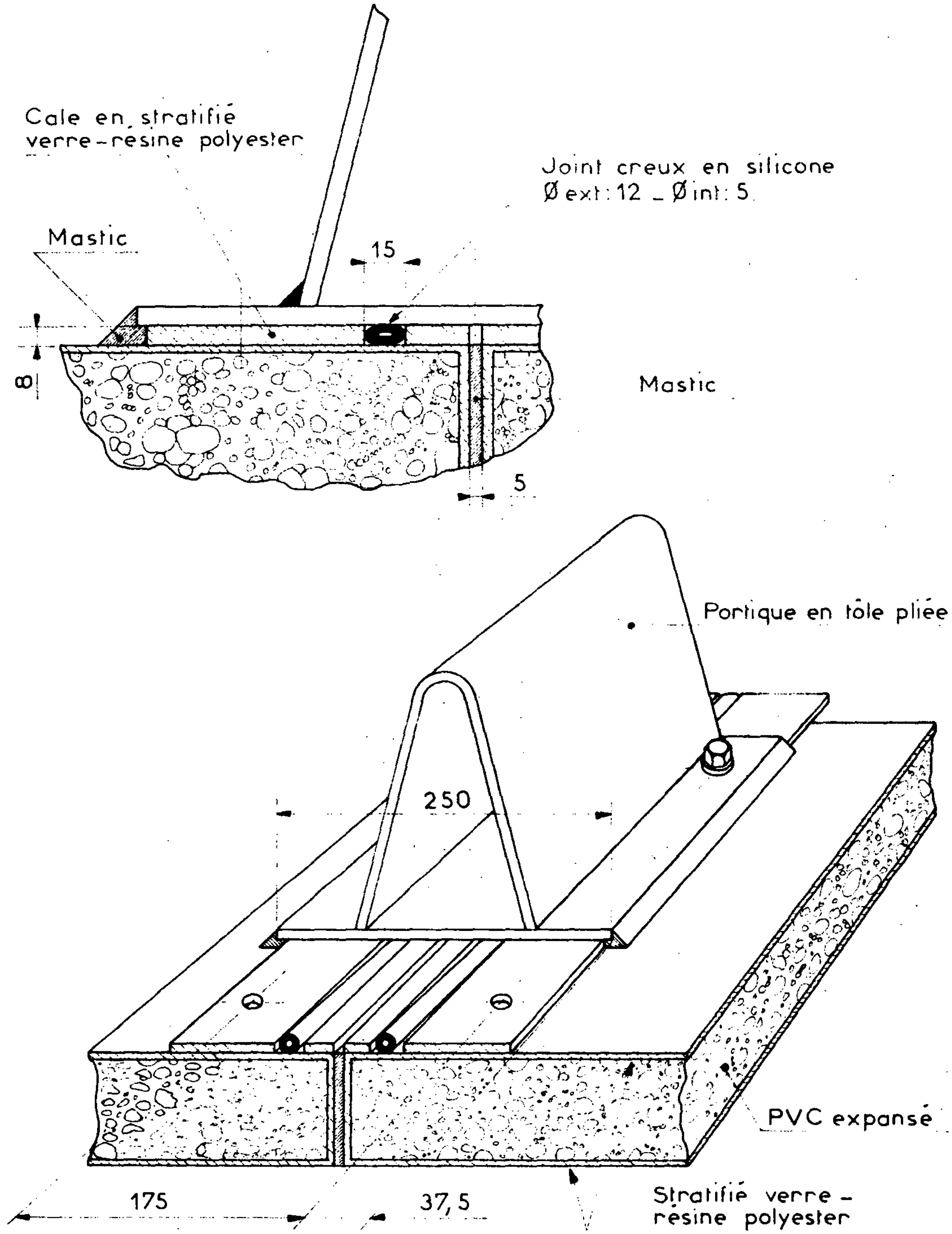
Office

1. Armoire de rangement des verres
2. Armoire de rangement de la vaisselle
3. Ensemble plonge à vaisselle
4. Ensemble plonge à verres
5. Table mobile

⊟ Poteaux, support de l'ossature à ntérieure

◎ ◎ Poste à incendie (2 bouteilles de 30 kg de CO^2)

⋈ Tableau électrique



JOINT POUR BATIMENT SEJOUR

Schéma de principe

Expéditions Polaires Françaises

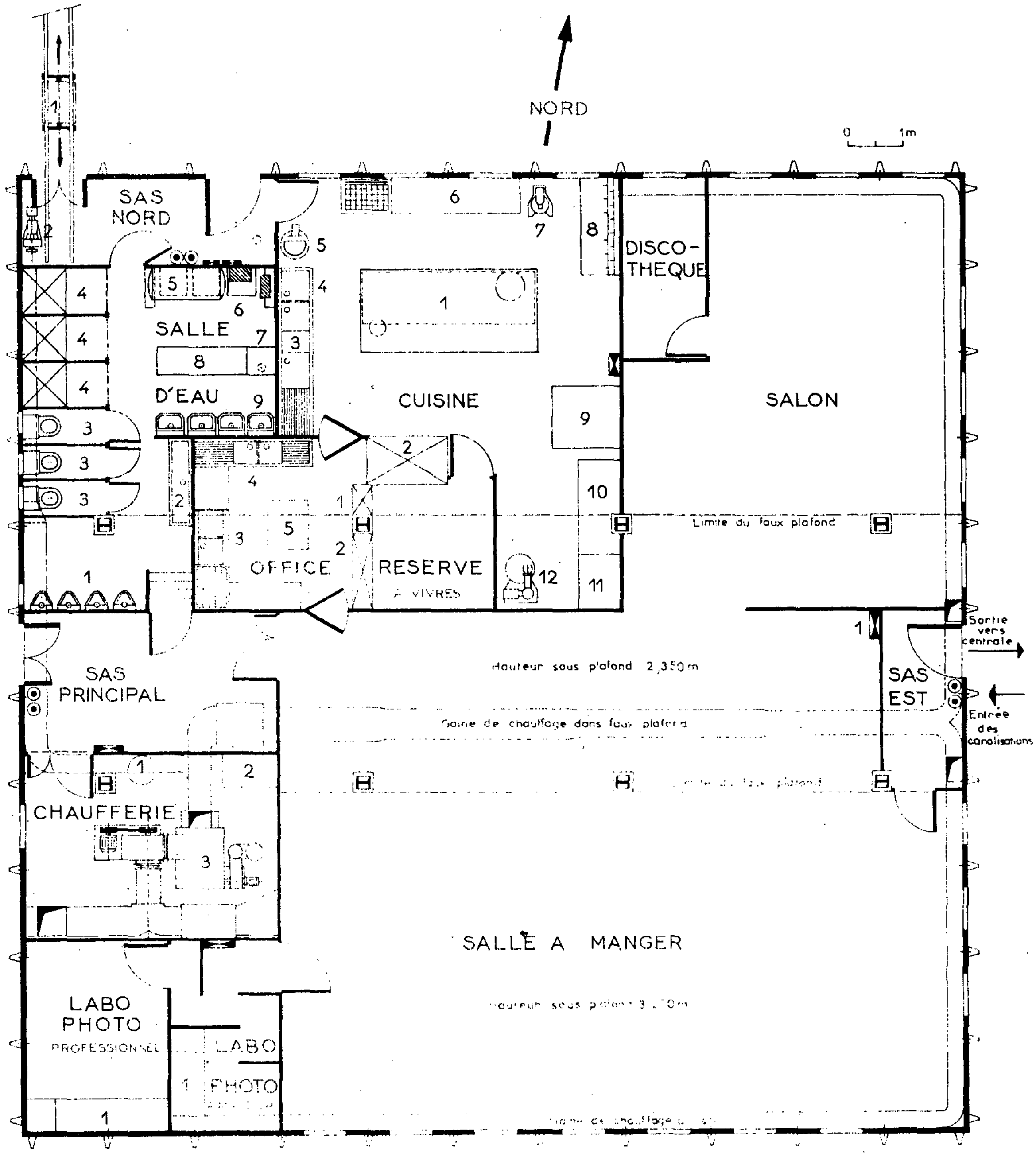
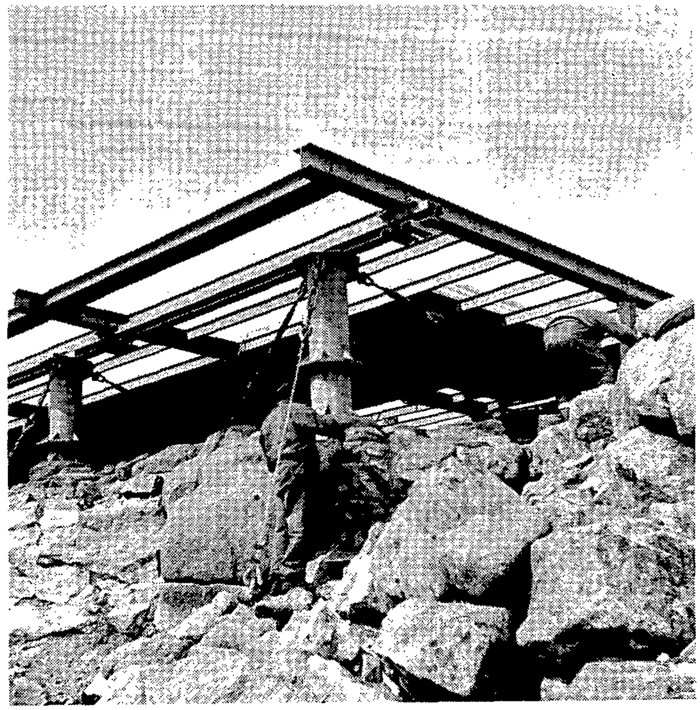

NORD
0
1m
SAS NORD
SALLE D'EAU
CUISINE
DISCO-THEQUE
SALON
OFFICE
RESERVE A VIVRES
Limite du faux plafond
SAS PRINCIPAL
Hauteur sous plafond 2,350m
Gaine de chauffage dans faux plafond
SAS EST
Sortie vers centrale
Entrée des canalisations
CHAUFFERIE
SALLE A MANGER
LABO PHOTO PROFESSIONNEL
LABO PHOTO

Photo 1. Construction of a metal platform. View of 2 posts with 2 components; the first with 1 m and 0.50 m components, the second with 1 m and 0.25 m components. 3 guy cables for each post. On the post; the templet. On the templet; the metal framework of the floor.



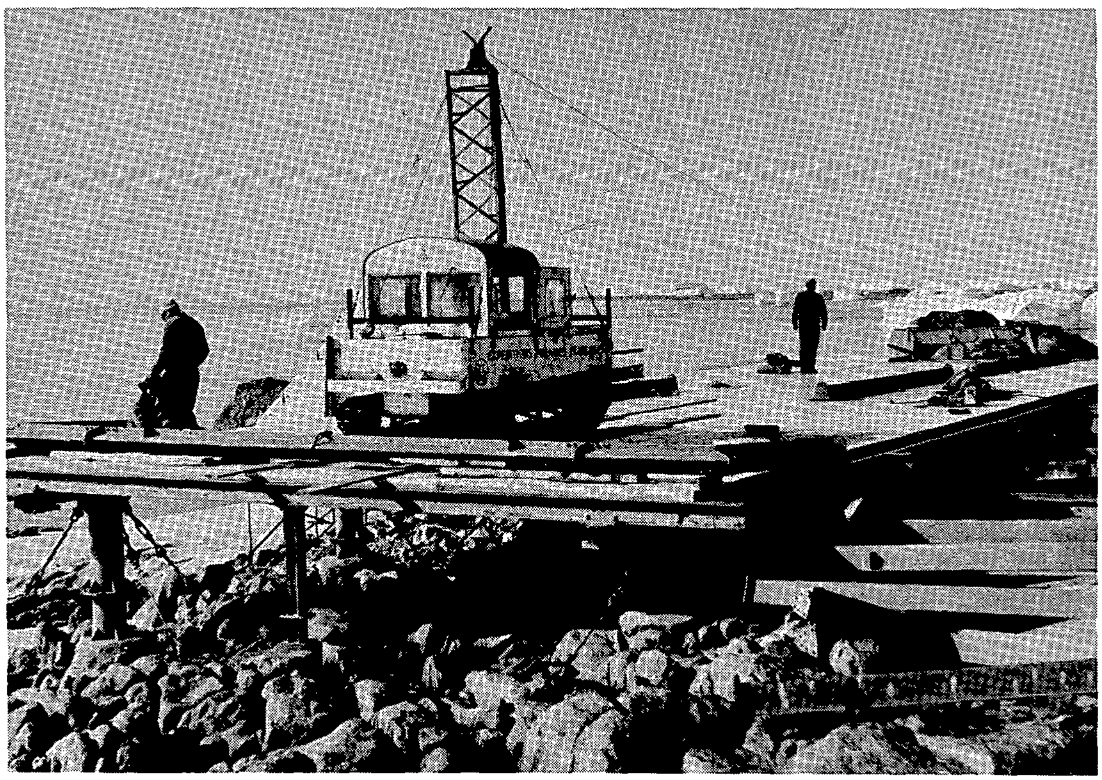
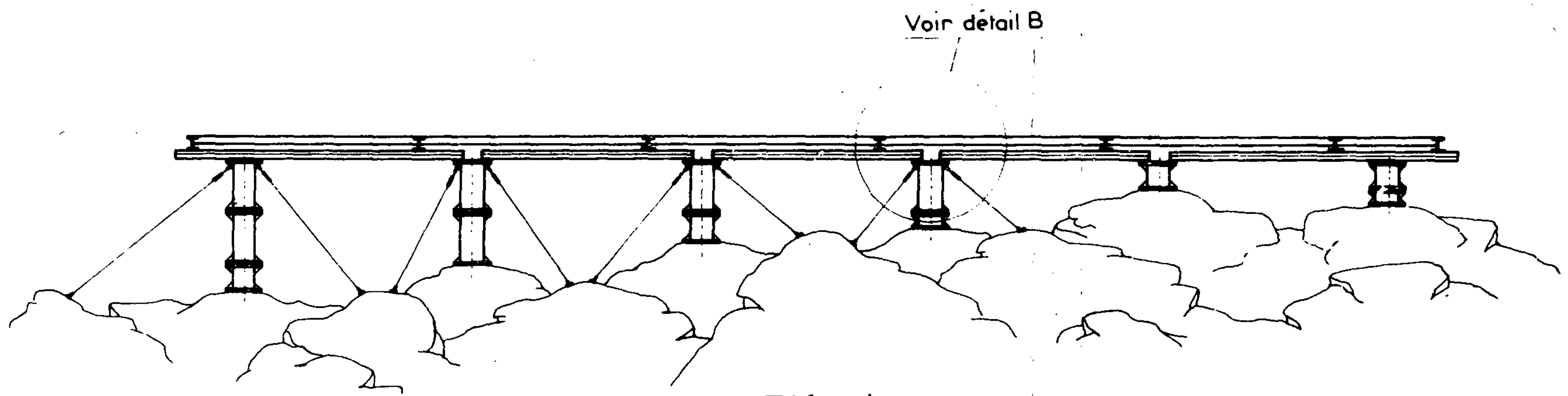
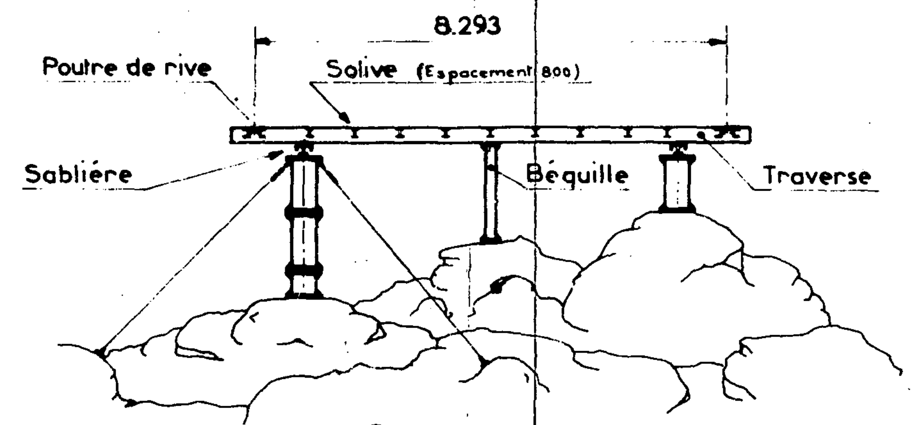


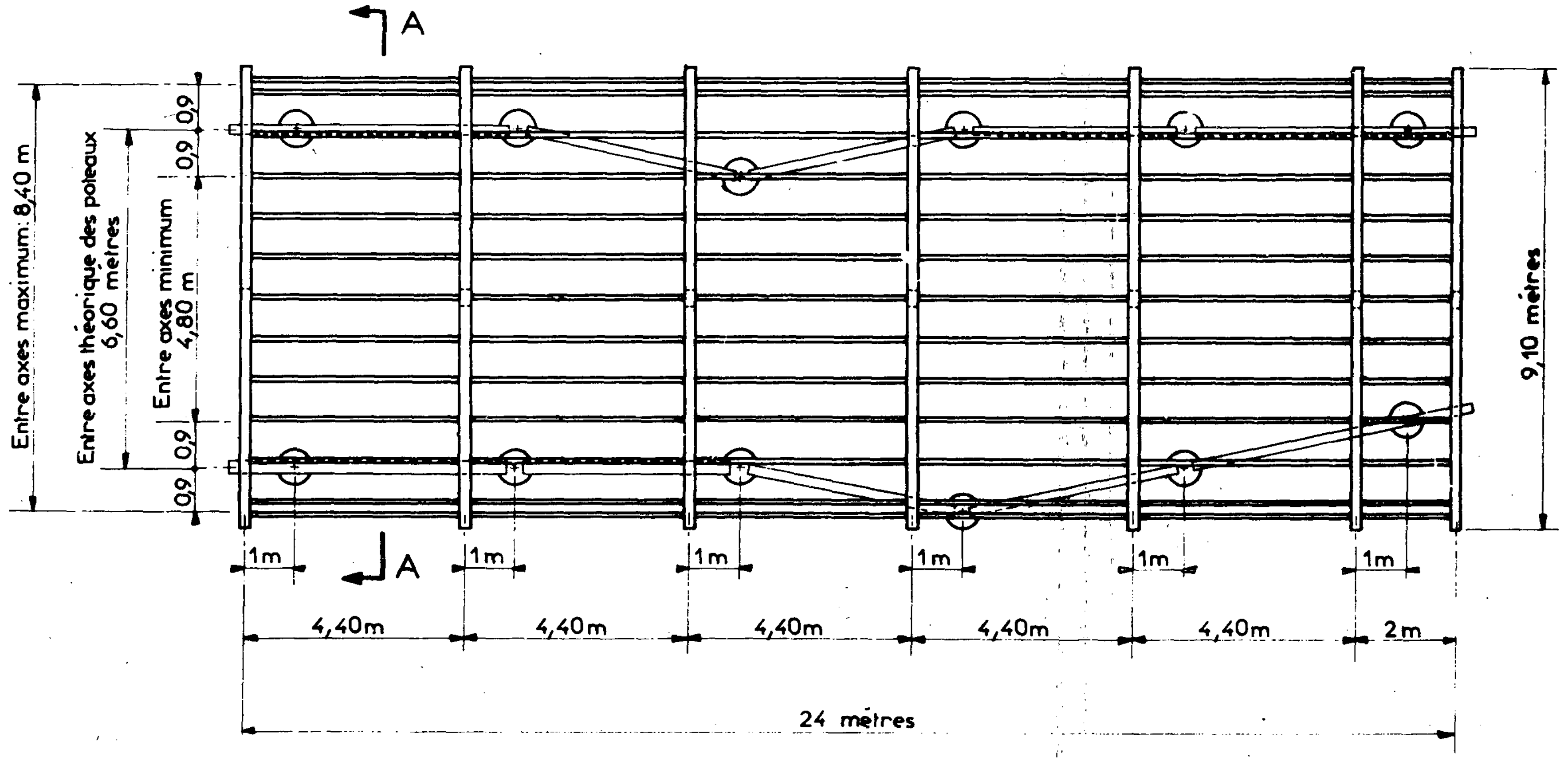
Photo 2. Laboratory building. Platform is completed. Floor plastics panels are laid. One span of the metal framework, completed on the floor, is to be lifted.



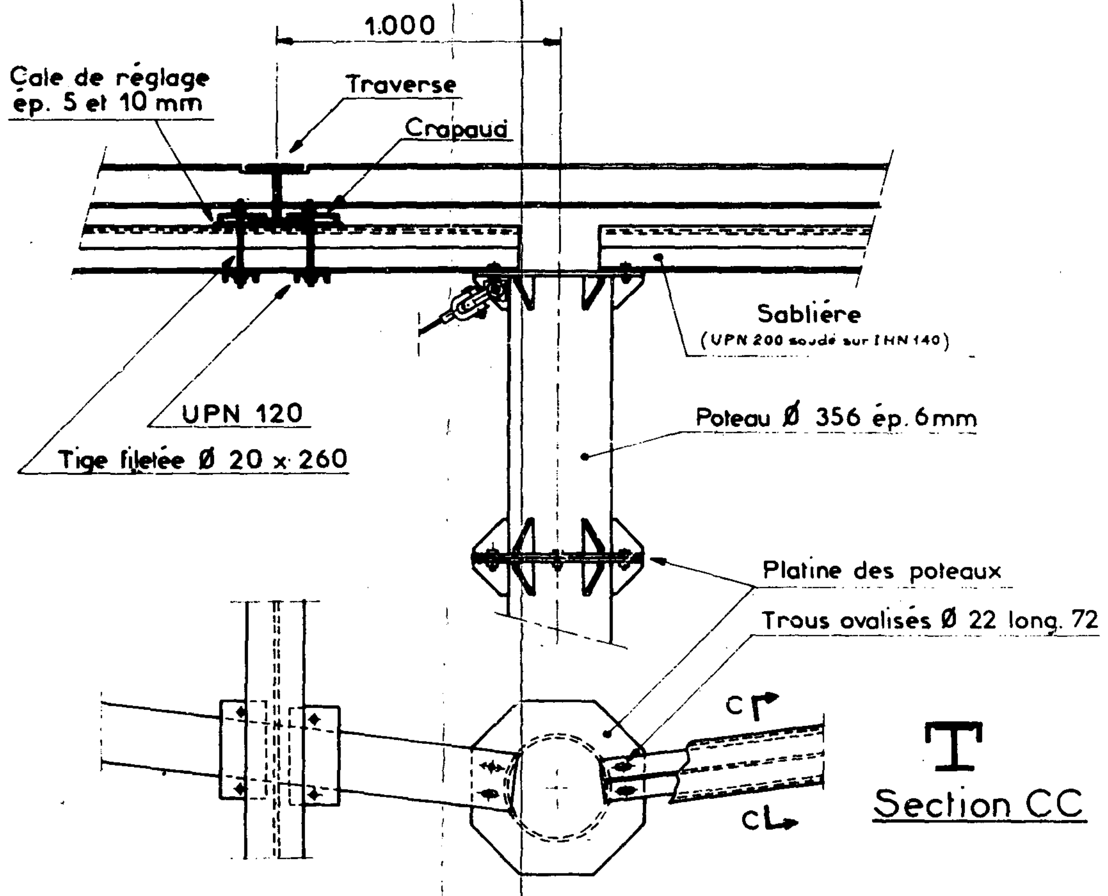
Elévation _ Ech: 1/100



Coupe AA _ Ech: 1/100



Vue en plan _ Ech: 1/100



Détail B _ Ech: 1/20

LES NOUVEAUX BATIMENTS
de la
BASE DUMONT d'URVILLE

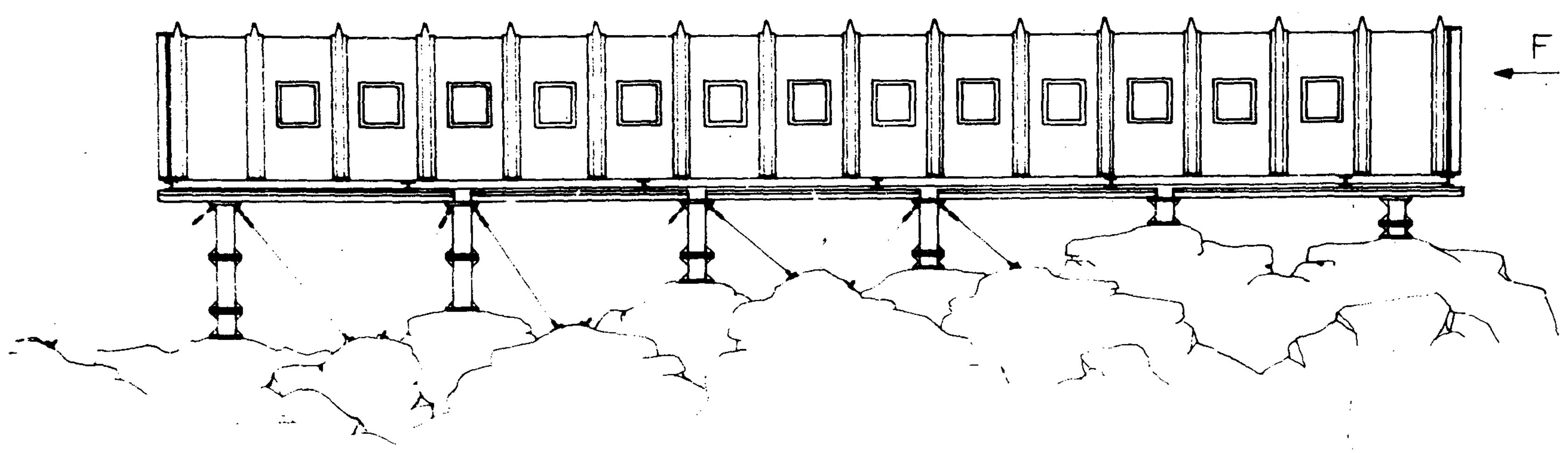
PLATEFORME METALLIQUE
SUPPORT DE BATIMENT
Type laboratoire

Schéma de principe

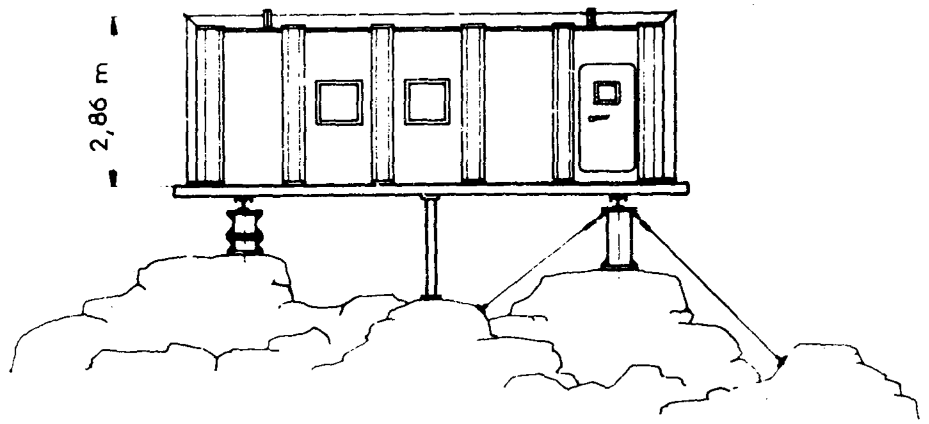
1962

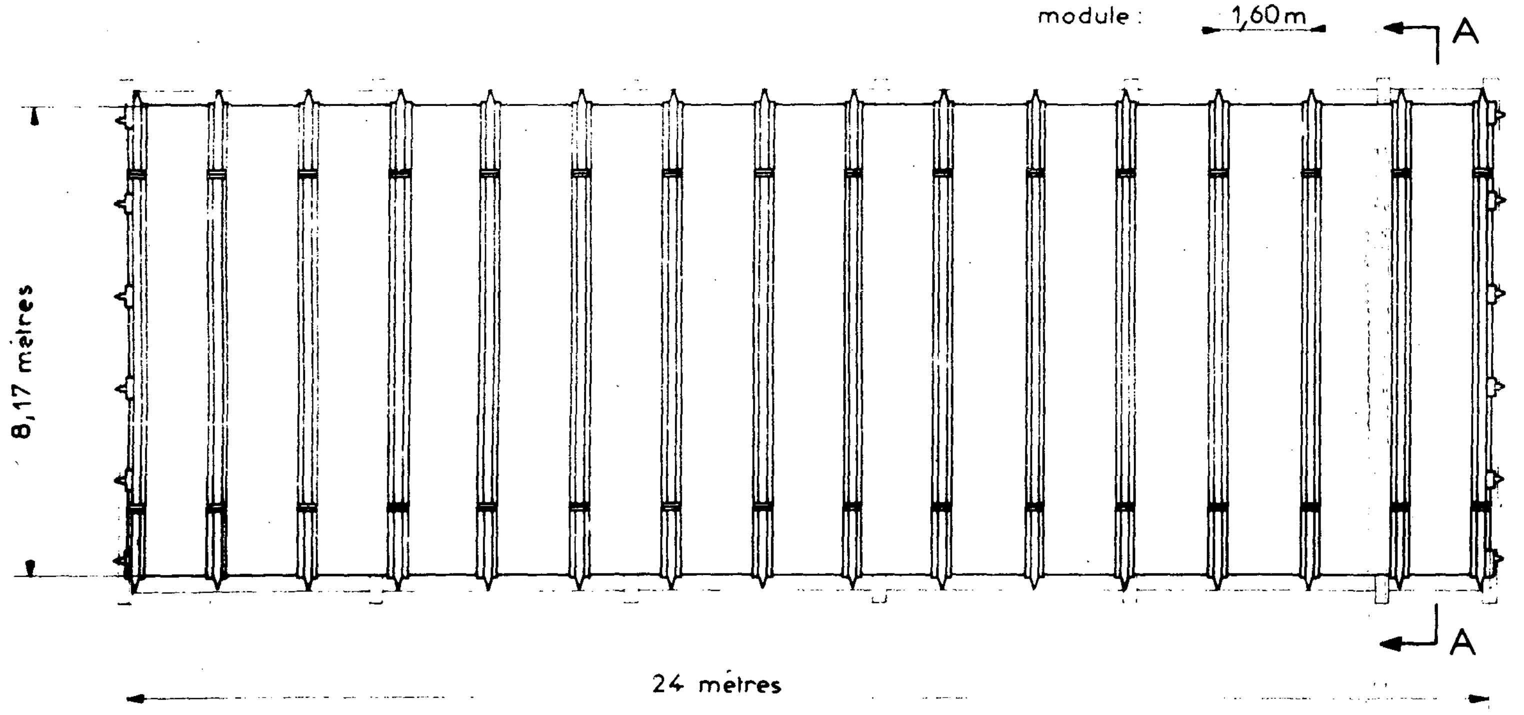
Expéditions Polaires Françaises

Elévation _Ech 1/100



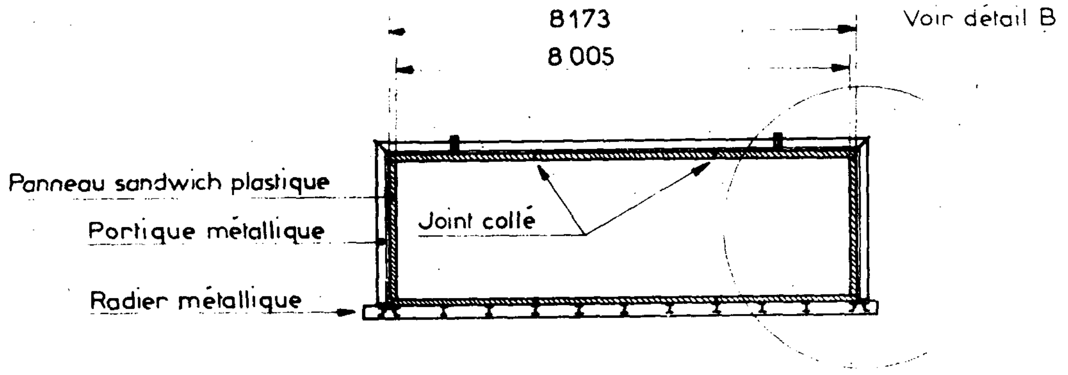
Vue suivant F
Ech 1/100

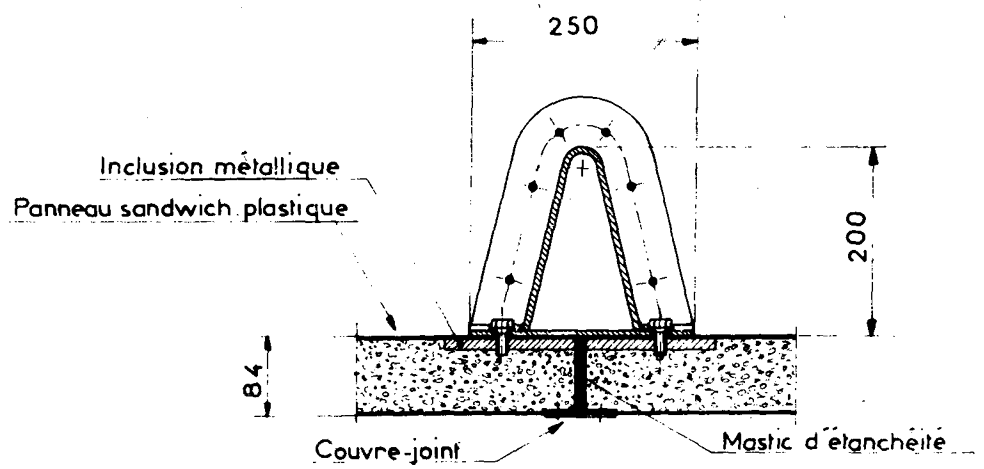




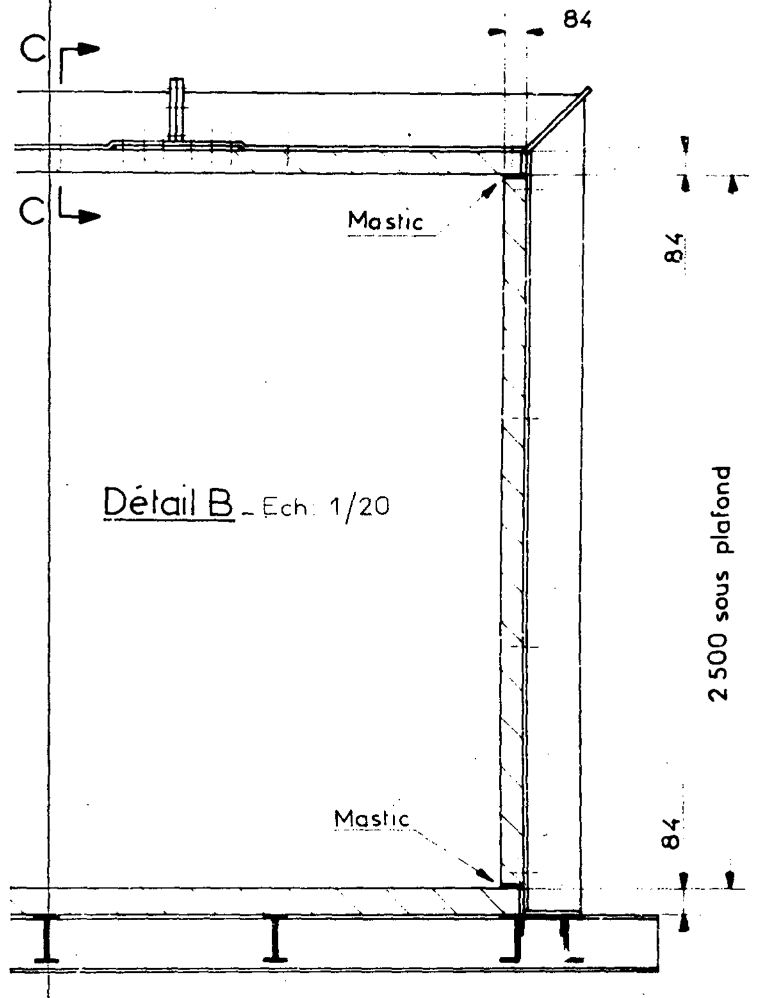
Vue en plan _Ech 1/100

Coupe AA _Ech 1/100





Coupe CC _Ech 1/6



Détail B _Ech 1/20

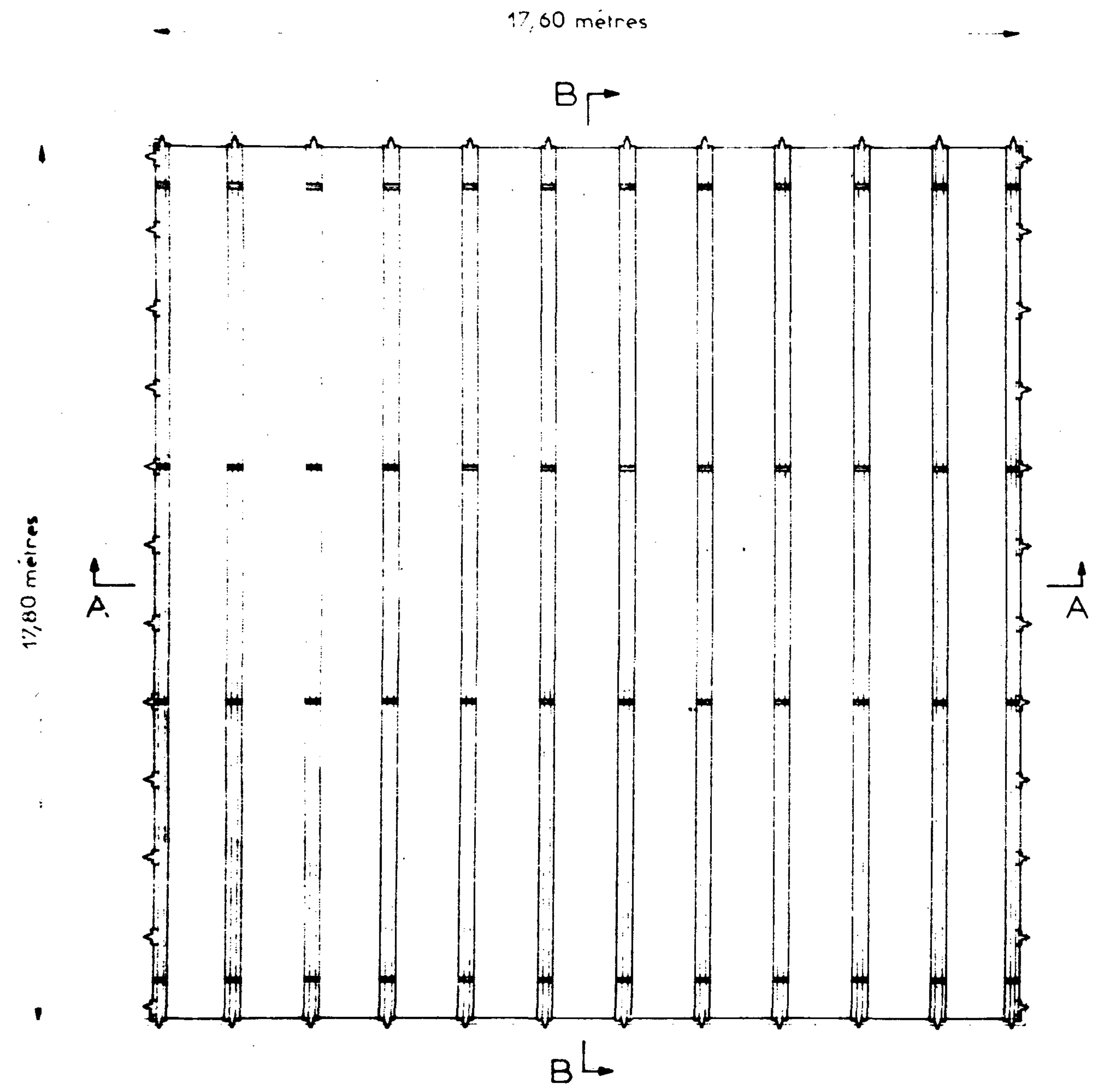
LES NOUVEAUX BATIMENTS
de la
BASE DUMONT d'URVILLE

BATIMENTS LABORATOIRES

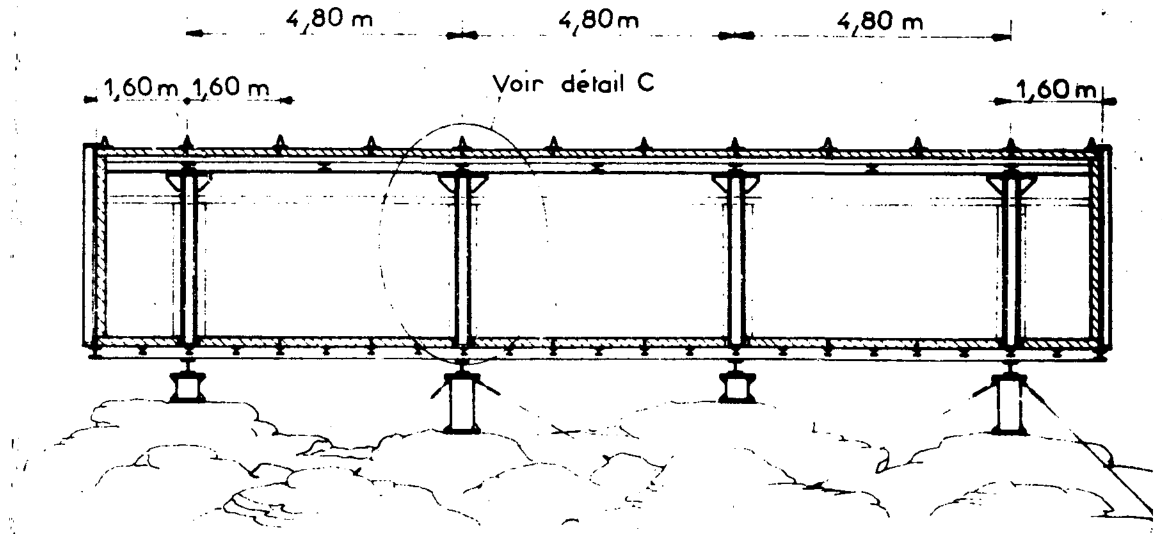
Schéma de principe

1964

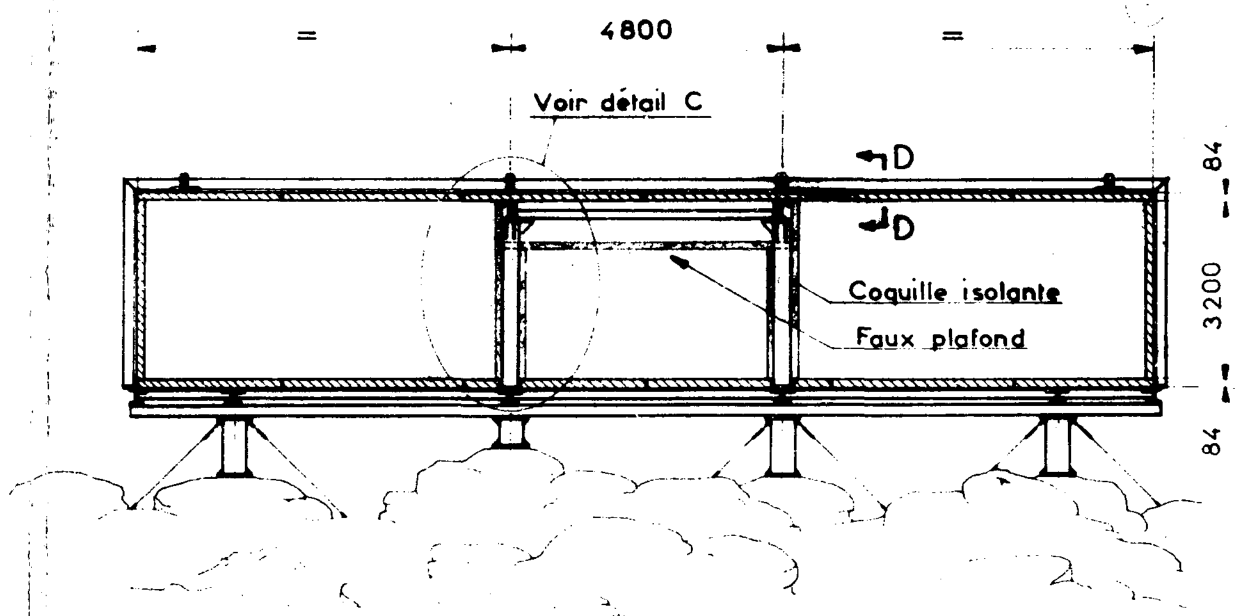
Expéditions Polaires Françaises



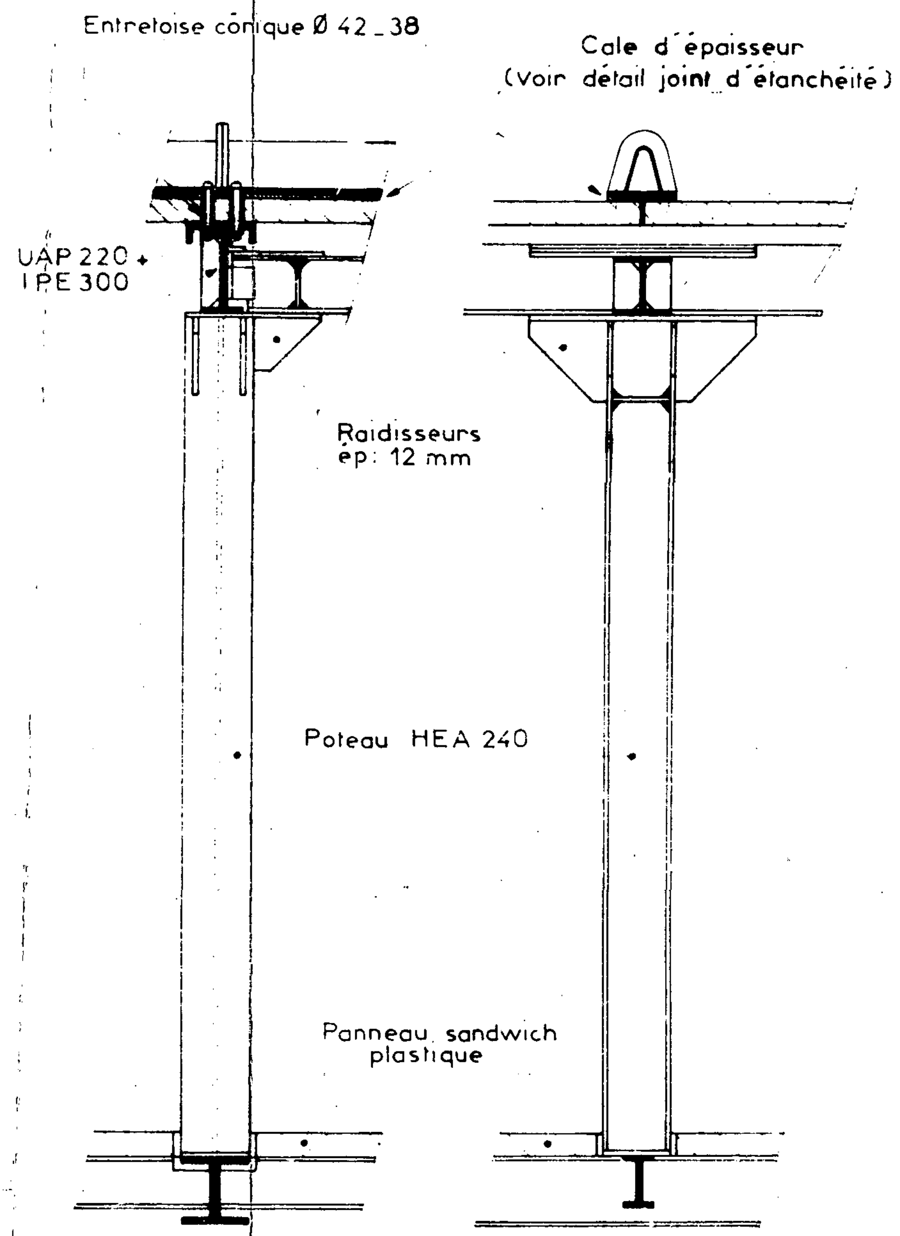
Vue en plan _ Ech: 1/100



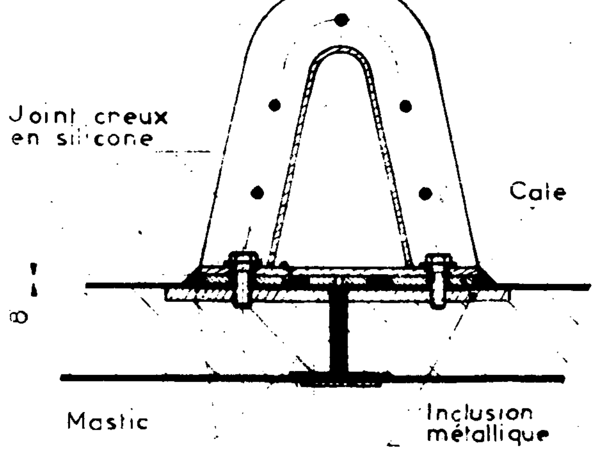
Coupe AA _ Ech: 1/100



Coupe BB _ Ech: 1/100



Détail C _ Ech: 1/20



Coupe DD
Ech. 1/5

LES NOUVEAUX BATIMENTS
de la
BASE DUMONT d'URVILLE

BATIMENT SEJOUR
Schéma de principe

1965

Expéditions Polaires Françaises

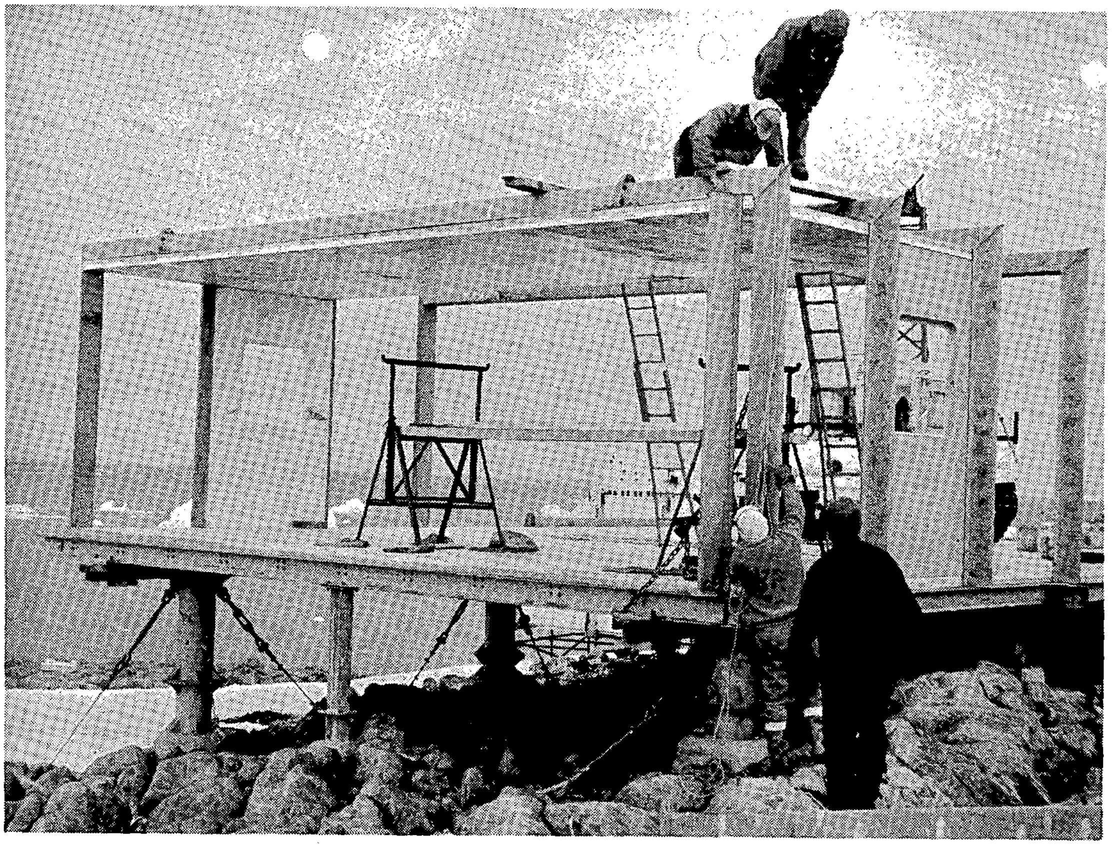


Photo 3. Laboratory building. 4 spans are lifted; 2 rows of roof panels are laid as 2 window panels; 1 upright is mounting.

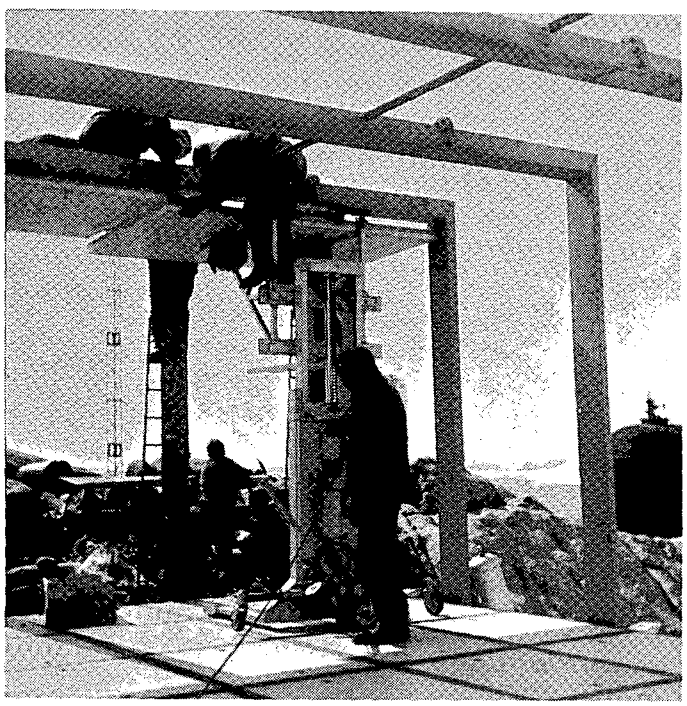


Photo 4. Laying of roof panel. Gluing of 2 consecutive panels of a row. Panel is lifted by lift-truck. Temporary wind-braces will be lay down after lay-ing of panels. The floor in concrete slabs (power plant building).

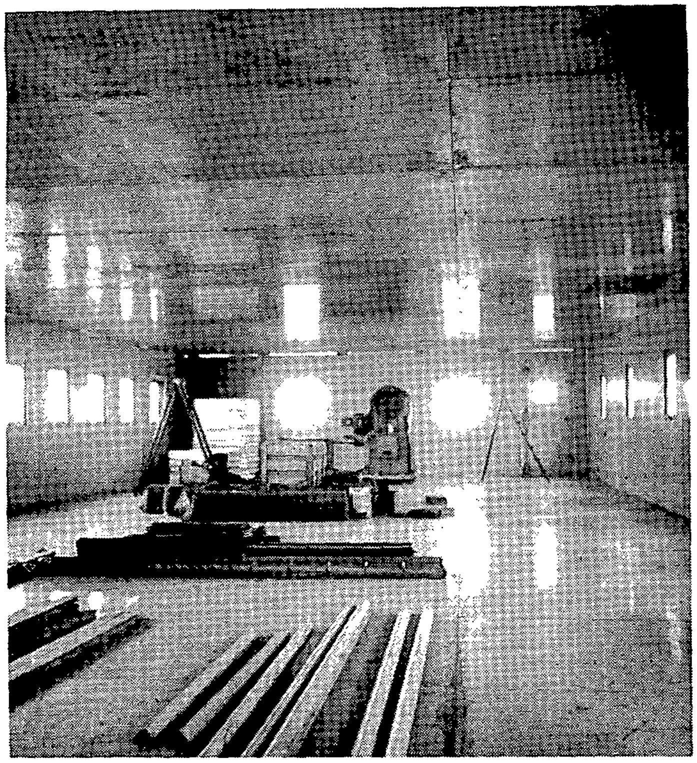


Photo 5. Inside view of a laboratory building after laying of panels and before assembly of the prefabricated metal partitions. Neither beam nor post; surface and volume are free for all installations. Weather proofing and joint covers are not yet laid. In the background; hot-air generator.

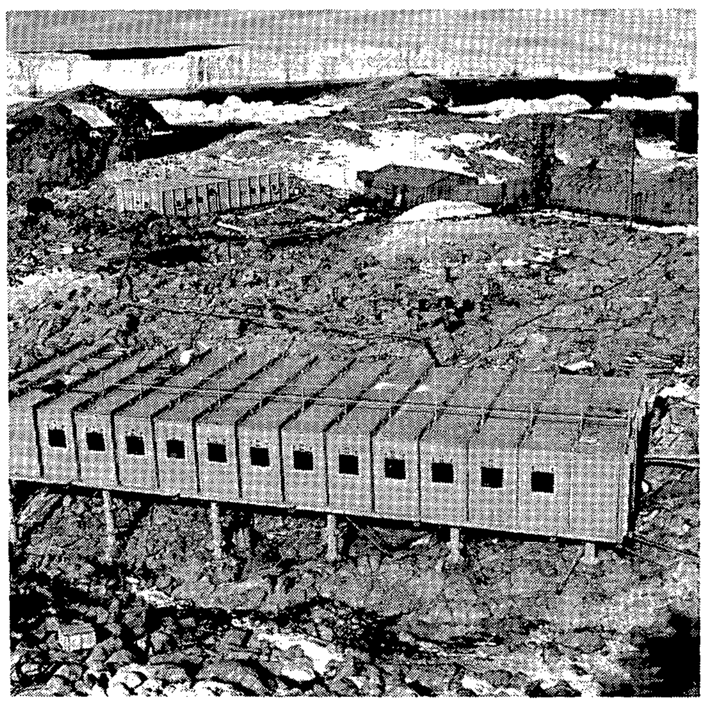


Photo 6. General view of laboratory building No. 2. On the left; one 3 m high post. On the roof; safety handrail; on the left part; aurorae apparatus. In the background; new power plant building.

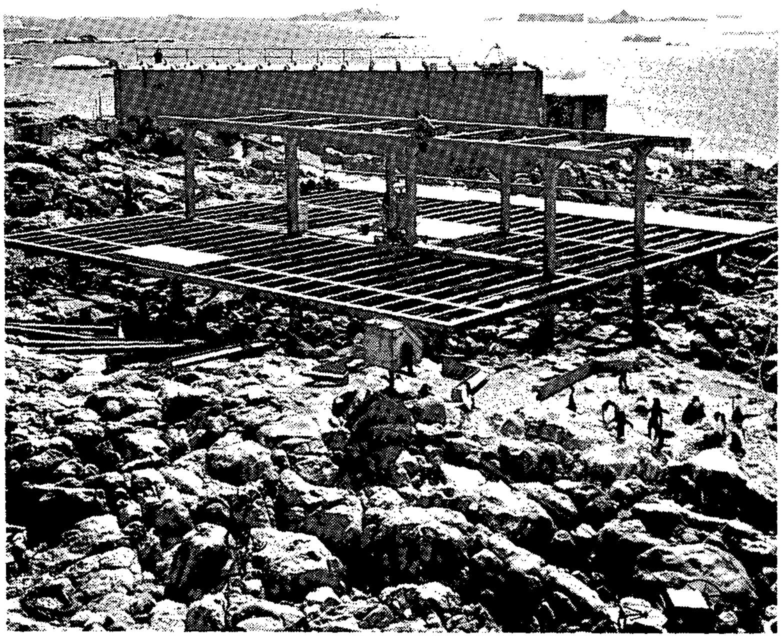
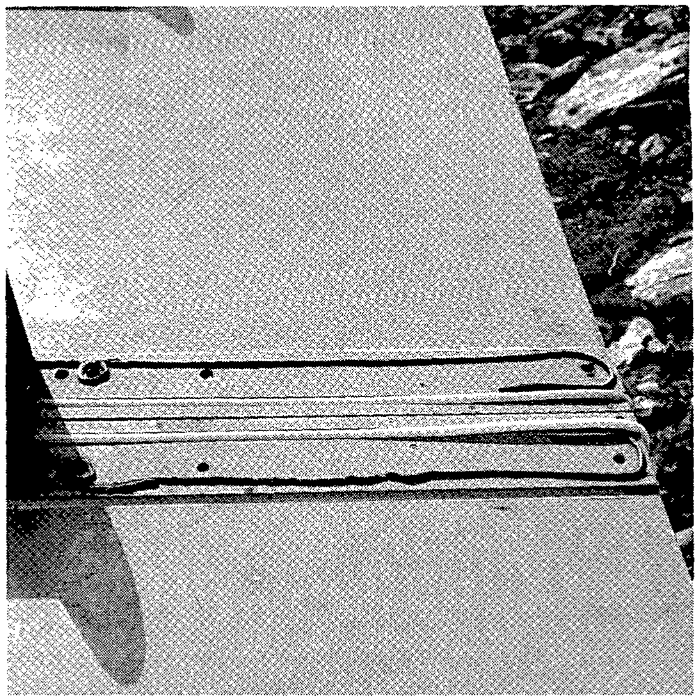


Photo 7.
Living quarters. Platform and inner framework. This framework bears the middle roof panels and the metal span.

Photo 8. General view of the living quarters. On the right ; the starting point of the refuse monorail.

Photo 9.
Living quarters. Weather-proofing joint; 2 beads carrying a housing for a hollow seal ring (silicone pipe); 2 cement bead. On the left; assembly clamp of the central part of the metal span.



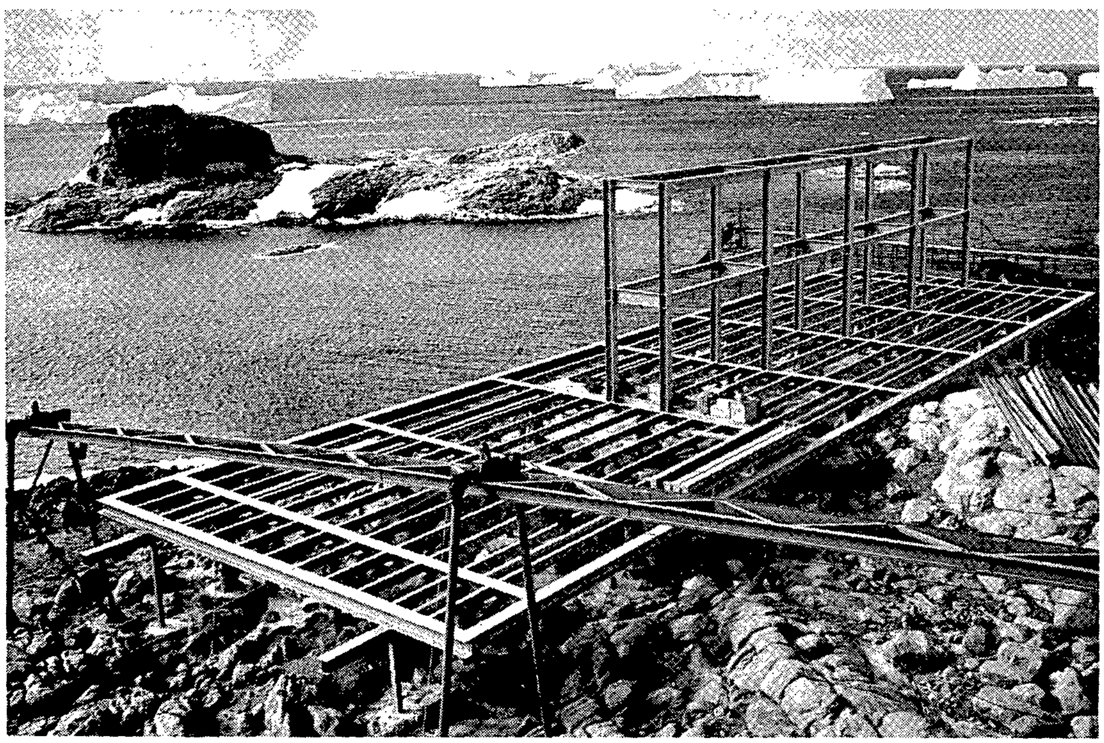
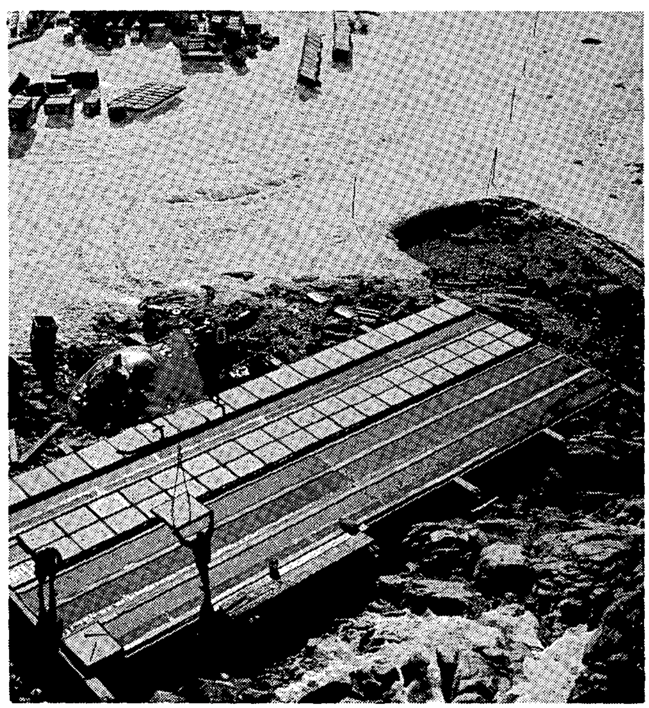


Photo 10. Winter dwelling building with 1 upper floor.
Platform and inner framework during mounting. This inner framework will bear the upper floor. Foreground; refuse

Photo 11.
Meteorological probe balloon launching building. In the corner cut off; the sliding trap-door for launchings. Weatherproofing of the door by an inflattable joint.

Photo 12.
Laying of prefabricated concrete slabs on metal platform (by helicopter). The slabs are laid upon wood-fiber panels overlapped by an asphalt/aluminium sheet for weatherproofing.



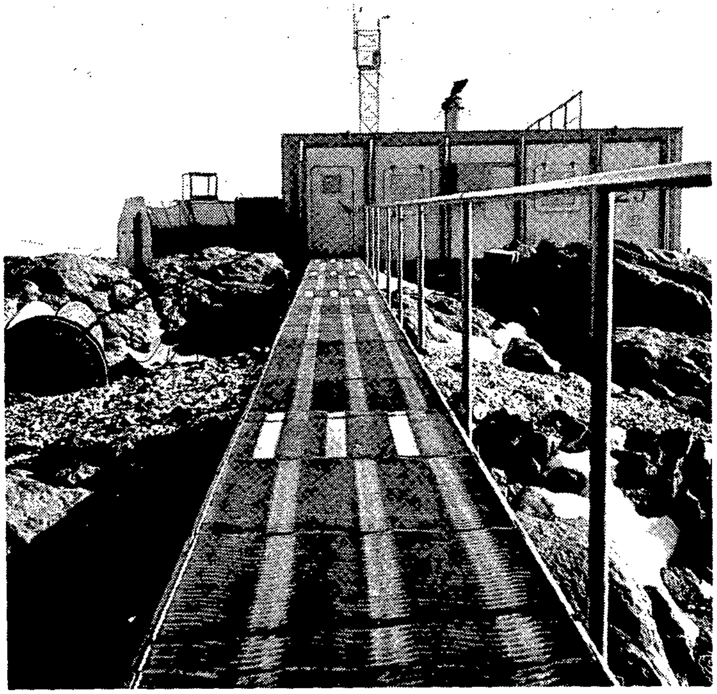


Photo 13.
Metal foot-bridge between the 2 laboratory buildings; consisting of iron-gate supported by tubular scaffolding.

Photo 14.
View of the laboratory building No. 1 in winter. The metal platform resting on piles allows the outflow of snow. The snow-drift behind the building melt in summer.

RECENT BUILDINGS AT SYOWA STATION

Akira Murauchi, Toshio Sato

Zenkichi Hirayama and Yoshio Kobayashi*

1. Introduction

Syowa Station located at 69°S and 39° 35'E was established in 1957 on an exposed rock area in Ongul Island, Antarctica. The station was closed twice from 1958 to 1959 and from 1962 to 1965. During the periods of activity, the installations have gradually developed and the members of wintering party have been increased from 11(1957) to 28(1958) and the number of buildings was increased from 4(250.6 m^2) to 21(1269 m^2). The buildings constructed between 1957 and 1965 were designed by the Committee of Antarctic Architecture in Architectural Institute of Japan, while the buildings after 1966 were primarily designed by the Committee of Antarctic Architecture of Nihon University in Tokyo in which the present authors were the members.

This report describes the laboratory hut, mess hall, balloon inflation shed, and garage which were built in 1967 by the Japanese Antarctic Research Expedition(JARE) and one living quarter built in 1968.

2. Conditions for design

As the buildings are to be constructed by limited manpower during short changeover period, a complete prefabrication system is required. Because of adverse ice conditions in the vicinity of Syowa Station, it was planned to transport cargo and personnel by helicopters on board the icebreaker "Fuji". Due to the cargo-carrying capacity of helicopters, the maximum size of construction material should be 1.5 x 6.0 m and less than 2 tons in weight. The number of workers engaged at one construction site is estimated to be about 20 during a limited construction period of 30 days.

The design philosophy for buildings is based on minimising snow drift accumulations. A maximum wind speed of 60 m/sec is to be expected. The room temperature should be kept between 18 and 20°C during the winter. The relative humidity should be 45 to 80%. Non-combustibility of buildings is also to be considered.

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3. Laboratory

Laboratory hut, balloon inflation shed, and mess hall were erected on elevated steel-grid platforms. In the case of mess hall a relatively low floor was finally adopted in relation to the height of existing buildings. The following dimensions were employed for standard panels.

Floor panel	997mmx 1997 mm x 130 mm
Wall panel	997 mm x 1997 mm x 100 mm
Roof panel	497 mm x 5997 mm x 150-400 mm
Balloon inflation shed only	997 mm x 3338 mm x 160 mm

The laboratory hut (area about 140 m^2) is used for observations of upper atmosphere physics and also includes four cubicles (Figs. 1 and 2). Frame structure of panels is shown in Fig. 3. Floor panels and steel-grid platforms are connected with bolts. Two panels were connected side by side by means of metal connectors (Fig. 4). A series of experiments was carried out to determine the best connectors and adhesive agent in making wooden panels.

4. Balloon inflation shed

This building has a relatively high ceiling of 3.2 m and a large door(3.2 x 3.7 m) for the release of balloon. A steel-frame release deck is attached to the building. Details will be seen in Figs. 5 and 6.

5. Mess Hall

This building has a kitchen of 20 m^2, a dining room of 42 m^2, and a lounge of 20 m^2. About 30 people will be accomodated (Figs. 7 abd 8).

6. Garage

This building has a semi-circular section with a diameter of 5 m (Figs. 9 and 10). A large opening is capable of accomodating a small aircraft in the future. At present, this building is used for accomodation and maintenance of surface vehicles. This is composed of steel frames and wooden panels, thus enabling an extension work whenever possible.

7. Living hut

This hut was built in 1968 to accomodate ten people. In Fig. 11 a comparison is given to three different types of buildings at Syowa Station. The living hut was designed in considering the experiences obtained in the previous year. Since the difficulties were encountered to transport long materials by helicopters, the length of building materials was decided to be 5 m. Concrete work at Syowa was easier than anticipated, so the concrete piers of 1 to 1.5 m high were employed in replace of heavy steel- grid substructures. Detail of concrete peir is given in Fig. 12.

Plan and elevation of living hut are shown in Figs. 13 and 14, respectively. It is to be remarked that the dimensions of panels are essentially the same as the laboratory hut, with the exception in the case of floor panel. That is:

Floor panel	999 x 4999 x 130 mm
Wall panel	999 x 2338 x 100 mm
Roof panel	499 x 4999 x 150-400 mm

Outside of these panels was covered with a single sheet of galvanized sheet iron (28-gauge) glued to both insulator and frame with "Hiyoshi" epoxide. The surface was oil painted.

As for the inside surface of panel, "Perlite board"(asbestos cement slate) and "Century board" (cemented excelsior board) were used for fire-proof of laboratory hut, mess hall, and balloon inflation shed. In the living hut, fire-proofed plywood was used to decrease the weight of panel.

Connection between wall panel and room partitioning panel is shown in Fig. 15. Two kinds of connectors were used to join. This was the same in the case of laboratory hut, mess hall, and balloon inflation shed.

In the living hut, connecting wooden members were attached to the lower surface of floor panel, and fitting was made with steel framework by means of metal connectors (Fig. 16).

8. Implementation

Mechanical plant and equipment employed:

Cargo truck, 3/4 ton	1
Fork-lift	1
Bulldozer, BS-3	1
Bulldozer, CT-25	1
Crane truck, boom length 6.5 m	1
Air compressor and rock drills	1
Portable, motorised rock drill	5
Concrete mixers	2

Adequate supplies of hand tools were provided. Temporary 100 V, 50-cycle AC electric power was supplied.

Total number of man days for construction, starting from earthworking to erection:

laboratory hut	78
mess hall	84
balloon inflation shed	54
garage	74
living hut	ca. 100

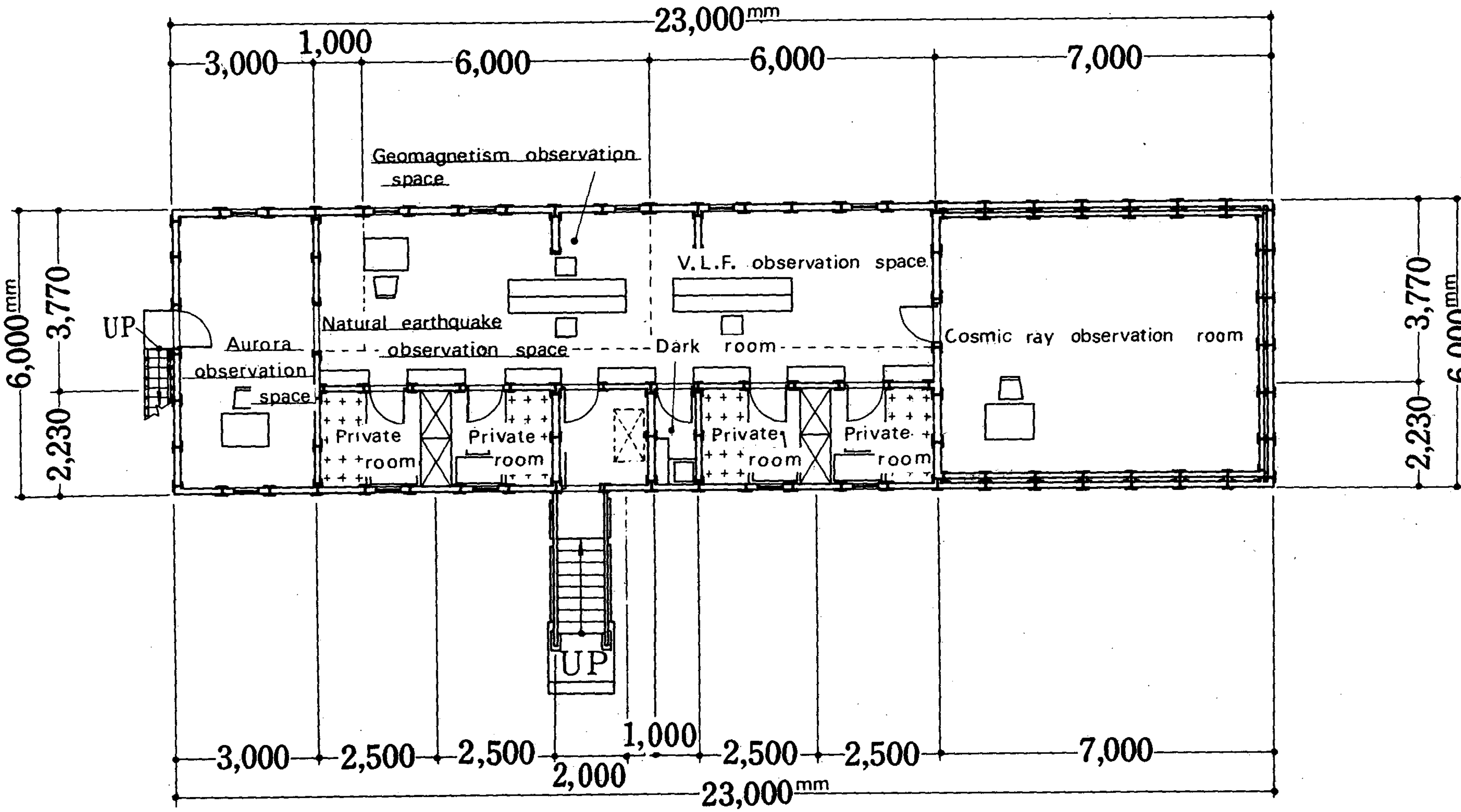

Fig. 1. Laboratory hut (Plan).

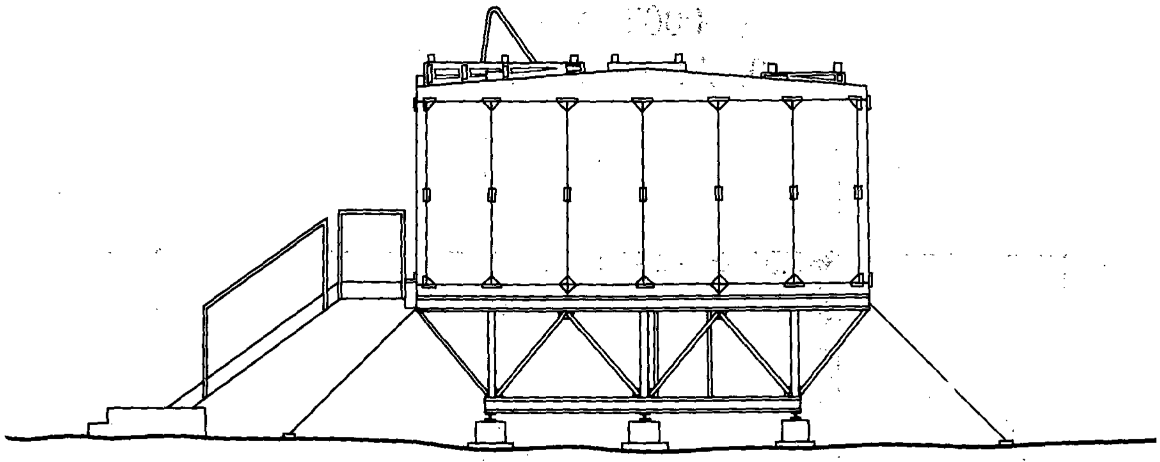

Fig. 2. Laboratory hut (Elevation).

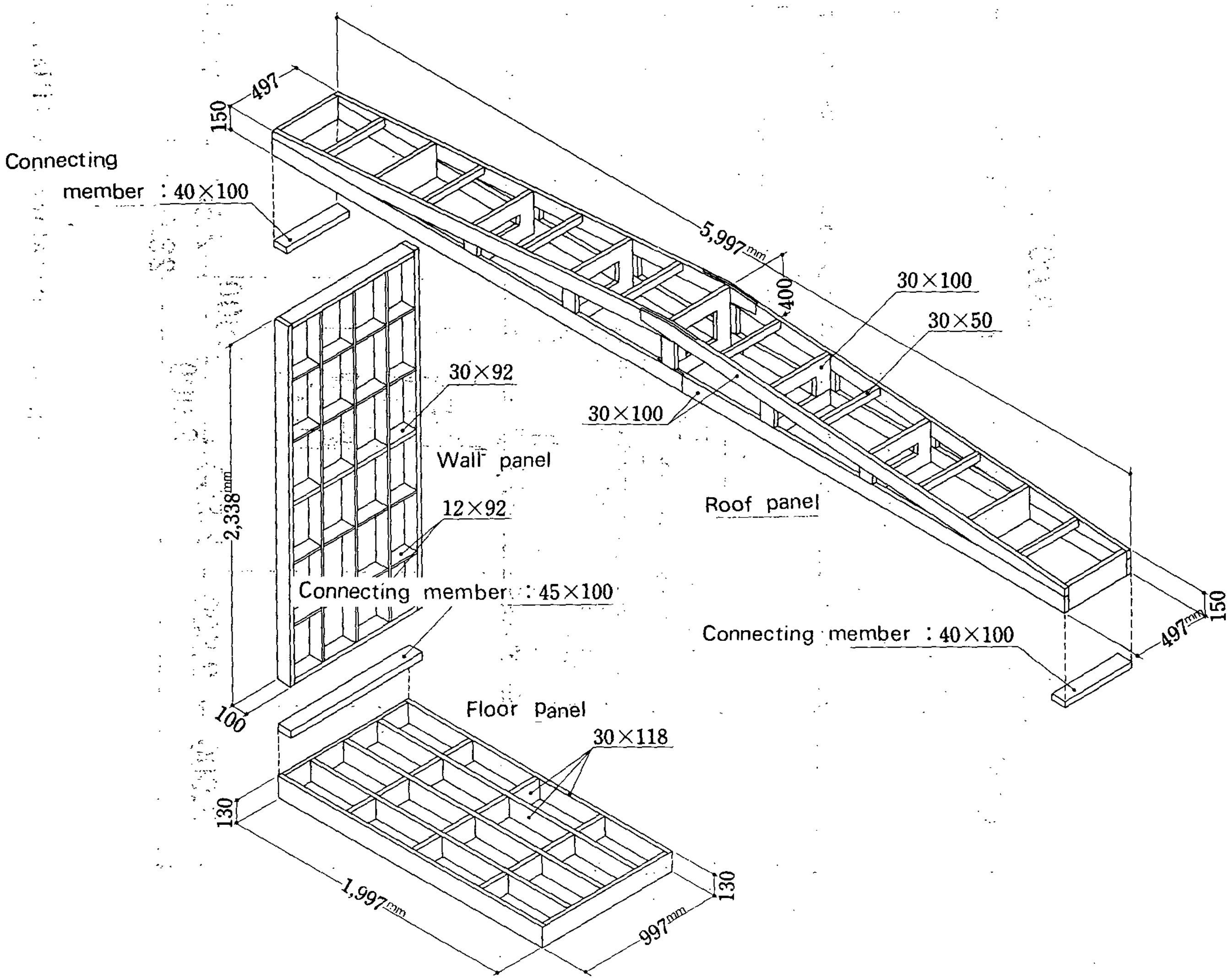

Fig. 3. Framing details of panels (Laboratory hut).

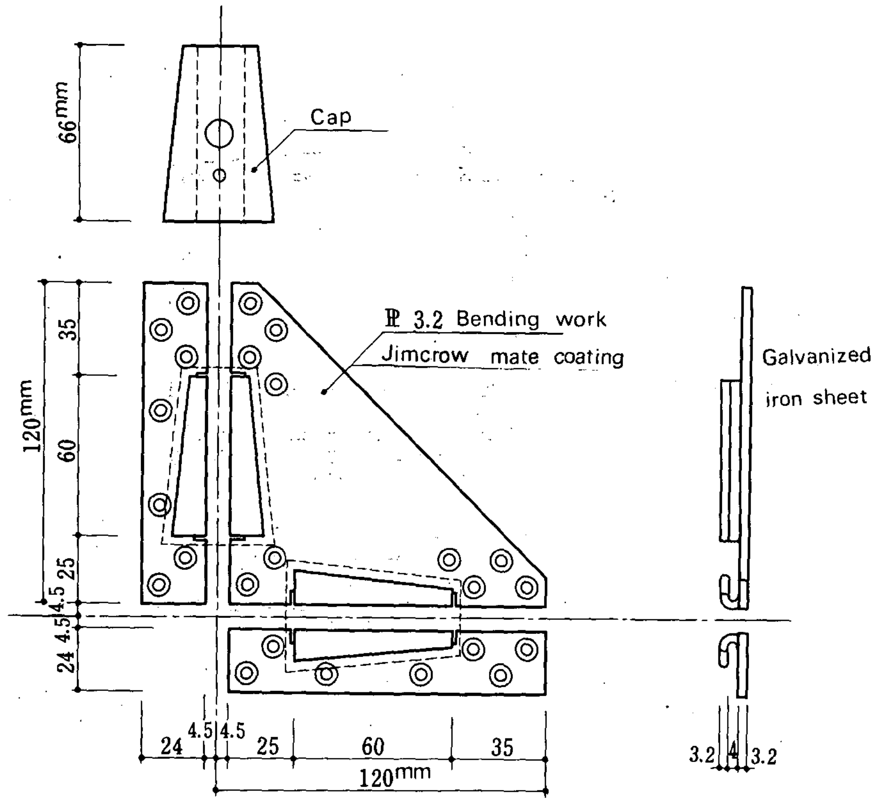

Fig. 4. Details of connector.

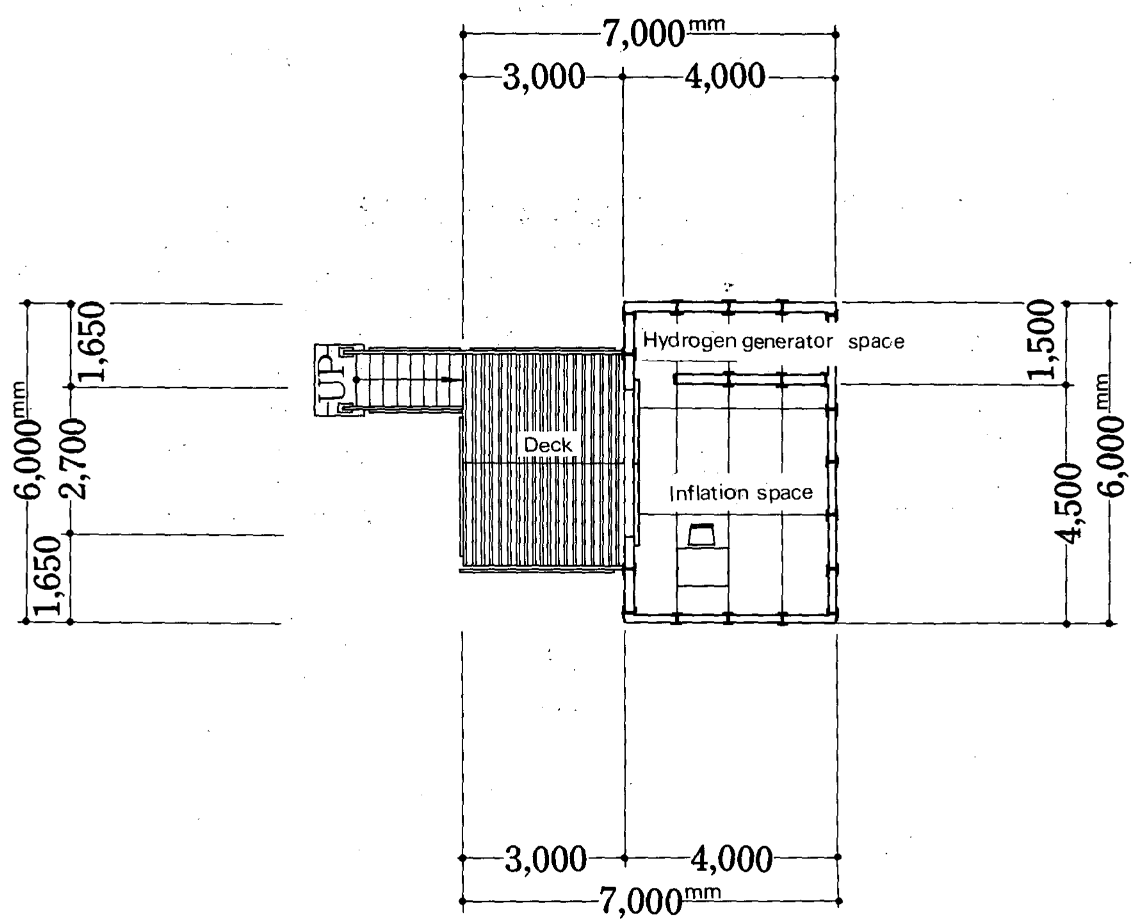

Fig. 5. Balloon inflation shed (Plan).

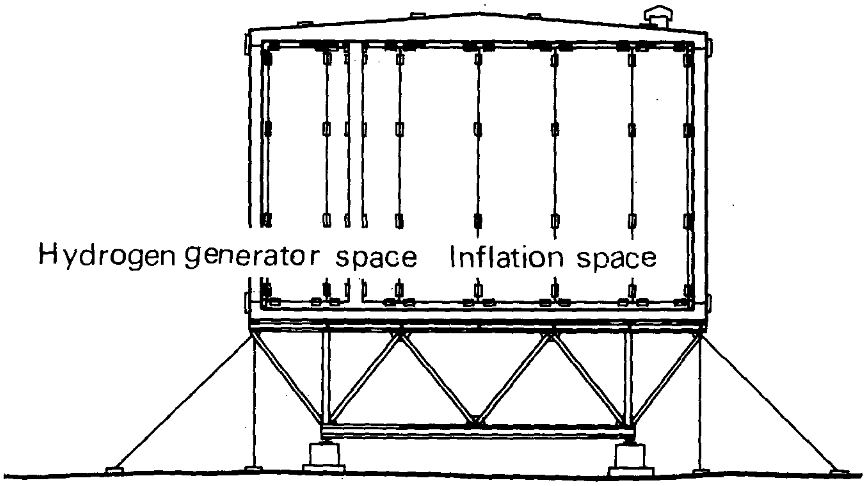

Fig. 6. Balloon inflation shed (Section).

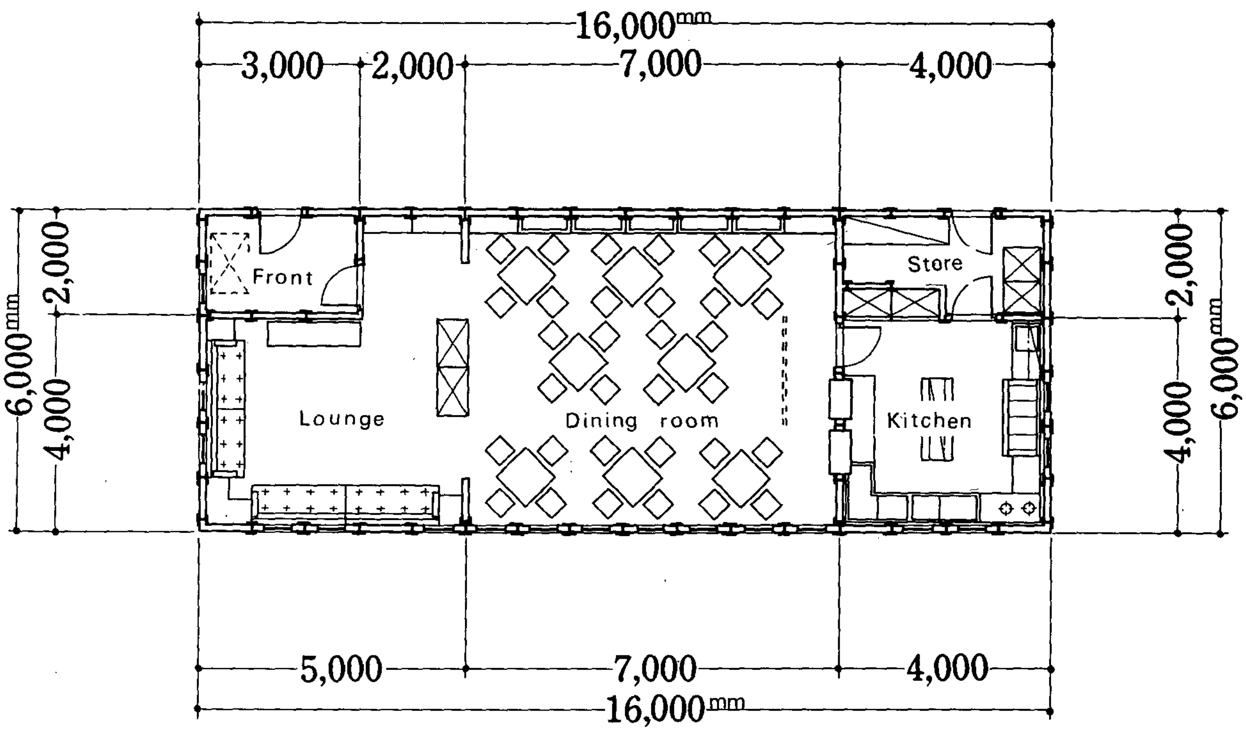

Fig. 7. Mess hall (Plan).

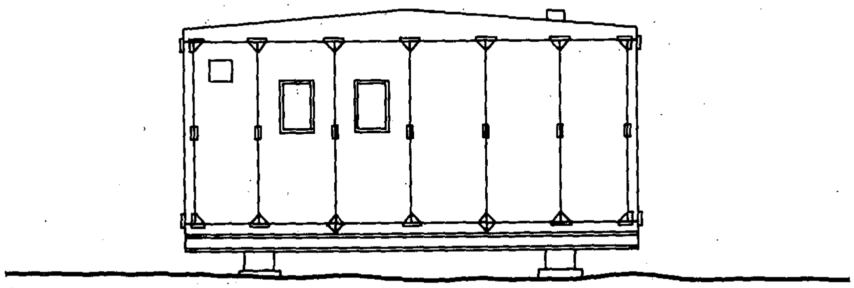

Fig. 8. Mess hall (Elevation).

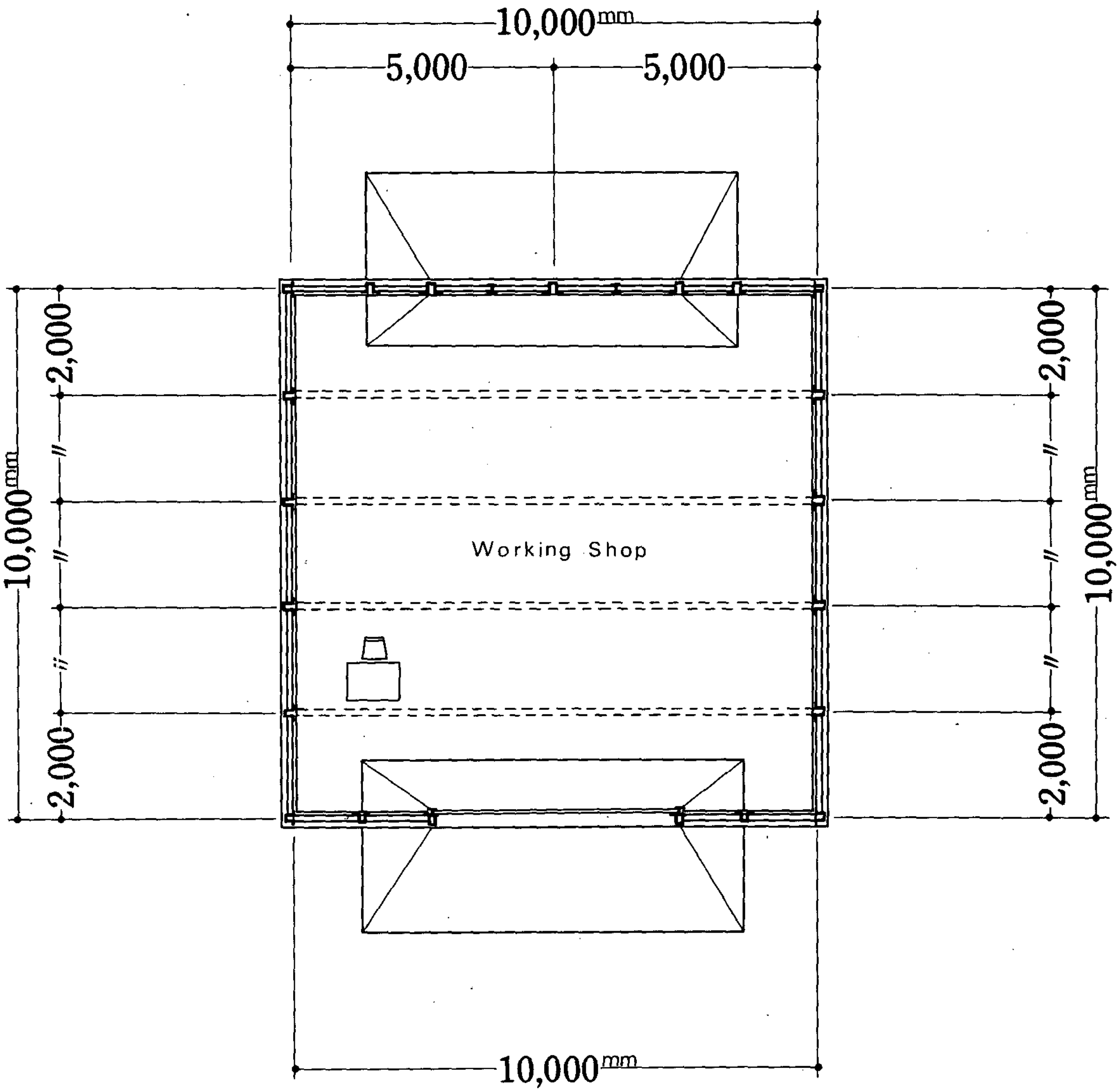

Fig. 9. Garage (Plan).

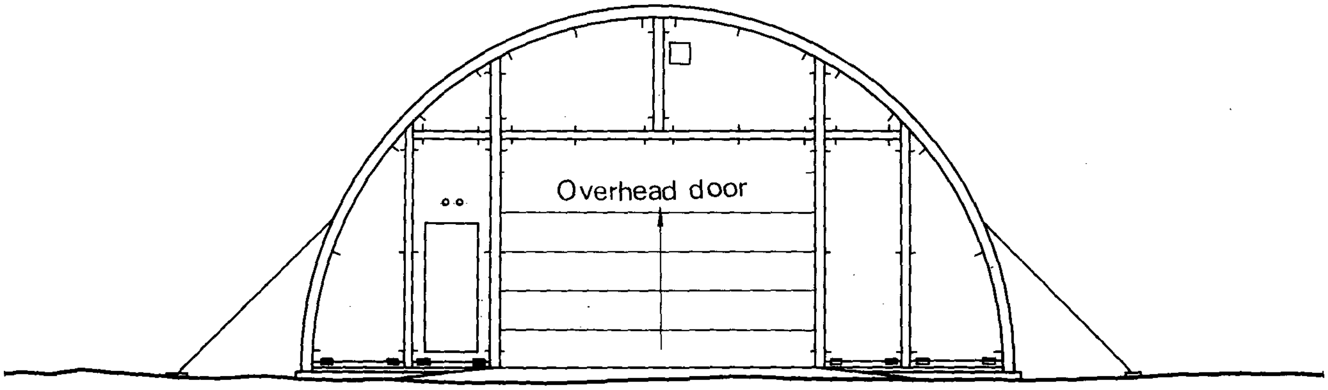

Fig. 10. Garage (Elevation).

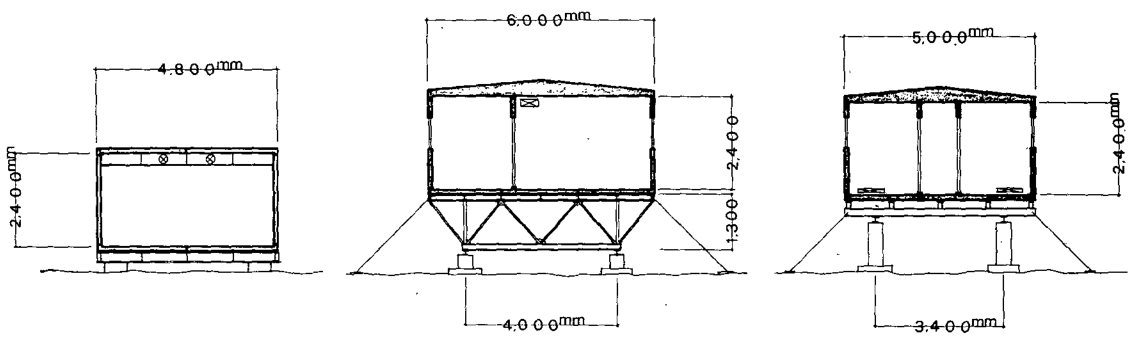

Fig. 11. Three types of buildings.
(A) Living hut (1957).
(B) Laboratory hut (1967).
(C) Living hut (1968).

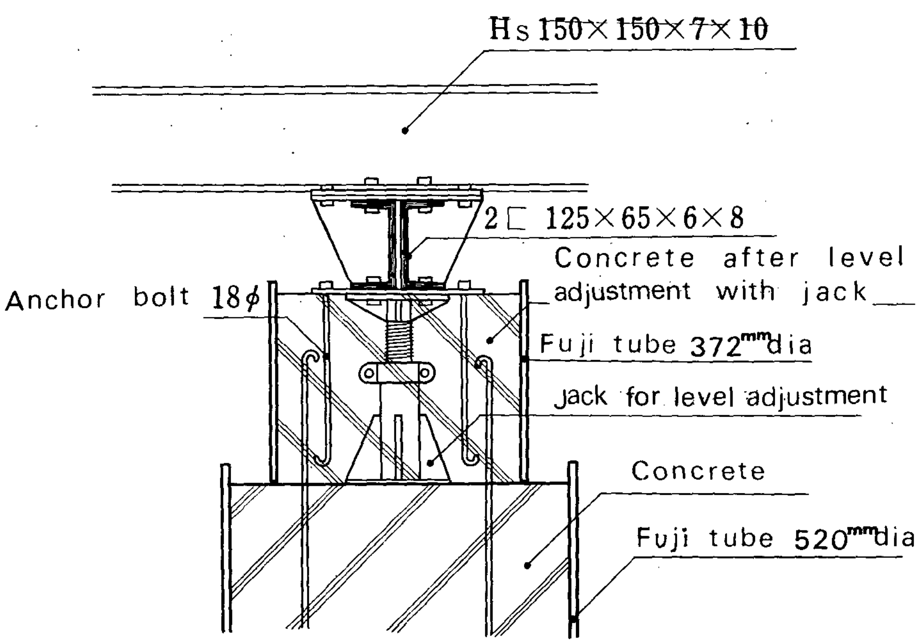

Fig. 12. Concrete pier in substucture.

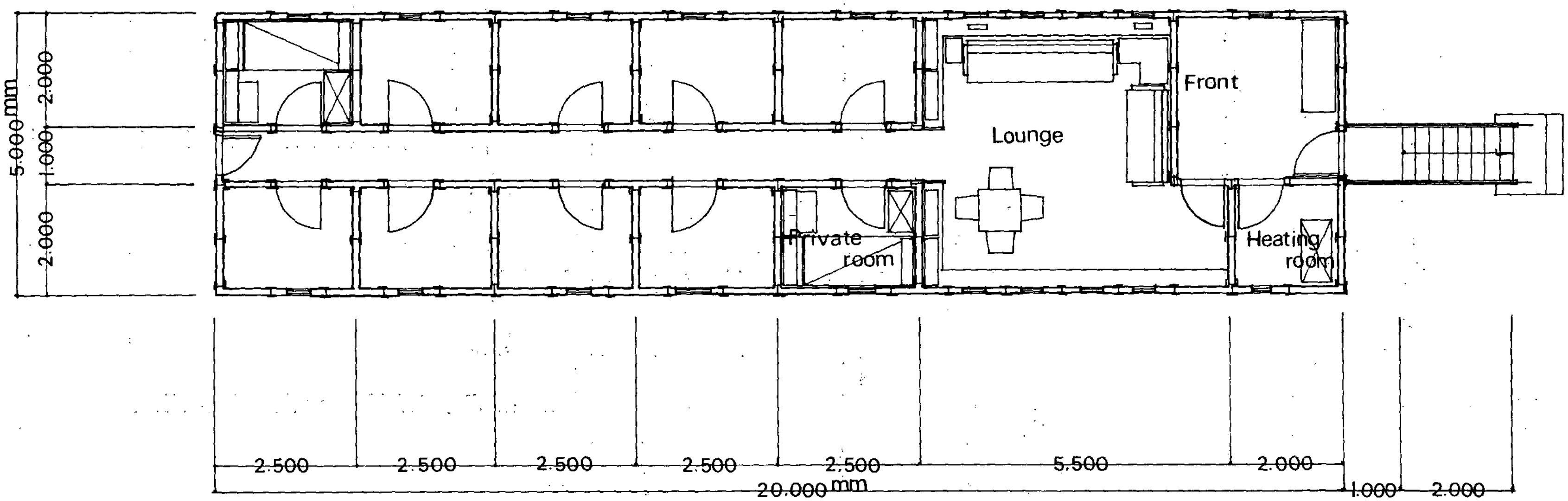

Fig. 13. Living hut (Plan).

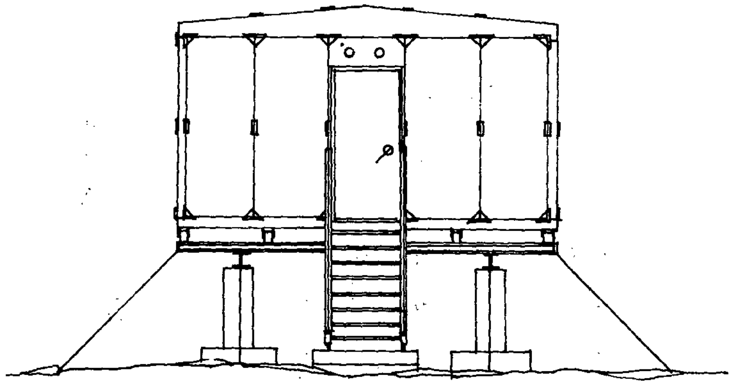

Fig. 14. Living hut (Elevation).

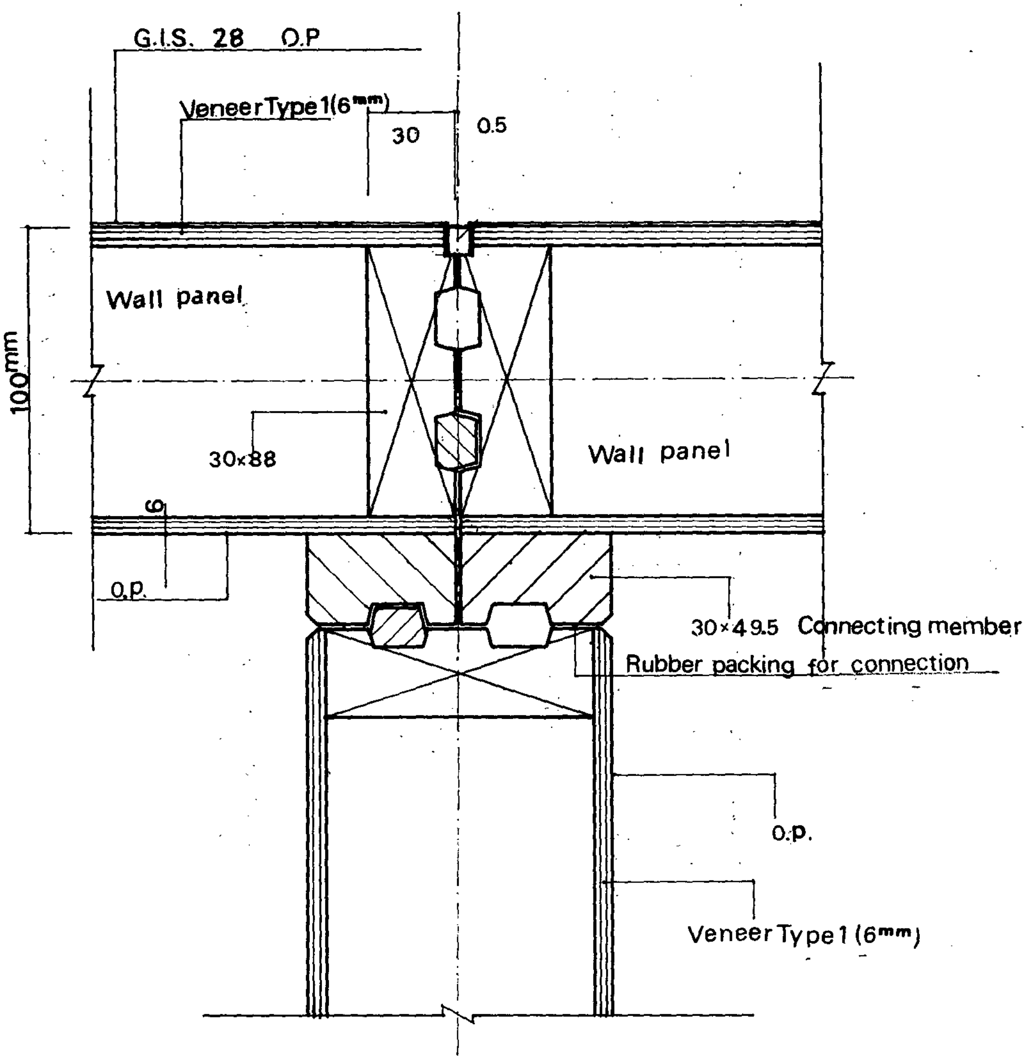

Fig. 15. T-type connection of panels (Living hut).

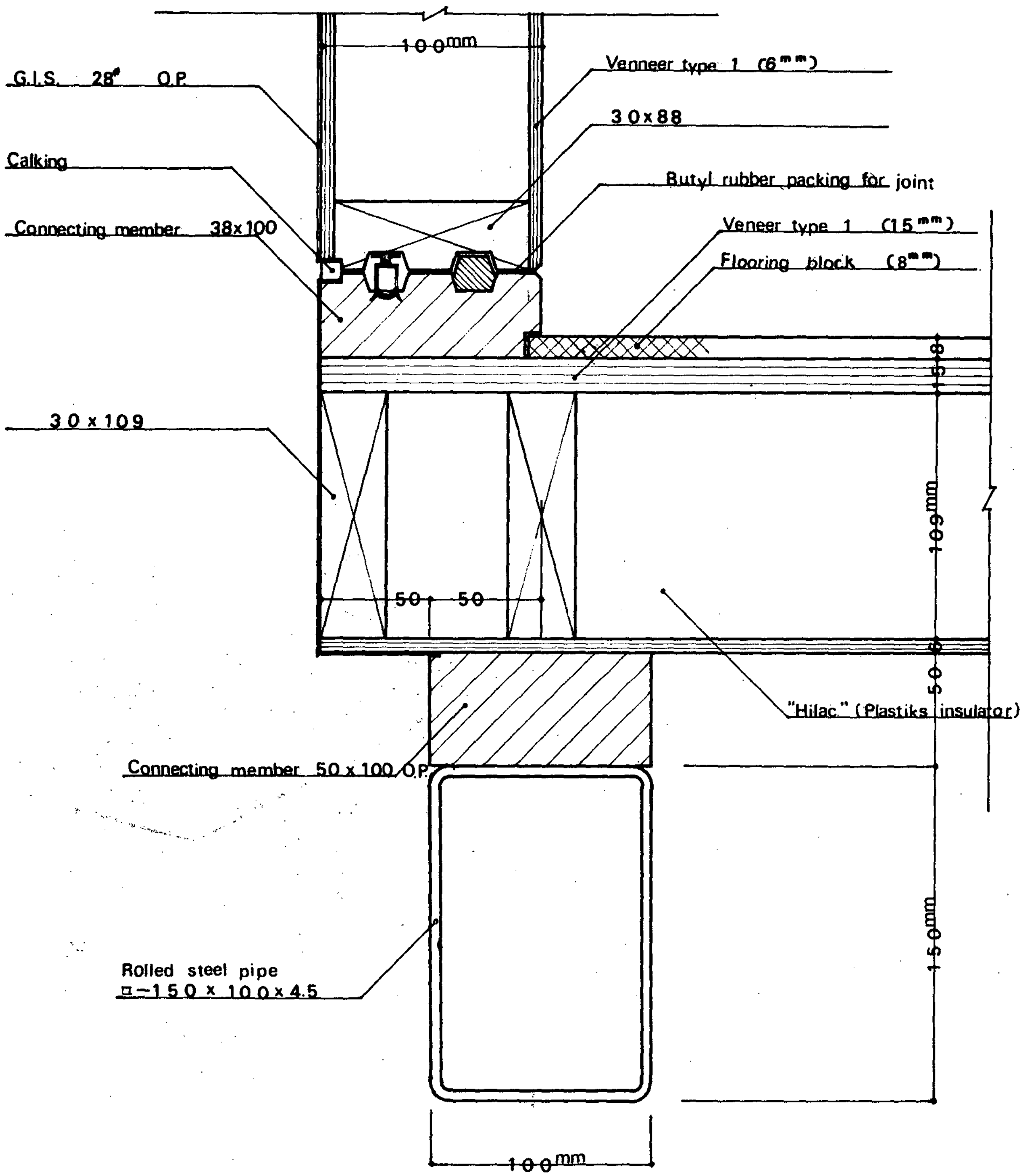

Fig. 16. Details of connection between floor panel and supstructure (Living hut).

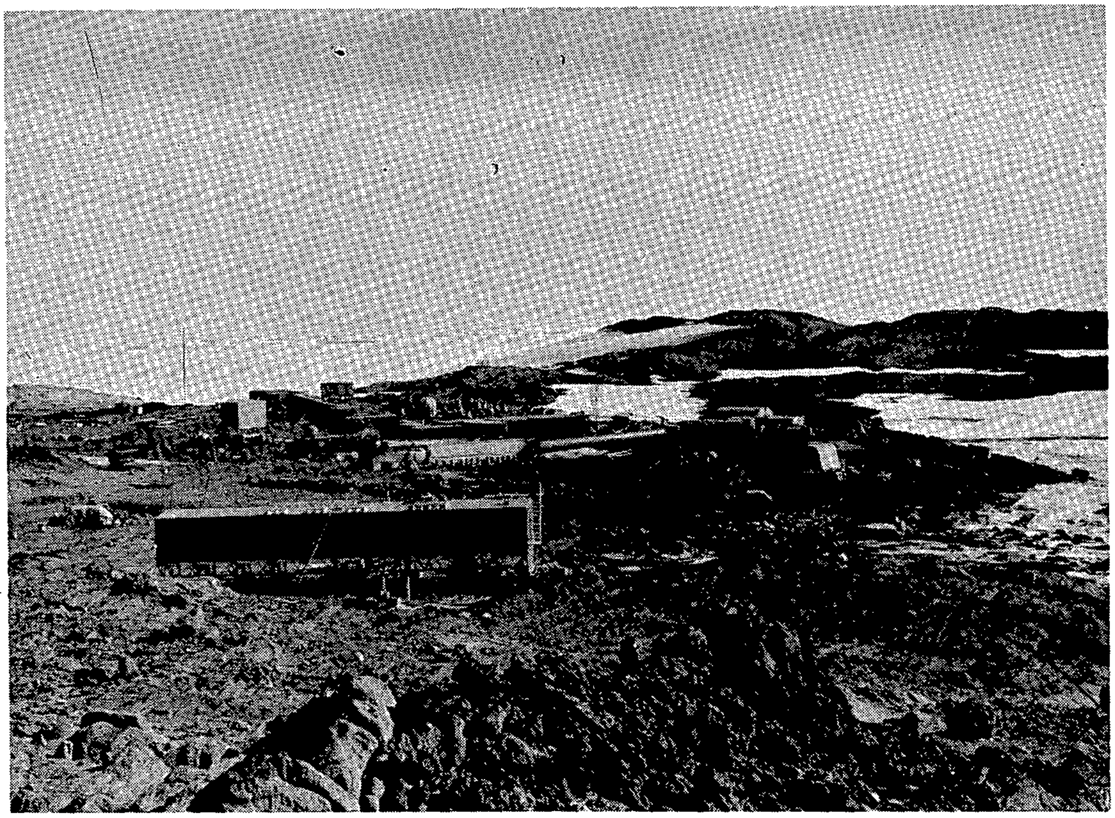

Photo 1. Syowa station. Laboratory hut in the foreground.

Photo 2. Inside view of mess hall.

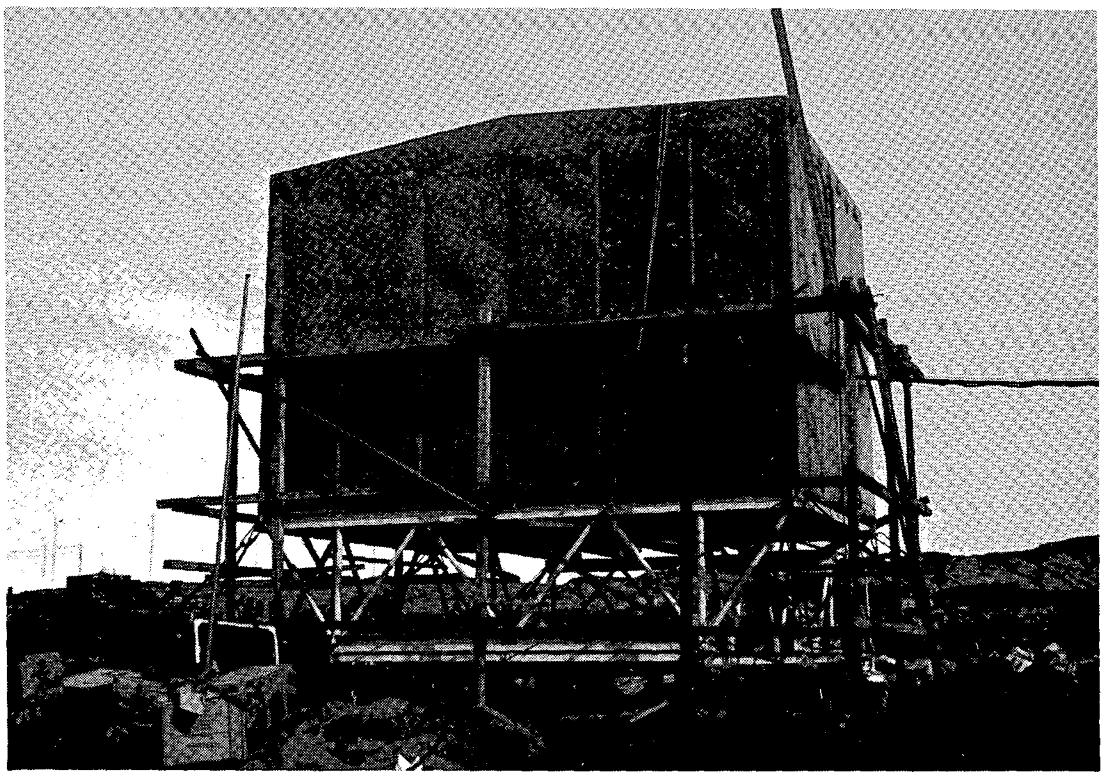

Photo 3. Balloon inflation shed.

Photo 4. Garage

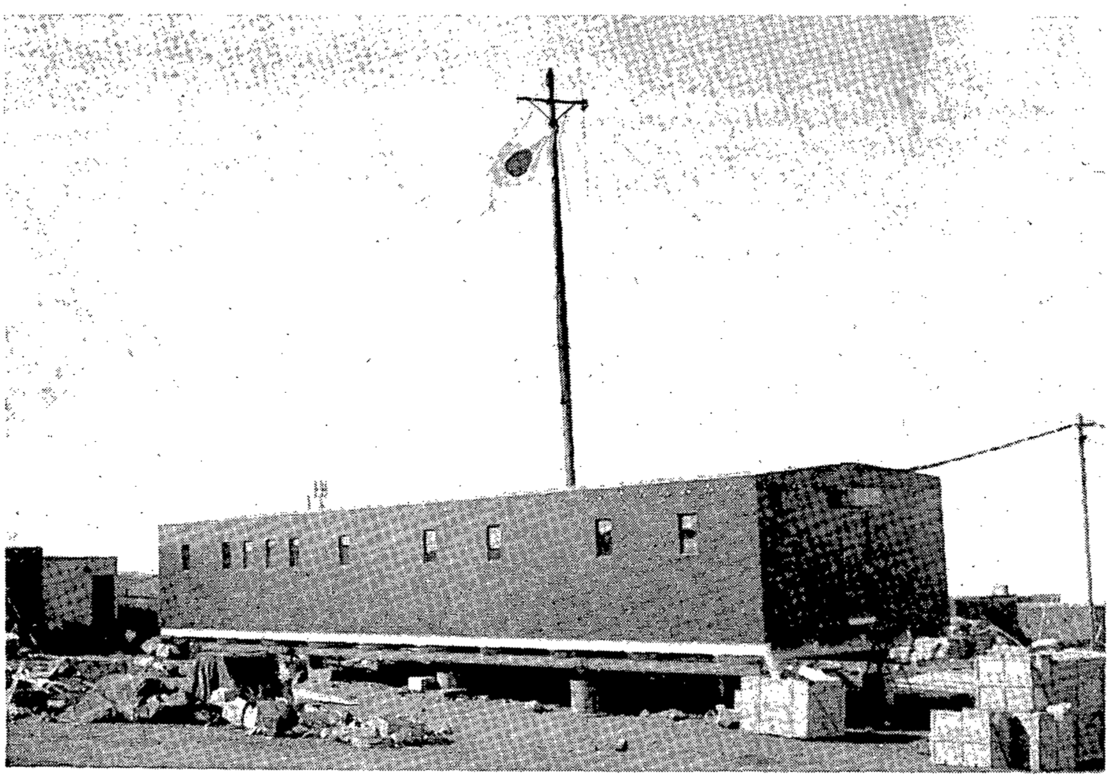

Photo 5. Living hut.

THE CONSTRUCTION OF SMALL SUMMER HUTS AND WANNIGANS

R. B. Thomson*

Simply constructed huts and wannigans have been found by New Zealand Expeditions to be inexpensive, adequate in every way and far superior to tents for most purposes particularly where laboratory space is required. These small buildings are in the main of bonded plywood construction and are not insulated. Huts are made from 8 ft x 4 ft sheets, ½" to 9/10" thick while the wanningans due to weight considerations are constructed from 6 ft. x 3 ft sheets, ¼" thickness.

It was not found necessary to insulate these huts for summer operation in the McMurdo Sound/Ross Island area. The external use of dark paint provides more than sufficient warmth from the prevalent sunshine to keep the huts well above freezing temperatures. In fact, it has been found necessary to provide additional ventilation in order to keep the interior temperature at a sufficiently low comfortable level.

Simple frame construction provides the means for securing the plywood panels. Joints are covered with wooden cover strip glued and screwed to ensure snow proofing. Similar methods are used to secure the roof panels to form a waterproof joint against snow melt water.

An escape hatch is provided in either one wall or the roof as a safety precaution against fire, or snow piling up and blocking the door. Hut foundations usually rest on railway sleepers, adequate steel wire tie-downs being provided to keep the hut secure.

The wanningans are usually mounted on Maudheim sledges, thus keeping the total load light to facilitate towing by light vehicles. Tie-downs are also provided to secure the wannigans when stationary.

Fire extinguishers are fitted to the interior and exterior walls (near the door) of these buildings. It is customary to have alternative shelter available, usually a small tent (not erected) placed some distance from the hut or wanningan as a precaution against destruction by fire.

Summary of Main Points, and Advantages of Huts and Wannigans over Tents

1. Less costly in initial outlay.
2. Little deterioration over considerable period of time.
3. More comfortable living for occupants - warmer and drier.
4. Increased head room provides better working facilities and easier

*Antarctic Division, D.S.I.R., New Zealand.

means of installation of scientific apparatus, cooking and heating equipment, etc.

5. Floor provides some insulation against frozen surface.

6. No time lost due to unpacking, erection, disassembly and packing as in the case of tents.

7. Can be left unattended for long periods and can be relied upon in cases of emergency for food and shelter.

PLANNING A BASE TO MINIMIZE MAN-MADE INTERFERENCE AND SITE CONTAMINATION

R.B. Thomson*

Many countries, due to the necessity of expediency, failed during their establishment of bases to plan against site contamination and minimize the ultimate effect man would have on the environment.

Prior to the establishment of a base in Antarctica, it is essential that all the scientific potential of the area be fully understood to allow planning of construction and location of logistic working areas to not disrupt the areas likely to be required for scientific investigation.

Areas of particular scientific interest should at an early stage be adequately marked and declared "scientific reserves" thus providing a means of preservation. Such action is particularly important where personnel of other nations are working within the same area and may not be aware of the locality of the specific areas of scientific interest.

During the summer of 1967 New Zealand constructed a small scientific base near Lake Vanda in the Wright Valley of Victoria Land. As a considerable part of the proposed scientific programme involved physical, geological, and chemical investigations of the area within, and close to, the area of the base, it was essential to plan against any contamination of the environment. Further, in order to provide ideal conditions and facilities for geophysical studies, particularly those requiring a 'quiet' site, no large electrical installation was permissible and restrictions were necessary to substantially limit the type, power output, and number of radio transmitting equipment.

In order to meet the above requirements the following policies were adopted:

1. Rubbish
   Strict tidiness regarding rubbish and litter. No rubbish to be thrown on the ground. All combustible rubbish must be disposed of through burning in a closed incinerator. Non-combustible rubbish to be placed in disposable bags and brought out to McMurdo Sound whenever transport available.

2. Drainage
   No drainage into the lake is permissible. The buildings were sited to permit drainage away from Lake Vanda. Drainage will be confined to a deep depression in no way connected with the lake.

* Antarctic Division, D.S.I.R., New Zealand.

3. <u>Human Waste</u>
An incinerator latrine (Page 197 Symposium on Logistics 1962) will be installed.

4. <u>Electrical (Radio) Noise</u>
   (a) Diesel electric generators installed in Antarctica invariably produce radiation of electrical noise which often seriously impedes scientific programmes, particularly projects requiring sensitive instruments recording in the low to high radio frequency ranges. To keep such interference to a minimum, Vanda Station is provided with a 12 volt D.C. supply. This is provided by a number of large capacity storage batteries which are kept charged by a number of high output (1.5 KW) to be supplemented by an isotopic powered thermo-electric generator.

   (b) The installation of transmitting equipment has been closely controlled. No high powered or broad band radio transmitters are permitted. This restriction includes pulse transmitters associated with ionosondes. At Vanda it is probable that an ionosonde receiver recorder only will be installed. This will receive pulses transmitted from the ionosonde at present installed at Scott Base.

5. <u>Sign Posting</u>
Sign posting of all areas of specific interest, particularly when it is not obvious investigations are being undertaken and where sites are reserved for future purposes.

6. <u>Transport</u>
A helicopter port and fuel dump were established 500 yards south of the base to minimize any possible interference.

CONSTRUCTION OF DWELLING AND OFFICIAL BUILDINGS AT MOLODEZHNAYA STATION

Representative of Soviet Union

Molodezhnaya Station, Alasheyev Bay, Enderby Land was established by the Soviet Antarctic Expedition in 1962. This region proved to be very convenient for building of a station. There are vast areas of outcrops, numerous fresh water lakes of different sizes, convenient landfalls and inland outlets. All these features contribute to the development of Molodezhnaya Station into a large-scale scientific observatory - center of the Soviet investigations in Antarctica.

The scientific observational complex of this station is being enlarged year after year. This fact naturally promotes increasing of scientific and subsidiary personnel, demanding the construction of dwelling and official buildings, scientific laboratories and stores.

For the long period of time the Soviet polar explorers have accumulated a great experience of the erection and maintenance of different buildings and constructions under the harsh climatic conditions of the sixth Continent. This experience has been completely used for established of Molodezhnaya Station.

Special attention was paid to the problem of snow drift burying the site for most of the year. At Mirnyy Observatory this problem was overcome in the first year.

Most buildings of the station were decided to erect on piles elevating them 1.5 to 2 meters above the surface. This decision has proved its value in practice: an aerodynamic current being formed beneath the buildings prevents drift formation.

The second problem of great importance deals with providing fire protection and prevention of dwelling and official quarters. During the construction of Molodezhnaya it was decided to give detailed attention to fire protection and prevention at the planning and design stage of the buildings and to use fire resistant materials.

Taking into consideration difficulties of building components and materials from the Soviet Union to Antarctica and the necessity to decrease the labour consuming character as much as possible, various materials were considered.

At Molodezhnaya Station the main dwelling and official buildings were made from "arbolite" plates - mixture of wood chips and cements. The "arbolite" plates were welded, their joints being packed with foam polyurethane. The new building material first used under the Antarctic conditions has proved its value in practice.

A comparison of temperature regimes within the buildings made of "arbolite" and wooden sheets gave the following results:
at an air temperature -26°C and a wind velocity up to 27m/sec, an air temperature within the building of "arbolite", ceiling height being 2.5m, was:

near the floor.....................................+13°C
at a level of 50cm from the floor................+18°C
at a level of 100cm from the floor...............+20°C
at a level of 150cm from the floor...............+21°C
and near the ceiling.............................+21°C

At the same time at an exterior air temperature -21°C and a wind velocity 26m/sec an interior air temperature within the building made of wooden sheets, was:

near the floor.....................................+ 3°C
at a level of 50cm from the floor................+ 8°C
at a level of 100cm from the floor...............+12°C
and near the ceiling.............................+16°C

Thus the buildings of "arbolite" better keep the heat than those of wooden sheets.

There are heated ablutions, heated lavatories, shower baths and special drying rooms for clothes in all the buildings made of "arbolite" material.

However, in spite of many positive qualities of "arbolite" it has some essential shortages: a great weight of panels, insufficient strength especially of thin panels and the necessity to use finishing work of a labour consuming character both outside and inside. Therefore, new type buildings of aluminium panels were decided to build. Foundations on piles, a steel carcass, and panels bolted to the carcass are the main components of the new type building construction. The building carcass consists of cross bearing frames and longitudinal beams made of standard profiles. The panels bolted to the carcass consist of three layered aluminium alloy sheets, insulated with a material like polystyrene and faced with bakelite plywood. The aluminium sheet and the insulating layer are 1.5 mm and 150 mm thick, respectively. The total weight of these panels depending on their purposes is 100 to 300 kg. The building made of such panels can withstand an air temperature of minus 50°C and a wind velocity of 50 m/sec. This construction withstands a snow cover weighing up to 200 kg/m^2.

The main dimentions of a dwelling are:

rentable space	316 m^2
living space	178 m^2

auxiliary space	138 m^2
building site space	345 m^2
construction volume	1280 m^2
total construction weight, except foundation weight	80 tons
seven rooms of an area	15 m^2 each
one room	10 m^2
mess room	40 m^2
library	15 m^2
kitchen	15 m^2
auxiliary room	11 m^2
food store	15 m^2
lavatory with a washing set	5 m^2
shower bath and laundry	10 m^2
surgery	10 m^2
cloak room	14 m^2
drying room	5 m^2
switch board room	2 m^2
ventilation room	10 m^2
store room	2 m^2

Power heating and cold water are supplied from the outside electro-power and heating from a diesel power station and water from one of the lakes situated in the station area.

The aluminium panels are very convenient in transportation and they are not needed an external trimming up but it is necessary to insulate the aluminium sheets and steel components by means of a special insulating tape. The building floors made of wooden shaving plates or bakelite plywood are laid down on the wooden logs and covered with linoleum.

A number of such buildings of different purposes/including receiving and transmitting radio-station buildings/ are proposed to be erected at Molodezhnaya station. The building construction permits to consolidate/unite/ several buildings. This block consists of living quarters, different scientific laboratories, a meteorological station, surgeries and etc.

In 1968 an automatized diesel power station was built at Molodezhnaya. Its power is 1400 kwt. Its building was also erected from the aluminium sheets bolted to the steel carcass.

In 1969 two buildings of a dwelling and a radio station will be completed. At present a store-building / 12 x 24 m and 4 meters in height, is being erected from "silicalcite" blocks. "Silicalcite" as a building material is also used in the Antarctic conditions for the first time. A comparatively low weight, convenience in transportation and prefabrication low cost in comparison with the aluminium panels make this material promissing in the erection of auxiliary constructions.

Thus, Molodezhnaya station is used as an experimental base where the investigations on the behaviour of various building materials under the antarctic conditions are conducted. At present the main station buildings occupy an area of approximately 1 km^2. There are twenty-two buildings of different purposes built from different materials on this site, including:

two living houses from wooden sheets (there are also scientific laboratories, a radio station and a meteorological station attached);
two official prefabricated sheets buildings, the sheets being composed from two-layered bakelite plywood, insulated with a material like polystyrene;
one mess room from "arbolite";
two wooden food stores;
four wooden stores;
one wooden building of the former power station;
one aluminium panel building of the new power station;
four aerological wooden buildings;
one wooden building of a magnetic pavilion;

Furthermore two building foundations were laid and carcasses erected from the aluminium panels/a dwelling and a radio station/ and a store building was built from "silicalcite" blocks. The refrigerated food store was built by a method of well shooting in the rock, the interior air temperature being negative, permanent and equable.

In future the construction of a structural unit for the atmospheric rocket soundings is proposed to build.

Thus, Molodezhnaya Station is gradually being deweloped into a well equipped complex scientific observatory. Presently on the average 4 m^2 of living space is per capita, a ceiling height being approximately 2.5 m. Next year with putting into operation a dwelling and radio station from aluminium panels the life and work conditions of polar explorers will be considerably improved at the station.

CONSTRUCTION OF FUEL OIL TANKS IN MIRNYY OBSERVATORY AND MOLODEZHNAYA STATION, A N T A R C T I C A

Representative of Soviet Union

The technological aids of the Antarctic expeditions consume a large quantity of various fuels. Without sufficient and timely supply of diesel fuel, gasoline, jet aircraft fuel and aviation gasoline it would be impossible to heat buildings and generate power, to cook the meals and propel vehicles, to melt snow and ice for fresh water and fly aircraft.

Until 1966 The Soviet Antarctic Expedition shipped the fuel to its Antarctic stations in steel barrels, the number of which grew from year to year, and in the last years it equaled 6,000.

The difficulties that are inherent to unloading and storage of such large numbers of barrels as well as the widening of power sources of the Soviet Antarctic stations have led to the necessity of construction of the stationary fuel oil bases in Mirnyy Observatory and at Molodezhnaya Station. Rouleau reservoirs with 700 and 1,000 m^3 capacity were adopted as fuel oil tanks. Even surfaces, that should be prepared specially, are necessary for the erection of such tanks. Obviously, these tanks can be installed neither on the glacier nor on the moraine. And since Mirnyy nunataks are of small area, the erection of the tanks posed certain problems. The site for the storage of the main large quantity of the fuel was chosen on Stroiteley Island near Mirnyy. The tanks with one-year supply of diesel oil and aviation gasoline were erected on the hills within the Mirnyy territory on Komsomolskaya Sopka and Morennaya Sopka.

The preparatory work to make the site ready for reservoir erection at Mirnyy was begun at 1964. The base for the storage of 4,000 m^3 of fuel oil had been completed by January, 1966.

At Molodezhnaya Station the problem of site selection for the fuel reservoirs was solved without complications, since there are large areas of rock surface free from ice there. The fuel reservoirs were installed on the coast of Vozrozhdeniya Bay, the site is convenient for tanker unloading.

Here the site preparation was begun in 1965 and by February, 1966 the base for the storing of almost 6,500 m^3 of fuel oil at Molodezhnaya Station had been completed.

The practice of the construction of these fuel bases proved quite effective being adequately convenient for transportation and erection even in such difficult conditions as those found in Antarctica.

Rouleau reservoirs ready for fuel acceptance represent cylinders welded to the bottom and covered by a special cap with mounted air valves, manholes and measuring units in it. The size of the cylinder depends on its capacity and climatic characteristics of the area of installation. For instance, in Antarctica it is reasonable to diminish the height of the reservoirs on account of their diameter, in order to increase their security from the wind. The height of the reservoir with 1,000 m^3 capacity is 4,470 mm and the diameter is 17,170 mm. The sides of the cylinder for the convenience of transportation and erection welded from separate steel sheets, 6 mm thick each are rolled up like a rouleau with a diameter of only 3 meters. Inside this rouleau there is a special tube which serves as a central pole that holds the whole cylinder. When the tank is being erected, this tube is filled with sand or stones to give better stability to the whole installation. The bottom of the reservoir also welded in a steel sheet is rolled up on the main rouleau. The roof is transported as separate trapezium-like sectors, packed in parcels.

The successive order of erection and installation of the reservoir is the following: the prepared ground area is covered with the layer of sand and broken brick which is in turn covered by a layer of melted bitumen to serve for hydroinsulation. Then the bottom of the reservoir is placed on it by means of a special joint device. The sides of the cylinder are raised vartical by tractors. The rouleau is swung open by tractors also, simultaneously the lower part of the cylinder is being welded to the marked on the bottom perimeter. The central tube is installed in the centre of the bottom, at the top of this tube the derrick of a small crane is fixed to raise and put the sectors of the roof on their places. The welding finished, the reservoir is filled in with water, the strength and impenetrability being tested. The admission and bleeder valves are in the lower part of the cylinder, not far from the bottom.

For more convenient charging the special distribution boxes are connected by hoses with charging "pistols". The fuel to the power stations moves by gravity. First it comes to the fuel oil settling tanks and then the fuel goes to the diesels.

The Soviet tanker "Fridrich Engels" approached the Antarctic continent in March, 1966 for the first time. She brought 10,000 tons of various fuel oil. The first unloading stop was the fuel base at Molodezhnaya Station. By the time of ship arrival the roadstead of the station was free from ice and the tanker was able to come up to the coast, where the reservoirs are. Two flexible hoses from the tanker were connected with the fuel oil filling system on the coast, thus two kinds of fuel were possible to pour off to the coast. The speed of reservoir filling being 100 tons per hour, 2,400 tons of fuel was poured off during the first 24 hours.

Completing the filling of the Molodezhnaya reservoirs the tanker proceeded to Mirnyy.

The tanker unloading in Mirnyy was accomplished under more difficult conditions than in Molodezhnaya. Coastal cliffs of Stroiteley Island and small depths near it made the tanker approach to the main fuel oil reservoirs impossible. From the practice of the last operations the ship anchoring in the roadstead of Mirnyy was known to be also impossible as the bottom of the Davis Sea in this area presents the rocky surface. The only possible way left was to moor the bow of the tanker to the ice edge of the continent near Mirnyy and to connect the tanker with the reservoirs by the flexible floating hoses through the water distance of 800 m. The tanker was standing near the ice edge, resting its stem against it and slowly turning the screw. The floating hose was lowered to the water from board the ship, by means of the cutter the hose was stretched to the island and connected with the coastal fuel oil filling system. The second hose was stretched onto the barrier, it poured the fuel off to the coastal tanks on Komsomolskaya and Morennaya Sopkas. The hose that went through the water was constantly under the careful observation of the people on the cutter as the ice floes presents a certain danger to it. In such a way all the oil fuel reservoirs were filled in and Mirnyy Observatory was provided with fuel oil for the period of three years.

The erection and implementation of fuel bases in Mirnyy and Molodezhnaya stations permitted to give up the annual supply of barrels with diesel oil, gasoline and jet aircraft fuel to these stations.

The total capacity of the fuel base is planned approximately for the 3-year period, the quantity of fuel oil of various types is sufficient for the growing of the stations and construction of larger power stations.

If need arises the expeditional ships also may refuel at the fuel bases at Molodezhnaya. The next voyage of the tanker with fuel supplies for Molodezhnaya and Mirnyy bases is planned in 1969.

CONSTRUCTION CONCEPTS FOR CAMPS ON PERMANENT ICE CAPS

F. W. Brier* and E. H. Moser*

Abstract

Conventional shelter concepts and criteria for temperate climates are not readily adaptable to the snow- and ice-covered polor regions. In recent years, many new design concepts have been hypothesized for camps and stations in these regions but only a limited number have been actually used. All of these concepts are variations of three general types of stations: below-grade, at-grade, and above-grade.

This paper discusses the development of various design concepts for antarctic stations and the advantages and disadvantages of each. The major problem is the perpetual accumulation of snow; any design concept must take this into account. One version of the below-grade concept is Byrd Station, Antarctica. It was hoped that by building the station under the surface, snow accumulation would not adversely affect logistics and camp maintenance. It turned out, however, that burial of the access tunnels, the overburden of accumulated snow, and excessive tunnel temperatures have created serious problems. Several versions of the at-grade concept have been tried in Antarctica; Amundsen-Scott South Pole Station and Williams Field are two examples. Both have experience excessive snow accumulation. Pole Station has accumulated such large quantities of drifting snow that the buildings are completely covered. This problem has been avoided at Williams Field by moving this camp every 2 or 3 years. In the above-grade concept, the buildings are elevated on a snow platform or on columns. Within limits, this increases the useful life of the station, but it introduces high construction and maintenance costs. Also, it does not entirely prevent the accumulation of drifting snow.

Any one of these design concepts can be used advantageously for specific conditions. Design criteria, such as annual snow accumulation, population, station design life, and function must be used to determine which concept is best suited for a camp or station in Antarctica.

Introduction

Modern, comfortable camps are essential to good morale and high productivity for personnel living in polar regions. This is particularly true of camps on the permanent ice cap of Antarctica where the occupants are isolated for long periods, recreational facilities are limited, and scientific exploration has replaced high adventure. Many concepts have been hypothesized for camps on permanent ice caps, but few have met the general design and con-

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struction requirements. Of these camp concepts, only a limited number have been actually used by the United States in Antarctica. All have been variations on the three general types of camps for permanent ice cap locations: below-grade, where the camp is located under the surface; at-grade, where the camp is located on the surface; and, above-grade, where the camp is elevated above the surface.

This paper presents the general requirements that control the design and construction of camps on permanent ice caps and discusses the need to better define and apply these requirements in future camp designs to simplify construction, improve comfort, and reduce operation and maintenance costs. This paper also discusses the 1956-57 United States stations established on permanent ice for the International Geophysical Year (IGY) and the advanced-camp designs used on permanent ice caps since that time. These include the new below-grade camp at Byrd Station, Antarctica, the new at-grade camp at Plateau Station, Antarctica, and the above-grade camps at the DYE sites in Greenland.

General Requirements

Scientific function, remote location, adverse climate, and natural processes necessitate design and construction considerations for camps on the permanent ice cap of Antarctica that differ distinctly from those for temperature climates.[1] A number of general requirements that control the design and construction of these camps have been delineated and applied in recent years. Others are developing through experience and a better understanding of the antarctic regions; these will be defined and applied as they are developed. The present general requirements that must be satisfied for camps on permanent ice caps are:

Function. All United States stations in Antarctica are established for scientific research or logistical support of scientific research. Consequently, the concept for the camps at these stations must not interfere with the basic function.

Climatic Conditions. Adverse weather must be considered for all camp concepts on the permanent ice cap of Antarctica. While specific locations control the degree of severity, temperatures as low as -120°F, winds in excess of 100 knots, and annual snowdrift accumulation up to several feet deep occur in some locations.

Construction Season. Because of the extremely adverse weather in Antarctica, and almost continuous darkness in winter, the construction season at most locations is limited to about 4 months during the austral summer.

Construction Team. The construction teams for new camps in the interior of Antarctica must be limited by the support required for their deployment but large enough to be efficient and effective.

Air Transport. Shelters for inland camps must be composed of lightweight compact components for economical air transport to the construction site. In addition, the building components must be capable of withstanding rough handling during shipment.

Prefabricated Shelters. Where possible, prefabricated shelters or shelter components must be used for antarctic camps because of the lack of building materials and fabrication shops in Antarctica.

Easy Erection. The need for composite construction teams with a minimum of skilled craftsmen, and the need for heavy gloves or mittens even during the summer construction season require that structures for antarctic camps be designed for easy and rapid erection with a minimum of unsophisticated tools. Also, simple design details and construction techniques must be used where possible to simplify field work.

Easy Disassembly. Antarctic stations are often established for short-duration usage; the United States Plateau and Eights Stations are two examples. For reuse at other locations, the shelters at limited-duration stations also must be designed for easy disassembly and shipment.

Fire Safety. Because of the low humidity and lack of standard fire-fighting equipment at most locations, all antarctic camps must be constructed of fire-resistant material.

Below-grade Camps

In 1911, Amundsen built a base on the Ross Ice Shelf near the Bay of Whales. He used at-grade wooden huts for living quarters and below-grade storage chambers and connecting corridors dug out of the snow.[2] With this venture, below-grade "burrowing" was started in Antarctica for use as semi-permanent shelters.

Since then, three large below-grade stations have been established in the polar regions: Camp Fistclench and Camp Century in Greenland, and New Byrd Station in Antarctica. All three of these below-grade camps used the same basic design concept - a network of roofed cut-and-cover trenches, some to shelter buildings and others for storage chambers.

New Byrd Station was built in 1960-61 to replace the 1957 IGY at-grade camp at this location; it is the newest of the large undersnow stations. The camp consists of a network of shallow tunnels which were constructed by excavating trenches with a Swiss Peter snowplow (Figure 1). After excavation, they were roofed with corrugated-steel arches, and covered by backfilling with processed Peter snow. The freestanding buildings used in these tunnels were Army T5 prefabricated panelized shelters designed to withstand heavy wind and snow loads.

Minimizing environmental conditions is the principal advantage of a below-grade camp. It provides complete weather protection for the occupants and permits the use of lightweight freestanding shelters of minimum structural design for housing the camp personnel and facilities. No-wind conditions and minimum temperature changes result in decreased fuel consumption for this type of camp - an important logistic and economic factor at Byrd Station, where all fuel must be imported by air.

The problems associated with drifting snow in at-grade stations are minimized in below-grade camps. The drift-free condition between the buildings permits easy access to all parts of an undersnow station. Below-grade construction, however, does not eliminate all snowdrift accumulation problems; access tunnels and exists must be kept free of drifting snow (Figure 2).

Compared with at-grade camps, undersnow stations are expensive and time consuming to construct. Experience at Byrd Station also shows some inherent disadvantages and expensive maintenance problems. These include plastic deformation, or creep, of the snow tunnels[3] (Figure 3), restricted work areas around buildings, surface venting of waste heat and exhaust gases, limited emergency exists, burial of access tunnels, and the requirement for scientific surface structures.

Because the rate of snow deformation is temperature dependent, during design, a maximum operating tunnel air temperature of 0°F was selected for Byrd Station to minimize tunnel creep. Exhaust fans are used to vent warm air from the tunnels to the surface. Because of continual accumulation of snow over the tunnels, the exhaust ducts require periodic extension, which increases pressure drop and reduces the volume of warm air moved to the outside. This, coupled with other factors, has resulted in average summer temperatures in the tunnels as high as 18°F, and accelerated deformation of the tunnels.

Trimming excess snow from the tunnels has been used with limited success to counteract this deformation. Trimming is hampered by the electrical wiring and plumbing located along the walls, and the narrow clearance between these walls and the buildings in the tunnels. The corrugated-steel roof-arch system, which was used to construct the snow roof over the tunnels, is also deforming under creep. Trimming the overhead snow to counteract this deformation is impossible because of the steel arches.

Freestanding shelters housed in below-grade tunnels exist in an environment free of wind. Lightweight, well-insulated, airtight shelters designed for minimum wind and roof loads should be used in undersnow camps. The use of such shelters at Byrd Station in place of the heavy, expensive T5 structures would have resulted in economic savings during the establishment of this camp.

At-grade Camps

Large-scale construction of at-grade camps in Antarctica by the United States began with establishment of IGY stations in 1956 and 1957. Four IGY stations were built by the U. S. Navy on the permanent ice cap of Antarctica. These were Little America V, Ellsworth, Byrd, and Amundsen-Scott South Pole Stations. The general construction concept was identical at all four stations - prefabricated buildings were grouped on the surface and interconnected by timber-framed corridors sheeted with wire netting and burlap.[2] Towers for auroral studies, which had to be free from snow accumulation, were elevated on columns. The construction materials were transported to Little America and Ellsworth by ship, to Byrd by tractor-train, and to Souch Pole by air. At the time, supplying the South Pole Station by air was a great feat.

The principal advantages of at-grade camps is complete mobility of material during construction, ease of erection, and a minimum of site preparation. In contrast to other concepts, at-grade camps require no excavations or costly foundation systems.

The principal disadvantage of at-grade camps is snow accumulation which results in their complete burial with time (Figure 4). All four of the United States IGY stations built in 1956 and 1957 were difficult to use after 2 years and completely buried in snow after 4 years. Eventually, all surface camps must be abandoned or moved because of burial.

Several techniques are available to alleviate snowdrift problems in at-grade camps. One is arrangement and orientation of buildings to control the deposit of snowdrift. This technique will extend the useful life of an at-grade camp but it will not prevent its burial with time. Another technique is the use of skid-mounted buildings which can be relocated when required for easy access and use. This technique is a more positive solution to the snowdrift problem; it requires less labor to relocate skid-mounted buildings than it does to keep stationary buildings free of drift.

The newest and most conceptually advanced United States at-grade camp in Antarctica is Plateau Station (Figure 5). This Station was established during the austral summer of 1965 to function as a scientific station and to provide logistical support for the Queen Maud Land traverse. The design of this camp was based on the general requirements presented in this paper for camps on permanent ice, including the extremely short construction season because of extreme cold at the 11,890-foot camp elevation and the 600-mile distance from Pole Station. The small station size - eight winterover personnel - permitted a single-building concept for the main camp structure. This structure is composed of four premanufactured vans, which emphasized ease of field assembly.

The vans were prefabricated of wood frames and plywood walls. The outside was covered with sheet aluminum, and the walls were insulated with 3-inch-thick rigid polyurethane insulation. To reduce thermal conductivity, no through connection was made between the outside and inside walls. For air transport by LC-130F Hercules aircraft (Figure 6), the vans were limited in size to 8 feet 6 inches in width, 8 feet 6 inches in height, and 36 feet in length, and a maximum weight of 23,000 pounds.

A special off-loading platform was used to unload the vans at the construction site. Each van was skidded from the aircraft onto the platform and moved into position, where it was skidded directly onto a timber foundation. All vans withstood the various moves between the manufacturer's plant and the timber foundation without damage to the structures or their fittings.[4] The entire Station was easily and quickly erected under extremely cold summer conditions in less than 4 weeks, including the installation of two 25,000-gallon fuel storage bladders and piping. For free flow when the temperature falls below -65°F, the fuel in these bladders is circulated through a heat exchanger connected to the generator engine coolant system.

In addition to the main building, an emergency camp is available in the event of fire or fuel loss; it also provides accommodations for additional summer support personnel. The emergency camp is located 1,000 feet from the main building. It consists of an interconnected 8- by 32-foot van containing a generator set, snowmelter, water heater, galley and bathroom, and a 16- by 32-foot Jamesway quarters building.

A total-energy concept for the mechanical-electrical system was utilized at Plateau Station. Normally, diesel generators use approximately one-third of the heat energy created by the burning of fuel. The total-energy concept reclaims about 40% of this waste heat by passing the engine coolant through a liquid-to-liquid heat exchanger.

An inspection of the Station in January 1968, or 2 years after construction, revealed that, in general, the main building was in good condition. Signs of wear and deterioration were present, but this is to be expected after 2 years of constant occupancy under extreme climatic conditions. The design concept of compact prefabricated vans is very effective for this type of polar camp; no air leaks have occurred and the main building is as comfortable and warm as the day it was first occupied.

Above-grade Camps

Above-grade buildings on columns or snow platforms can be used advantageously when the camp must remain above the surface to fulfill its function. Although no completely elevated above-grade camps have been built in Antarctica, this concept has been tried and proven in the Arctic.

In 1960, two above-grade radar stations were built on the Greenland Ice Cap. These stations, designated as DYE II and DYE III, are contained in single, 5-story-high, composite buildings.[2] Each composite building, which includes all of the equipment and space required for the station function, was constructed on steel columns 19 feet above the snow surface. Jacking equipment permits each building to be raised about 3 feet each year to maintain this clearance as snow accumulates on the surface. As shown in Figure 7, the elevating columns project above the roof of the composite building; prefabricated extensions can be installed on the top of the columns as needed.[5]

A conceptual study for an above-grade station at the South Pole[6] was based on the elevated stations in Greenland. Although this type of camp decreases drift accumulation, it has several major disadvantages. These include high construction costs, long construction time, maximum exposure to the environment, and vertical lifting of personnel and camp supplies. Also, at-grade or below-grade facilities are required for heavy support equipment and, in Antarctica, for certain scientific investigations.

Some special above-grade buildings have been used in Antarctica. At Byrd Station, the aurora tower, balloon pavilion, and rawin dome are elevated about 10 feet above the snow surface on extendable columns. These buildings must be kept free of drift to fulfill their function.

A new approach to the above-grade concept has been successfully tested near the 250-man camp at Williams Field, where an elevated camp on columns is impractical even if the useful life is greatly increased. The new approach utilizes an elevated-compacted-snow platform of limited height. Such a platform remains fairly free of drifting snow until the surrounding snow surface rises to the height of the platform. The snow-platform concept is ideal for a camp of skid-mounted buildings which can be easily moved when drifting snow becomes a problem. Although the snow-platform concept will not yield the prolonged life possible with extendable columns, it does increase the useful life of buildings, and simplifies their serviceability.

Summary

Considerable knowledge is now available on the requirements for camps on permanent ice caps. Also, many of the limitations and problems associated with the construction, operation, and maintenance of below-grade, at-grade, and above-grade camps are well known. However, little is known about natural processes, such as drift accumulation, snow creep, and surface movement that affect camps in Antarctica; consequently, until recently, they have received little consideration during design.

Present knowledge of construction and maintenance problems for camps on permanent ice caps does permit selection of the most appropriate design concept for specific environmental and construction conditions. A number of recent advancements, such as the total-energy concept at Plateau Station, can be applied advantageously to any camp, whether it be below-, at-, or above-grade. Others, such as the premanufactured vans at Plateau Station and the elevated snow platform at Williams Field, can be used to simplify the problems associated with at-grade camps.

The designers of new camps for Antarctica must keep an open mind when selecting the basic concept for a specific camp. Continued improvement and advancement of polar camp technology requires continual application of new materials and techniques for the solution of old problems.

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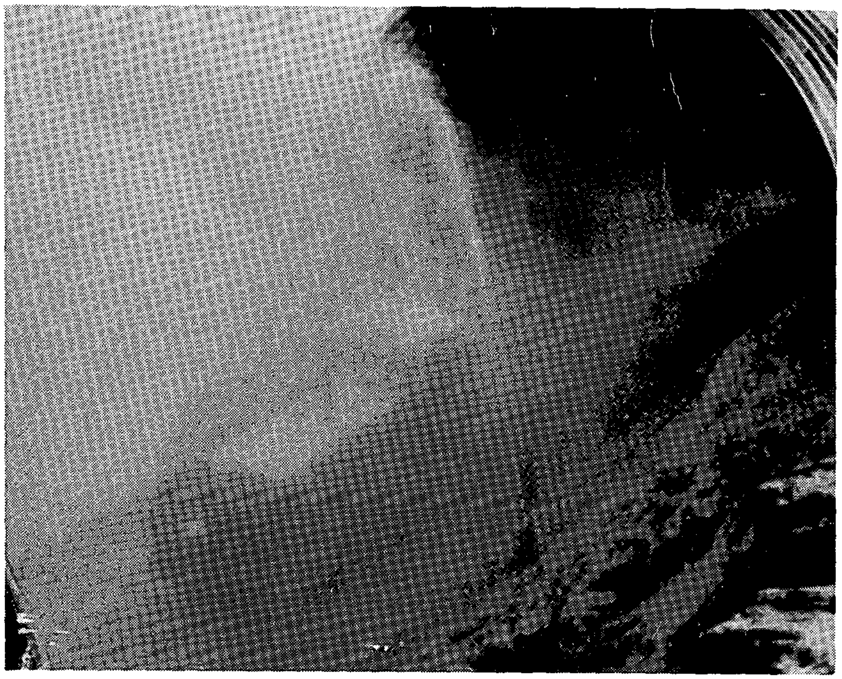

Fig. 1. Swiss Peter snowplow excavating trench.

Fig. 2. Entrance ramp to Byrd Station as seen from surface.

Fig. 3. Tunnel deformation of surface-ramp entrance.

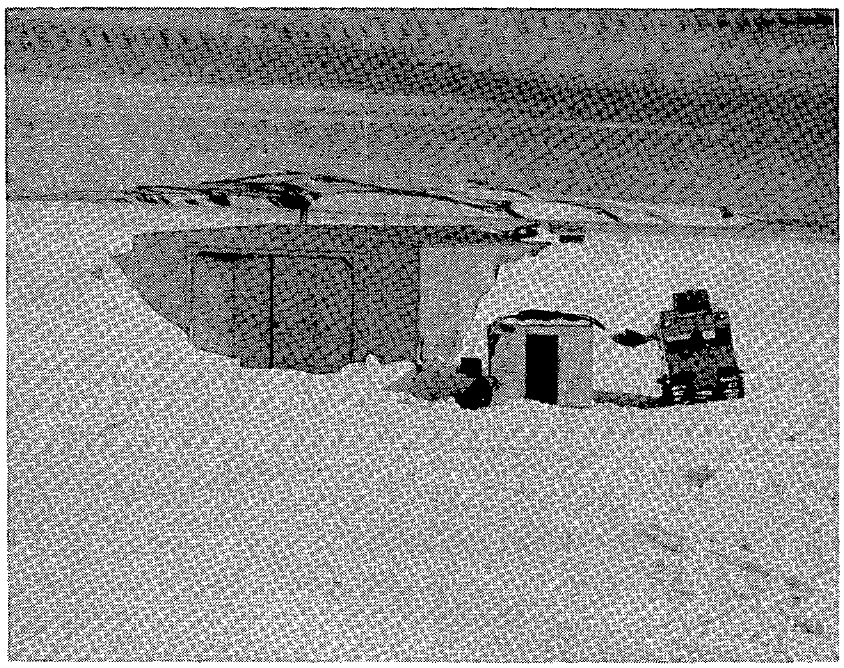

Fig. 4. T-5 building on Ross Ice Shelf 4 years after erection.

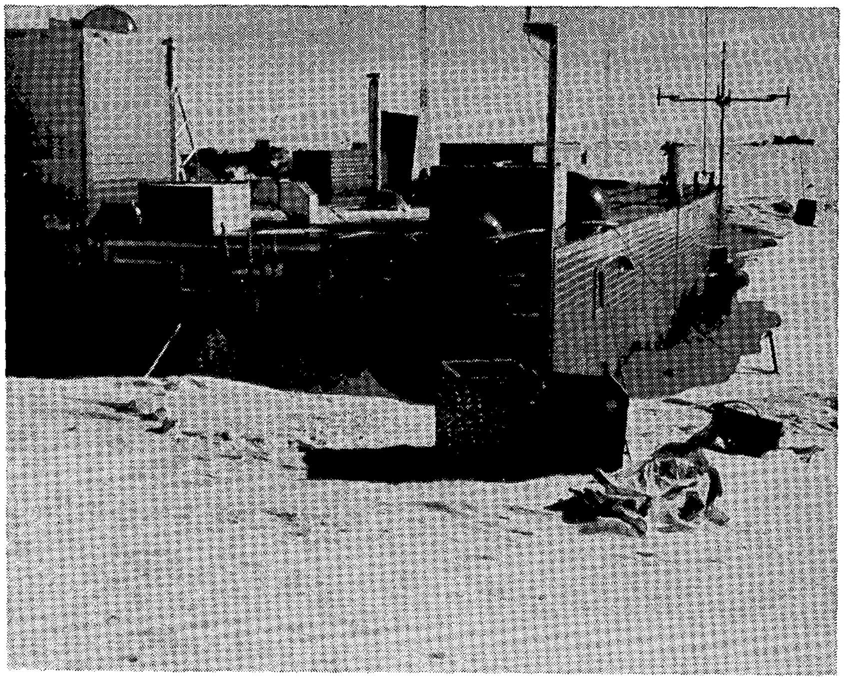

Fig. 5. Main building at Plateau Station.

Fig. 6. Off-loading a van onto the skid-mounted platform.

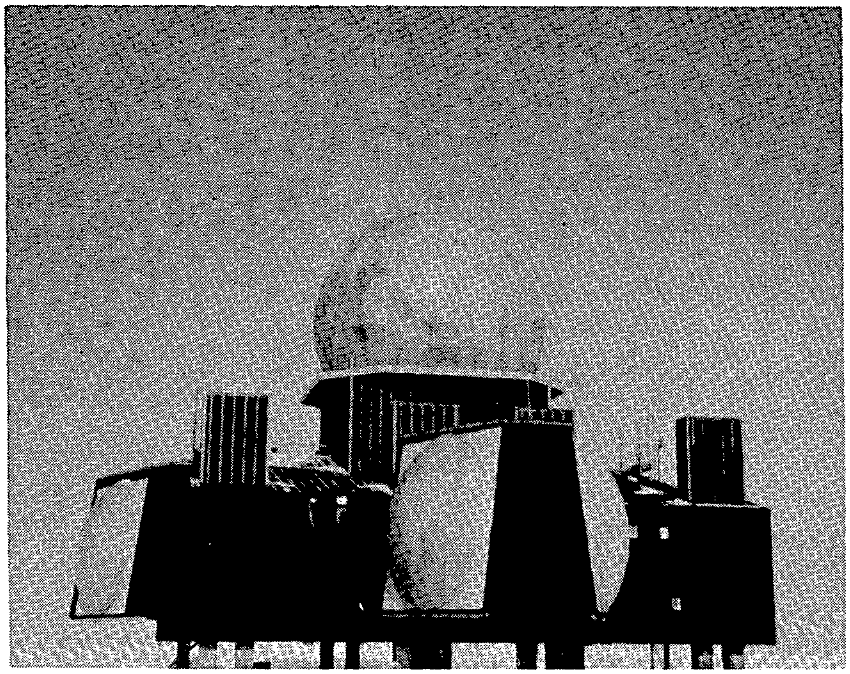

Fig. 7. Composite building at Dye II. Note columns projecting above roof.

FUEL SYSTEMS EMPLOYED AT ANTARCTIC STATIONS OF THE UNITED STATES

E. G. Walker*

Summary

This paper provides basic and general information about the fuel systems employed at antarctic stations of the United States. It includes a brief description of each of the major components of the flexible-bladder fuel system, names and addresses of manufacturers, and, where known, prices of components. In addition, it presents information on new systems of resupplying antarctic field parties with 500-gallon capacity collapsible drums.

Introduction

Two distinct systems are employed to store bulk fuel at U.S. stations in Antarctica. At permanent stations, where the topography provides areas which are free of snow and ice, permanent bulk storage tanks of welded steel are used. These tanks with their associated pipes and transfer systems are essentially the same as would be found in temperate climates, and for the reason they are discussed only briefly in this paper.

At temporary stations, inland stations, and other sites where it may not be feasible to erect welded steel storage tanks, a fuel system utilizing flexible rubber bladders together with associated pumping and dispensing equipment has been adopted. This system is described below in some detail.

Meeting the fuel requirements of antarctic field parties for limited quantities of various types of fuel while operating away from established stations has always presented problems. In past years, such resupply normally was accomplished by shipping the fuel in 55-gallon steel drum.** These drums are heavy and difficult to fill and empty, especially under adverse conditions. Further, because of their weight and volume, they are not normally returned from the field for reuse, and thus are considered excessively expensive. Because of these factors, collapsible lightweight rubber drums will be utilized, commencing with the 1968-69 antarctic season. The collapsible drums described in detail below are expected to eliminate most, if not all, of the disadvantages inherent in the use of steel drums.

Welded Steel Storage Tanks

Welded steel storage tanks are used at three U.S. stations. The basic capacities of those at McMurdo Station are 250,000 gallons and 500,000 gallons,

* U.S. Naval Support Force, Antarctica.

**In this paper, all fuel figures are expressed in terms of U.S. gallons, 1 U.S. gallon being equivalent to 231 cubic inches, or 3.785 liters.

and they currently provide a total storage capacity of 4,850,000 gallons. Palmer Station has two tanks, each of 125,000-gallon capacity. Hallett Station also has two tanks, each of these having a 100,000-gallon capacity.

The experience of the U.S. Navy in Antarctica has been that properly constructed welded steel tanks require little maintenance. In addition, where tanks have been calibrated for volume, quantities of fuel on hand or expended may easily be determined by gauging tanks. Physical losses of fuel from welded steel tanks have been minimal.

Flexible Bladder Fuel System

The principal advantages of this system are the relative ease with which it may be set up and placed in operation, its versatility, and its relatively low cost. This system is composed of the following elements:

a. Pump. The pump is a trailer-mounted, self-priming centrifugal pump that accommodates gasolines, jet fuels, and diesel fuel. The pumping unit is rated to deliver 350 gallons per minute (gpm) at about 80 pounds per square inch (psi) discharge pressure. The pump is a self-contained unit capable of transferring and dispensing fuels from and to storage tanks, vehicles, and aircraft in the field. It is suitable for operation on the ground and for transportation over all types of terrain under all weather conditions. The pump is manufactured by Gorman-Rupp Company, Mansfield, Ohio, U.S.A., and sells for approximately U.S. $2,500.

b. Fuel Bladders. The fuel bladders are collapsible tanks providing bulk storage of petroleum products. As vended, each unit consists of a collapsible tank and ground cloth complete with a drain assembly, filler and discharge assemblies, vent assembly, pressure relief valve and repair kit. The tank is made of 1-ply nylon fabric impregnated with petroleum-resistant polyurethane. Two sizes are in general use: 25,000- and 10,000-gallon. When filled, the tanks assume a pillow shape, the 25,000-gallon tank being approximately 5 feet 8 inches high, 22 feet 11 inches wide, and 33 feet long, and the 10,000-gallon tank being approximately 3 feet high, 8 feet 3 inches wide and 10 feet 10 inches long. When not in use, the tanks can be folded and stored in their shipping containers. Collapsible tanks are available in a wide assortment of sizes, with capacities ranging from 500 gallons to 100,000 gallons. A 25,000-gallon tank costs approximately U.S. $3,000; a 10,000-gallon tank, approximately U.S. $2,400. Uniroyal Plastic Products, Mishawaka, Indiana, U.S.A., is one manufacturer of such tanks.

c. Hoses and Couplings. Two types of hoses(suction and discharge) are used. Suction-type hose (of 2- or 4-inch diameter in 50-foot lengths) is wire-reinforced and therefore rigid; discharge-type hose (of 2- or 4-inch diameter in 25- or 50-foot lengths) is lighter in weight, non-reinforced, and therefore collapsible. The suction hose is not intended to carry positive higher pressure, but it will withstand high vacuum; discharge hose, on the other hand, will collapse under vacuum conditions but is designed to operate at pressure up to 125 psi. Metallic static wires are incorporated in both types of hose, thereby insuring positive electrical bonding between the fittings at each end of the hose. Each section of hose, regardless of length, has quick-disconnect fittings: a quick-disconnect adapter (male) in one end and a quick-disconnect coupler half (female) in the other end, secured to the hose with two stainless steel bands. All couplings in the system are of the quick-coupling type and may be completely interconnected size for size. Connection is effected by inserting the adapter into the coupling and depressing the bands. This results in cam action which forces the adapter and coupler together against a synthetic rubber gasket, forming a leakproof seal between the fittings. Because of its light weight, the discharge hose may be moved fairly easily. It has a service life of approximately three years, costs an estimated U.S. $2.75 per foot, and is also manufactured by Uniroyal of Mishawaka, Indiana.

d. Meter Assembly. The meter assembly required to measure fuel flow is equipped with suitable inlet and discharge fittings so that it may be readily installed or removed from the system as desired. The complete assembly is skid-mounted for easy transportation. Its rated capacity is 350 gpm maximum at 125 psi. The meter assembly is manufactured by the Washington Aluminum Co., Inc. of Baltimore, Maryland, U.S.A.

e. Pressure Regulator Assembly. The pressure regulator assembly required for the control of excessive pressures in the transfer lines is essentially a diaphragm-actuated hydraulic regulating valve equipped with quick-coupling fittings for ready installation into the system. It is primarily installed on the downgrade side of steep terrain between any two pumping stations, or between pumping station and tank farm. The regulator valve is factory set at 65 psi, but can be adjusted to meet specific operating conditions. The pressure regulator assembly is also manufactured by the Washington Aluminum Co., Inc., of Baltimore, Maryland.

f. Filter/Separator. The filter/separator, designed for removing undissolved solids and water from light petroleum products, is a vertical, skid-mounted, portable unit of 350 gpm flow rate capacity at a working pressure of 75 psi. Briggs Filtration Co., of Washington, D.C., U.S.A., is the manufacturer.

Collapsible Drums for Field Party Support

As previously stated, it has been past practice to use 55-gallon rigid steel drums in supplying fuel to field parties. Commencing with the 1968-69 operating season, however, 500-gallon collapsible rubber drums will be used for this purpose. Their most obvious advantage over rigid steel drums is the much lighter weight of container per pound of fuel delivered. (For 500 gallons of fuel, this weight savings is 435 pounds). In addition, the collapsible drum is more readily retrievable and reusable: when empty, it reduces to only 15 percent of its filled size. It can be safely filled and emptied aboard aircraft, and, since it is shaped like a large wide wheel, it contributes to its own mobility, *i.e.*, it is easily pushed, rolled, or towed.

Specially designed fittings at each end of the drum enable it to be lifted--suspended on a single cable--by a helicopter. These fittings also permit the drum to be secured in a vehicle or aircraft. Further, several drums may be tied down in series aboard an aircraft or in a vehicle by a single chain or cable strung through the shackles at each end of each drum. At destination, the chains are simply pulled free and the drum(s) rolled out of the vehicle or aircraft. (Ramps or lifting equipment are not required since the loaded drum is designed to withstand a free fall of 4 to 5 feet.) It can then be rolled or moved by tow bar to the defueling area. The collapsible drum is constructed of elastomeric-coated rayon tire cord, with an outer covering of neoprene and an inner lining of paracril; the drum is of 4-ply construction. In addition to the 500-gallon size, drums of 250-gallon and 55-gallon capacity are available. Specifications for these three sizes (as manufactured by Uniroyal Plastic Products, Division of Uniroyal, Inc., Providence, Rhode Island, U.S.A.) are as follows:

Model:	500-S	250	55
Capacity (gallons)	500	250	55
Diameter (inches)	53 1/8	40	23½
Length (inches)	62	60	34½
Maximum Weight, Empty (pounds)			
Type I - valving	275	240	50
Type II- valving	285	250	--
Operating Pressure (psig*)	5	5	5
Proof Pressure (psig*)	45	45	20
Uniroyal Part No.	RD-442	RD-461	RD-105
Approximate Cost (U.S. $)	$575	$500	$148

* Pounds per square inch gauge

This new type drum will virtually eliminate the use of 55-gallon steel drums to transport fuel. With the exception of a small quantity of white gas for stoves, lanterns, etc., and of a very limited quantity of automotive gasoline for Palmer Station, no new resupply of drummed fuel products to support United States operations in Antarctica is envisioned.

(Additional information on the various equipments discussed herein may be obtained directly from the manufacturers whose names and addresses have been provided for that purpose.)

2. OVERSNOW TRANSPORT; NEW VEHICLES INCLUDING AIR CUSHION TYPES

EXPERIENCE WITH NODWELL RN110B TRACKED CARRIER

A. M. Brown * and F. A. Smith *

Abstract

A Robin Nodwell RN110B tracked carrier has been used by ANARE since 1963 for inland field traverses. The performance of the vehicle is discussed and modifications described.

1. Description of Vehicle

A brief specification and a photograph of the vehicle are appended.

2. Operating History

The vehicle was ordered direct from the manufacturer in 1961 (because no agent had been appointed at that time) and shipped to Australia as deck cargo in 1962, complete with the all-over cab. The manufacturer's painting deteriorated badly on the voyage and the whole vehicle had to be stripped and repainted before shipment to Wilkes, Antarctica, in January 1963. Before shipment, a brief test was run at Falls Creek, an Australian snow resort.

During 1963 the Nodwell covered about 1000 miles mainly on traverses inland from Wilkes over the typical ice cap sastrugi and soft snow conditions. At 800 miles, the front main cross member of the chassis failed, causing the front right wheel assembly to break completely from the chassis. Field repairs were effected and the programmed work was completed. At about this stage, the vehicle began to turn persistently to the left instead of running straight, despite many checks and adjustments carried out by mechanics. This problem seriously limited further work, since traverses require a great deal of straight running.

In 1965 the vehicle was returned to Australia, since the left-hand turning fault had not been eliminated. By this time, the manufacturer had appointed an Australian agent (N.G. Clark Pty. Ltd.), and the vehicle was examined in their workshop.

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The tracks were completely dismantled and the cause was quickly evident - one belt of the left track was 4 inches shorter than the other belt (and those of the other track too). It is not known what caused one belt to differ from its fellows after being in use for some time. New belts were fitted. The engine was stripped, cleaned examined and, although in almost new condition with no wear measurable, all wearing parts and gaskets were replaced. The original preheating heater (Perfection Hupp Corporation, USA) was unserviceable. It had not proved reliable in extreme cold and spare parts were very difficult to obtain, so a different one was installed (Eberspacher, Germany). As other Nodwells in Australia had suffered failure of the stub axles which carry the wheel bearings, all eight were stripped down and subjected to crack detection by flourescent dye. Several were found to be cracked at the root of the axle adjacent to the bolting flange, due to a most inadequate radius fillet and some machining marks. New axle were made locally with the full radius allowed by the inner bearing race. (Later Nodwell PN110's have a heavier-duty axle-bearing and wheel assembly.) The chassis was repaired and strengthened in several locations, and the field repair of the front main cross member, carried out in 1963 and mentioned above, was replaced with substantial strengthening. (Later Nodwell RN110's have a stronger chassis, and none of the failures experienced with our model would occur.)

The vehicle returned to Wilkes in 1966 and was used fully on the field work that year, and again 1967. Early in 1967 the track belting showed signs of over-straining, perishing, or cold failure, and number of track failures limited the usefulness of the vehicle. This was unexpected on previous experience and it is hoped that the new track belts fitted early in 1968 do not fail prematurely. Instructions have been given not to overload the tracks by towing excessive loads in soft snow and to maintain correct track tension. The tracks are rated by the manufacturer as suitable for -65 °F, provided care is taken by starting off very slowly and avoiding strain until the tracks loosen up. Sharp turning and reversing will cause a sharp reverse bending of the track between the drive sprocket and the rear wheel, so these operations must be avoided until the rubber becomes more supple as it is warmed by internal friction. It is difficult to operate so carefully during the business of extricating vehicles and sledges from drifts after a blizzard.

The vehicle has travelled in the order of five thousand miles up to May, 1968.

3. Performance

The Nodwell RN110 has been a very useful addition to the vehicles in use at Wilkes. It is used either -

(i) as a lone vehicle;

(ii) as a basic-load carrier supporting smaller vehicles; or

(iii) as a scout and navigation vehicle in conjunction with the smaller vehicles.

In role (i), the large all-over cab is very useful for living, workshop, and stores, but the arrangement of satisfactory survival equipment and rescue facilities to cover all contingencies is very difficult for this mode of travel.

In role (ii), the Nodwell has not been able match the load-carrying and pulling performance of the usual vehicle used, the Caterpillar D4 tractor and sledge-train. This is basically due to the lower traction of the Nodwell rather than lower power. The premature track failure in 1967 described above indicates that the track belts may not withstand the loads imposed, either. The Nodwell is not a tractor, and towing is not recommended by the manufacturer, who has emphasised that it is a carrier. It was for this reason that ANARE installed tanks for 300 gallons of fuel (in addition to the 38-gallong standard tank) to put a heavy load on the vehicle rather than tow it on a sledge. The tanks were arranged as seats and bunks so that the cabin was suitable for living quarters, etc. Our experience would indicate that loads above about 4 tons should not be towed in soft or very cold conditions.

In very deep soft snow, the front wheels are inclined to "bull-doze" and models are now available with a small high front idler-wheel. ANARE has purchased two such models (RN35) and it remains to be seen what improvement results.

In role (iii), the Nodwell has been very successful, because it provides a roomy cabin for equipment and a reasonable speed, especially over rough ground (due to its large wheel base). Its fuel capacity provides several hundred miles' range and so its size is no limitation within its range. Operating with another similar Nodwell would seem to be a most efficient arrangement for the lighter types of traverse work which do not require heavy equipment or extra fuel loads beyond the vehicle's capacity.

At present the Nodwell is limited by its inability to operate in extremely low temperatures. The manufacturers claim that operating at -65° F is satisfactory with their lowest temperature track belt, but the rubber is extremely stiff at that temperature and special driving precautions are necessary. High on the plateau of Antarctica, even summer temperatures have been occasionally as low as -80° F for quite long periods. Other vehicles with rubber track components also suffer this limitation, and some at an even higher temperature. In general, rubber for track components needs to be compounded for much lower temperatures for it to be suitable for universal use in Antarctica.

The difficulties and risk of damage occasioned by attempts to start engines at very low temperatures have resulted in the provision of adequate preheating arrangements on ANARE expeditions in recent years. The Herman Nelson heater is used on the exposed Caterpillar D4 engine and this large heater is very useful for general warming-up requirements of other vehicles, too. However, vehicles with enclosed engines, such as the Nodwell, are fitted with a smaller heater which is mounted in the cabin, powered by the vehicle battery and fuelled from the vehicle tanks. Automatic starting operation and control after the turn of a switch produces a supply of warm air which is ducted to the engine, battery box, cabin or wherever it is required. The General Motors - Detroit diesel engine requires an ether capsule to start below +40° F on distillate and our experience indicates that it is required below +32° F on aviation turbine kerosene. Reliable and quick starting has been achieved, using the preheating and the ether capsule in conjunction at temperatures down to -50° F.

The noise emitted by the type of engine fitted is considerable and the engine-covers fitted by the manufacturer were quite inadequate to provide comfortable or even safe levels of noise in the cabin. An improved cover was fabricated, and ear muffs are used by occupants to protect their hearing if prolonged exposure to the noise is expected.

4. Conclusion

The Nodwell RN110B tracked carrier has proved to be a very useful vehicle for our traverse work. Several weaknesses have been revealed in track, suspension and chassis, most of which have been rectified. The design of later models has also rectified them. Rubber track components place unsatisfactory limitations on operation at extremely low temperatures.

The vehicle has shown definite operating advantages over tractors and smaller vehicles for light traverse work, performing very efficiently in terms of manpower and time.

From experience with the first machine, the following changes not mentioned previously seem desirable for ANARE purposes and are now available as manufacturer's options:

(i) Higher speed would be useful when conditions were favourable, so a 50% increase in power seems desirable to attain 15 m.p.h.

(ii) More flexibility of speed range to suit load and terrain, by including an additional two-speed gear box.

(iii) An odometer with tenth-of-mile registration is an essential accessory for navigation.

(iv) Increased cabin height to allow more comfortable living conditions - a curved roof was quite successful on our RN35's.

(v) Fuel tank capacity to allow loading to maximum carrying capacity, yet allow the cabin to be used for living and working space.

APPENDIX 1

Brief Specification of Robin Nodwell RN110B Vehicle

1.	Make and model:	Robin Nodwell RN 110B.	
	Country of manufacture:	Calgary, Alberta, Canada.	
	Year:	1961.	
2.	Dimentions:	length	19 ft. 4 in. ;
		width	8 ft. 11 in. ;
		height	8 ft. 0 in. ;
		ground clearance	1 ft. 4 in. ;
3.	Weight:	tare weight:	16,000 lbs. inc, fuel;
		carrying capacity:	11,000 lbs.
		towing capacity:	15,000 lbs.
		winch capacity:	12,000 lbs.
4.	Ground pressure:	2 pounds per square inch, fully laden, at zero penetration; 1.68 pounds per square inch at 10 inch penetration.	
5.	Tracks:	2 tracks, each 40 inches wide; each track having 2 rubber belts of 4-ply canvas set in natural rubber, connected by bolted track plates of forged spring steel and with grousers fitted at every sixth track plate.	
6.	Power drive system:	mechanical shafting and manually operated gears.	
7.	Engine:	"General Motors Detroit" diesel model 4/53; 4-cylinder two-stroke cycle, scavenge-blown; 82 BHP at 2,200 RPM net continuous rating; electric start with ether assistance, 60 amp alternator (12-volt); electric coolant heater (110-volt external supply).	

8.	Transmission:	"Fuller" 5-speed model S-A-43; speeds at 2000 RPM engine speed: 5th gear 8.3 m.p.h.; 4th gear 5.7 m.p.h.; 3rd gear 3.1 m.p.h.; 2nd gear 1.8 m.p.h.; clutch "Lipe-Rollway" 13-inch single dry plate, heavy-duty model 130-1-407
9.	Steering mechanism:	hydraulically operated brakes in "Oliver 15" controlled differential.
10.	Brake system:	main - steering brakes; hand - disc on drive line
11.	Final drive:	Nodwell planetary reduction gearbox within track driving sprockets which are rubbercovered steel.
12.	Suspension:	8 standard track wheels with 7.50 inch x 20 inch pneumatic tyres, mounted on crank arms with coiled torsion springs.
13.	Body:	chassis: fabricated steel frame; cabin: steel frame with external steel sheet insulated with 2 inches of rock wool, aluminium sheet lining throughout; usable cargo area: 12ft x 7 ft., floor-to-ceiling height 4 ft. 6 inches; access: Driver's and navigator's doors, loading door both sides, double loading door at rear; 20 inch x 20 inch escape hatch in roof.
14.	Fuel;	aviation turbine kerosense; consumption: approx. 1 mile per imperial gallon, fully loaded on traverse; capacity: original tank, 38 imperial gallons, removable tanks fitted by ANARE, 300 imperial gallons.

15. Lubricants:

grease:	to Mil-G-10924B specs;
engine oil:	Multigrade 10W/30;
gear-case oil:	Multigrade 10W/30;
differential oil:	Multigrade 10W/30;
coolant:	50/50 glycol water, and corrosion-inhibitor added.

16. Performance:

max. speed 10 m.p.h.;	
gradability (forward)	60%;
side	30%;
fording depth	3 ft.

17. Optional accessories fitted:

"Ramsay" 12,000 pound winch, p.t.o. - driven;

Eberspacher multi-fuel heater

low = 30,000 B.Th.U.,
high = 60,000 B.Th.U.,

front and rear tow hooks;

external battery-charging receptacle;

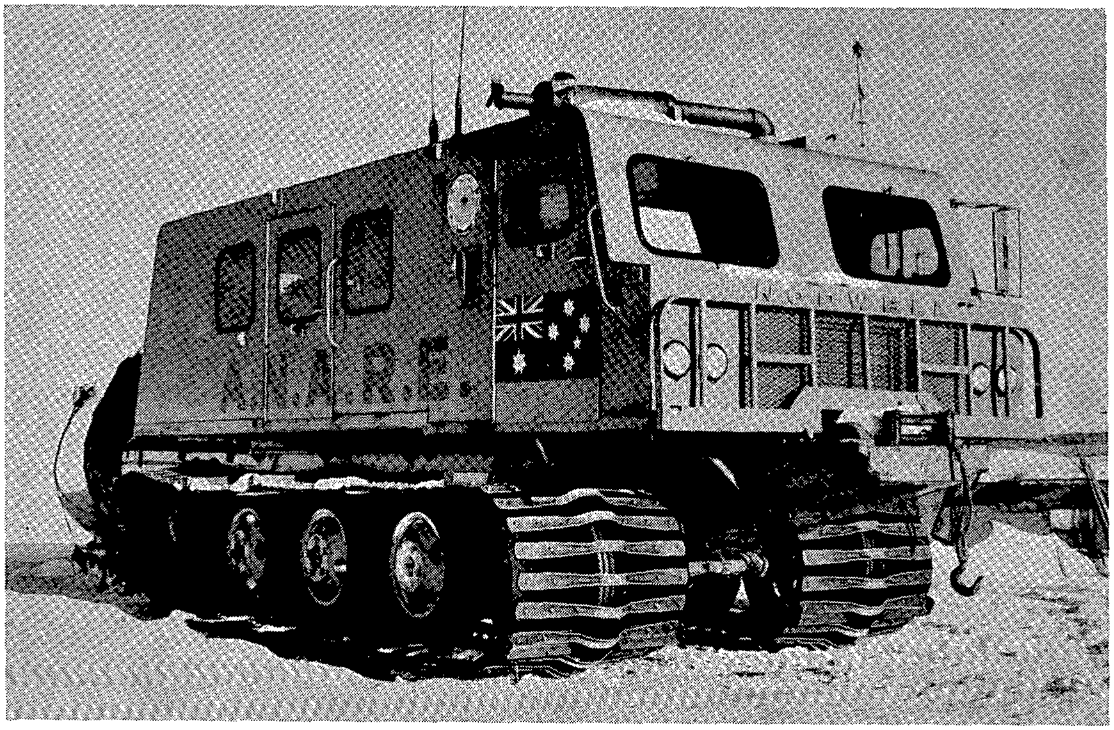
window-defrosting heater, using engine coolant;

4 batteries, 6-volt, 19-plate each (normally 2);

engine hour-meter;

two-way radio facilities;

radiator shutter: "Kysor" hydraulically-operated under thermostatic control.



ANARE photo 17787A

Fig. 1. Nodwell RN110B.

A SMALL CARAVAN FOR ANTARCTIC TRAVERSES

A. M. Brown* and F. A. Smith*

Abstract

The caravan is small and furnished for compact living for three men, or sleeping for four men. A moulded monolithic glass-fibre reinforced plastic and foam sandwich shell is mounted on sledge runners with leaf springs. A special kerosene heater is incorporated, using the balanced flue system for safety. The shape of the carvan is designed to keep drift snow clear.

1. Requirements and Principles of Design

Australian National Antarctic Research Expeditions conduct traverses inland from the coastal stations each autumn and spring, and to a lesser extent in winter, too. These traverses are entirely unsupported by air. Traverses usually use the Caterpillar D4 tractor to pull a train of sledges carrying living accommodation, stores, and fuel. Maximum load for each tractor train is 12½ tons. Living accommodation has usually been a large caravan weighing about 3 tons, mounted on a sledge weighing 3 tons. A smaller, lighter caravan was developed to allow increased tractor train payload or faster travel when required. A caravan of bare weight about 1½ tons was thought to be feasible.

A small caravan had been designed and used in a sledge train using a "Weasel M29C" as prime-mover in early explorations. This caravan was noted for its ability to avoid being drifted in by blizzard snow. This basic shape was therefore adopted for the new design.

The built-in interior furniture and fittings were required to accommodate 3 men with cooking and working facilities, or 4 men sleeping only, or various types of scientific equipment which might be used on traverse.

2. Manufacturing Method

Glass-fibre reinforced plastic constructions was adopted to provide a strong airtight monolithic structure of a rounded profile.

Polyurethane foam was adopted for insulation, due to its outstanding low thermal conductivity.

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A fully bonded sandwich construction was adopted to take maximum advantage of the structural properties of the glass-fibre reinforced plastic inner and outer skins and the rigid insulating foam.

To obtain a good finish externally, a female half mould was constructed of glass-fibre reinforced plastic. The mould was cast on a timber and wall board mock-up of half of the caravan.

The external skin of the caravan was laid up in the half-mould with the following:

gelcoat with orange pigment;

glass-fibre tissue;

glass-fibre matt, $1\frac{1}{2}$ oz/sq.ft;

glass-fibre matt, $1\frac{1}{2}$ oz/sq.ft;

4 glass-fibre woven rovings, $12\frac{1}{2}$ oz/sq.yd;

glass-fibre tissue.

The resin used was a polyester with good weathering properties. The first caravan produced was sprayed with foamed-in-situ polyurethane to a finished thickness of $1\frac{1}{2}$ inches. In subsequent caravans, cut sheets of foamed polyurethane to the same finished thickness were fixed inside the moulded outer skin with polyester rein.

The internal skin of the caravan was then laid up in the insulate half outer skin as follows:

glass-fibre matt, $1\frac{1}{2}$ oz/sq.ft;

glass-fibre matt, $1\frac{1}{2}$ oz/sq.ft;

glass-fibre woven rovings, $12\frac{1}{2}$ oz/sq.yd to floor only;

glass-fibre tissue.

The resin used was a polyester with fire-retardant properties.

The caravan was made in two halves up to this stage to avoid extensive laminating work inside an enclosed structure, as this would be very uncomfortable due to the fumes from the resin.

The two halves were then joined with an aluminium strip rivetted to join the outer skins. Pigmented gelcoat and reinforcement were applied externally over the joint.

The insulation was made continuous over the jointed and the inner skin joined by reinforcing glass-fibre and resin.

Built-in furniture of timber was then installed as shown on the drawings. Sheet-rubber floor covering was provided throughout the caravan. Double-pane fixed windows and a roof observation bubble were constructed from acrylic plastic.

3. Heating and Ventilation

To achieve compact yet comfortable design, it was necessary to use a heater which would operate efficiently, safely and comfortably in the confined space.

The heat requirement at even extremely low ambient temperatures is quite small, about 5500 BTHU at - 70° F, including an allowance for a small but sufficient ventilating air change in the caravan.

Caravan-heating had hitherto been achieved by the ordinary domestic portable kerosene room-heater or liquified petroleum gas-heater. These heaters usually have wick vaporisation and a wire gauze is heated by the flame to emit radiant heat which is then concentrated in one direction by a reflector. Some vaporise the fuel under pressure and use radiant candles or tiles. Despite various design improvements, they are dangerous in drafts, can be knocked over, and the concentrated heat and open flame can cause ignition of clothing, drapes, solvents, etc. They consume air from within the caravan and the products of combustion mix with the air in the caravan. Carbon monoxide poisoning is the worst hazard as a result, but the odour, very fine soot and lack of oxygen are also disadvantageous. The high temperature radiations and the hot products of combusion released cause great stratification of temperature with the result that a man in a top bunk is so hot and stuffy that he cannot bear to get into his sleeping bag while a man in a lower bunk is cold; lower still, there ice on the floor and in the cupboards. There is a considerable amount of water formed by the combustion of the fuel, and this condenses and forms ice unless it is removed. As a result of the problems arising from release of the products of combustion into the caravan, considerable amounts of fresh air must be introduced and without fail. Thermal efficiency is greatly impaired by the need to introduce very cold air from outside. Drift snow and icing make reliable provision of ventilation very difficult, and carbon monoxide poisoning is not unusual for this reason. Generally, the occupants would not dare to sleep with such a heater operating, for fear of carbon monoxide poisoning and fire.

The requirements for the heater to be incorporated in the new caravan were:

(a) no release of products of combustion into the caravan;

(b) safe surface temperatures and preferably no naked flames;

(c) even temperature distribution;

(d) kerosene fuel, the same as that used by the diesel tractors;

(e) no electric power requirement;

(f) operation in high winds and extremely low temperatures, and while travelling in rough conditions;

(g) output of about 6000 BTHU/hr, and a reasonable thermal efficiency, say 50% minimum.

The heater design which was developed to meet these requirements is shown in the drawings accompanying the paper.

The burner of a successful kerosene room-heater of the pressurised type ("Cosyglo") is incorporated in the heater as a removable assembly. Kerosene is delivered to the burner from a pressurised tank, vaporised as it passes through a tube over the burners and the gas is released through a fine jet where it induces and mixes with air. The mixture burns on perforated ceramic bobbins. To start the heater, the burner vaporiser is preheated by methylated spirit, "meta-tabs" or an LPG torch.

The combustion chamber is insulated with asbestos board to keep outside surface temperatures at a safe and comfortable level. The hot products of combustion pass through two long tubes arranged just above floor level, and the gentle rediant and convection heating achieves excellent comfort conditions throughout the caravan. A bypass connection allows for rapid warming of the flue when starting up the heater, and for control of heat output. The second tube is connected into the base of a flue.

The design of a flue, to provide reliably the correct amount of air for combustion, has proved very difficult. The effect of wind-induced pressures is considerable and the incidence of condensation or ice formation in the flue is a real problem. The flue assembly consists of an inner tube for the flue, which is insulated, and an outer tube down which the air for combustion is conducted to the burner. The exhaust gas outlet and the fresh air inlet are adjacent and subject to the same wind pressure effects. Ideally, no effect by the wind on the air flow should result, but this is difficult to achieve on such a small system. Quite good results have been achieved, but there is room for improvement and experiment is continuing. A serious difficulty occurs when starting the heater. During preheating and warming of the burner and flue tubes the burner box door is open, and this subjects the system to the pressure in the caravan induced by the wind on the ventilators. Consequently, it is sometimes very difficult to establish the flow of air through the heater when the burner-box door is shut. The heater starves for air and goes out. This is particularly trying, because preheating is necessary again.

The heater consumes about one imperial gallon of kerosene per day. Thermal efficiency can be over 80% but a lower efficiency is necessary to avoid flue condensation: 60 - 70% seems to be acceptable and still provides plenty of heating to the caravan.

Two ventilators were provided in the roof of the caravan. They have screw-caps for sealing or adjustment, and air circulates in through one and out through the other, depending on the wind direction. Ventilators in the end-walls were found to be unsatisfactory and unneccessary.

4. Sprung Sledge

The caravan is used over snow of varying cohesion and hardness, including extremely light powder of considerable depth, severe sastrugi or wind-furrowed snow, and blue ice. The caravan follows the tracks of a D4 tractor, Nodwell tracked carrier, or another sledge.

The first caravans were bolted to a typical wooden two-ton cargo sledge. Some flexibility was provided in the mountings, but the rigid caravan often broke away from the flexible sledge.

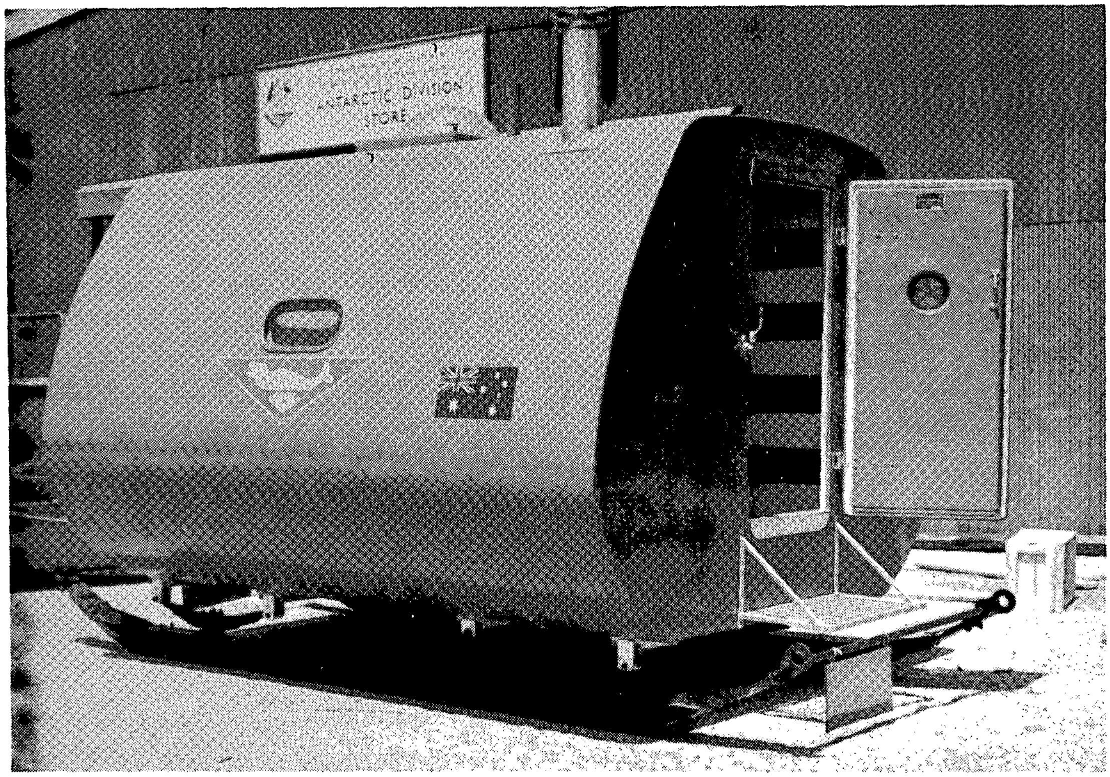
An integral sledge was designed which provided spring support for the rigid caravan. Two fairly flexible steel and timber runners were connected fore and aft by a heavy bar in spring steel trunnions. The spring steel trunnions provide flexibility, as well as cushioning and transmitting the towing and over-run bumping shocks of the tractor train. These shocks do not pass through the caravan. Conventional leaf springs of the type used for caravans are used, and this provides adequate damping without hydraulic shock-absorbers.

5. Operation Experience

The sledge and the caravan have proved entirely sound structurally and no failures have occurred. The ride on rough ground is considerably improved by the springing, which reduces breakages and is more comfortable for men who are resting while the train is moving.

During blizzard or drifting snow, an electric charge builds up inside the caravan and some uncomfortable sparks can be drawn by the occupants. This appears to be due to the use of glass-reinforced plastic which is an excellent insulator. Conductive paint and earthing to the sledge would appear to be required if this problem is to be avoided.

Figure 5 shows the effectiveness of the shape in scouring away drift snow. The open, simplified design of the sledge promotes wind flow beneath the caravan. Expeditions report that very little work is required to free these caravans, compared with other types.

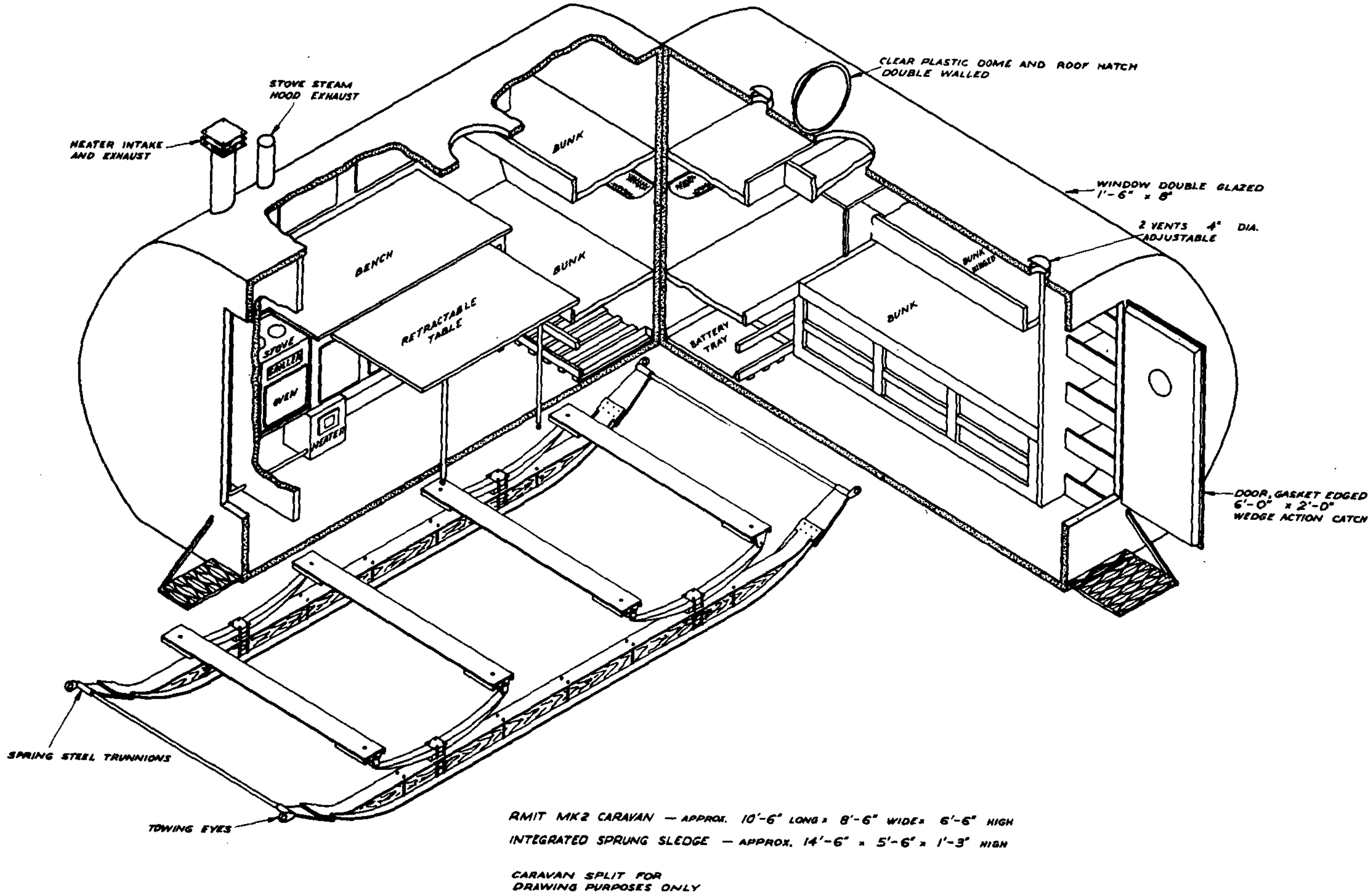


ANARE photo 16398B

Fig. 1. The completed caravan.

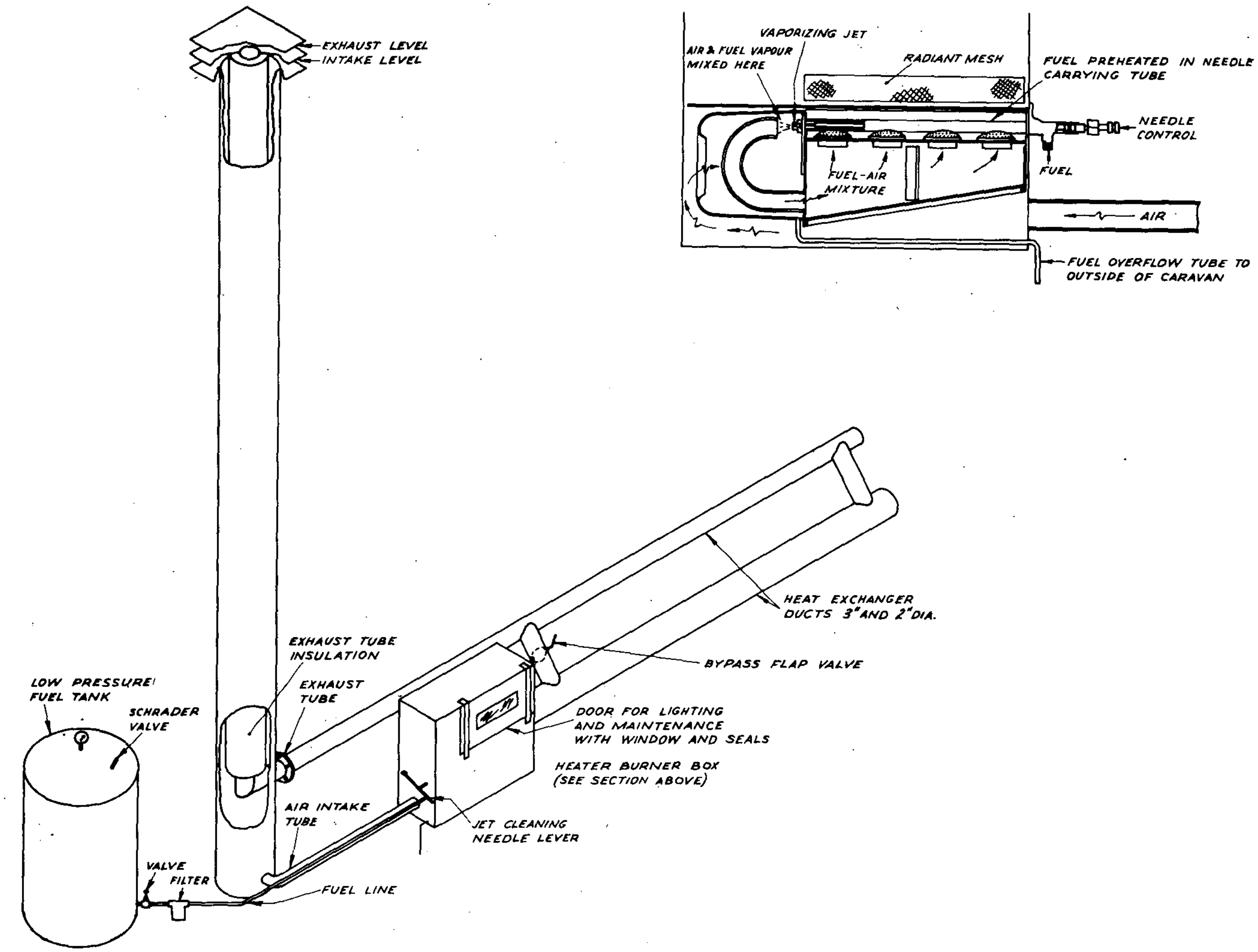
ANARE photo 14001/36

Fig. 2. Interior view.



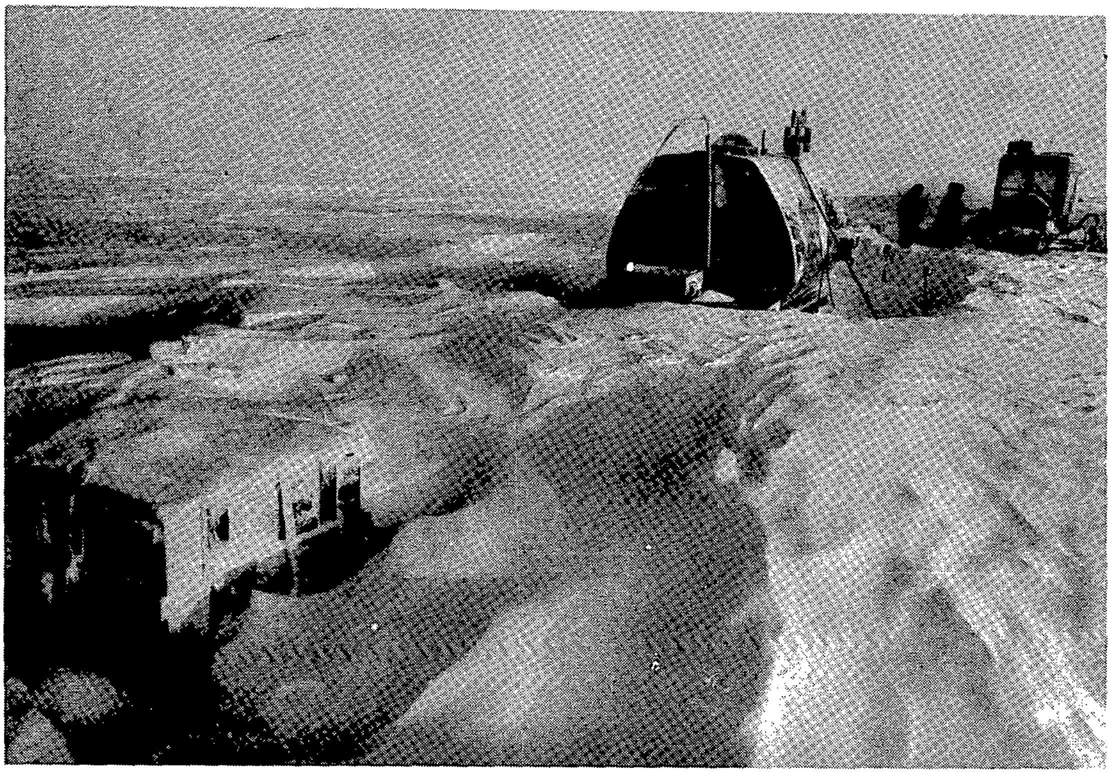
ANARE Drawing 5/68/02

Fig. 3. Drawing of the interior fittings and sledge.



ANARE Drawing 5/68/03

Fig. 4. Drawing of the heater.



ANARE photo 14960 A

Fig. 5. The caravan in the field showing effective scouring of drift snow. Note the buried sledge in the foreground.

NEW FRENCH POLAR VEHICLES HB 40

Expeditions Polaires Françaises

Since 1948 Expéditions Polaires Françaises use as ground transportation means, the tracked vehicles cargo carrier M 29C called "weasel" equipped with wide tracks. The spare parts and the maintenance being more and more difficult to obtain, Expéditions Polaires Francaises have either directly experimented some new vehicles, or studied carefully the experimentation made either in France or abroad with some other types of vehicles. None of them afford the great and complete possibilities of use of the "weasel": to be used on rocks, snow, ice, muddy terrains, to be amphibious for use on pack-ice and to allow crossing of "rivers".

In 1956, Expéditions Polaires Françaises are aware of the characteristics of a prototype of a French military vehicle (called VP 90, conceived by the engineer Victor BOUFFORT). The rolling system and the track specially well adapted seem to attain our purpose. Another type of this vehicle with wide tracks is carried out in 1958, and experimented in 1959 in France, in the Pyrénées mountains. The first results are encouraging and the design of a derived prototype is decided. Characteristics and specifications of this vehicle are established, in 1961, by Expéditions Polaires Francaises. The vehicle is called VB 40, trials and adjusting take place in 1963 and 1964 in the French Alps. The trials are decisive, but this vehicle is equipped with a mechanical set (engine - gear box - differential) which is not standardized and the prices are consequently prohibitive.

The design of a new prototype of this vehicle, equipped with a mechanical standardized HOTCHKISS set is decided. The prototype is experimented in the French Alps during the 1965 - 1966 winter. In the same time 5 vehicles are ordered by Expéditions Polaires Françaises to HOTCHKISS, to allow experimentation in the field, during the campaigns in 1967 and 1968 of the Glaciological International Greenland Expedition. These 5 vehicles are sent to Greenland in August 1966.

During the 1967 campaign of the Glaciological International Greenland Expedition, from March to September, these 5 vehicles cover on the whole 15,000 km on the Greenland Ice Cap, without any noticeable break or difficulty, with temperatures below to - 40°C at the beginning of the campaign. The forseen performances are carried out and can be summed up as follows:

- payload of the vehicle	1,500 kg
- payload towed by sledge	4,000 kg
- total payload on snow	5,500 kg
- speed on snow (according to the surface ground) with full load	12 to 15 km/h
- petrol consumption at full load	1.5 l/km

In September 1967, these 5 vehicles are stored on the Ice Cap (altitude = 2,400 m) where the temperature, during the 1967-1968 winter, are -60 C. In April 1968, after digging the vehicles out of the snow, they are in a good state of driving. For the moment they take part in the 1968 campaign. They have to cover again, on the whole 15,000 km. The final results of this experimentation on a large scale will be established at the end of the 1968 campaign. Nevertheless, this vehicle henceforth allows to relieve the "weasel" affording similar characteristics but with better performances especially with regard to speed and payload.

1. General Description

The vehicle consists in a steel sheet hull entirely welded and water tight which by its capacity, homogeneity in its general shape and distribution of loads, allows a perfect floatability a good access to river banks when going in or coming out, and a good grip on snow or ice.

The patented suspension is secured by rubber blocks of high flexibility.

The 12 road wheels are in steel alloy and rubbered.

The 6 track guiding wheels are also rubbered.

The truck consists in a continuous reinforced rubber belt equipped with interchangeable metallic driving and guiding elements. Wide reinforced rubber paddles allow the vehicle to be used on snow and on very soft or swampy terrains.

The driving wheels are placed backwards. Their shape have been specially designed to avoid "padding" in snow and also for the use on iced or stony terrains and so preserve the track.

2. Power and Steering Units

The vehicle is equipped with a HOTCHKISS petrol engine type 3501 developping 125 HP, (it can also be equipped with a HOTCHKISS diesel engine type 3505 developping 90 HP).

The engine is placed in the front of the vehicle.

The 4 synchro-mesh speeds gear box (HOTCHKISS type 1784) is coupled with the engine through a classical 11" dry clutch.

The motion is transmitted by a universal joint placed longitudinally in the middle of the vehicle, which drives the differential through a transfer box of 2 ratios giving 8 forward speeds and 2 rear speeds.

The Cleveland type differential has sun and planet gears braked by coiling bands working in oil and allow a very supple steering.

The differential placed backwards drives directly the driving wheels through robust driving shafts.

Steering, brakes and clutch are operated from the driving cab through cables.

3. General Equipment of the Vehicle

The vehicle can receive various equipments according to its employ.

The cab is fitted with a powerful heater giving 10,000 calories/hour.

Its platform can serve to transport personnel or materials. In the first case, it is fitted with longitudinal and transversal seats which can receive 12 persons, and which can be raised along the walls for an eventual transport of goods or materials. A downfolding gate, at the rear, permits an easy access or an easy loading.

The cab is fitted with a seat for the driver and seat for a passenger. These 2 seats are adjustable longitudinally and vertically. The back of the seats are also adjustable at will.

The dashboard includes all instruments necessary for a permanent control.

In the front of the vehicle can be housed a winch operated mechanically and having a tractive effort of 2,000 kg.

The hull is fitted at front and rear with attachments allowing the vehicle to be towed or lifted.

A standard switch plug, water-tight and of a huge section exists for an external source of energy if needed.

Each of the four water-tight compartments of the hull is fitted with a drain plug permitting to drain simultaneously the 4 compartments by including the vehicle. Under the floor 4 trap-doors effect the draining of the engine, gear box, rear axle and fuel tank.

4. Approximate Dimensions and Main Specifications

Overall length	:	4.185 m
Overall width (with paddles)	:	2.195 m
Wheeltrack	:	1.615 m
Overall height	:	2.260 m
Height of the floor over ground	:	0.960 m
Height of hinged sides over ground	:	1.560 m

Ground clearance (- empty	:	0.335 m
(- loaded	:	0.320 m
Pressure on ground at full load	:	0.180 kg/cm^2

5. Performances

Max. speed petrol engine	:	60 km/h
diesel engine	:	49 km/h
Number of seats available	:	12
Percent of grade	:	60%
Percent of grade on snow	:	40%
Side slope	:	40%
Floatable		
Crossing angle	:	45°
Release angle	:	45°
Starting and normal operation	:	
up to	:	- 20°C without heater
up to	:	- 40°C with heater
Operation in altitude	:	from 0 to 3,000 m
Storing up to	:	- 60°C
Fuel consumption	:	60 to 70 litres per 100 km on roads moderately uneven
per hour in terrain	:	25 to 30 litres (about)
Weight:		
Chassis in running order	:	about 3,500 kg
Total weight	:	5,000 kg
Draw bar pull	:	4,000 kg (allowing to tow very important loads according to the nature of ground).

6. Description of Mechanical Sets and Equipment

Engine:

A) HOTCHKISS petrol engine

Capacity: 3,456 cm^3 - Bore and stroke: 100 - 110 mm
4 cylinders water-cooled
Hemispherical cylinders head, overhead valves driven by push rods and rocking levers. Cramshafts into the casing.

Compression ratio (7.75/1 with standard petrol
)
(8.5/1 with petrol "Super"

Carburettor for terrain with starting device for very cold temperatures and automatic altimetric corrector.

Oil radiator

Rotation regime : max. 3,900 r.p.m.

B) HOTCHKISS diesel engine

Capacity : 3,456 cm^3 - Bore and stroke : 100 - 110 mm
4 cylinders water cooled
Hemispherical cylinders head, overhead valves driven by push rods and rocking levers. Cramshafts in the casing.

Compression ratio : 18.5/1

Injection pump rotating or in line

Cold starting device

Oil radiator

Rotation regime : 3,200 r.p.m.

Clutch:

11" dry clutch plate with shock-absorber
Ball thrust bearing self lubricating
Mechanical clutch drive

Gear box:

4 forward ratios and 1 rear
Twist gear permanently in gear
4 synchronized speeds
Gear ratios : 1st : 0.178 - 2nd: 0.369 - 3rd: 0.641
4th : 1/1 - in reverse : 0.197

Transfer box:

2 ratios
Twist gears permanently in gear
High speed ratio : 1.08   Low speed ratio : 0.485

High speed ratio of the transfer box

Gear Ratio	Petrol engine Speed in km/h		Diesel engine Speed in km/h	
	Max. torque	Max. engine r.p.m.	Max. torque	Max. engine r.p.m.
1st : 0.0278	5.4	10.5	5.4	8.5
2nd : 0.0577	11.2	22	11.2	18
3rd : 0.1003	19.5	38	19.5	31
4th : 0.1566	30.5	60	30.5	49
Rear: 0.0308	6	11.7	6	9.5

Low speed ratio of the transfer box

1st : 0.0125	2.5	4.7	2.5	3.9
2nd : 0.0259	5	10	5	8
3rd : 0.0450	8.7	17	8.7	14
4th : 0.0103	13.5	26.5	13.5	22
Rear: 0.0138	2.7	5.2	2.7	4.2

Differential:

Cleveland type with two sun and planet gears braked by coiling bands and securing the direction of the vehicle by the difference of speed of the tracks.

The differential operates into oil cooled by a radiator; oil circulation is secured by a special pump driven by the engine.

The differential shafts operate directly the driving wheels of the tracks.

Mitre wheel gearing 7/48 (ratio 0.145)

Rolling system:

It consists at each side in:

- The driving wheels of the track, placed backward, 6 road wheels, 1 tension wheel placed in front of 3 guiding wheels to support the track. Each of these elements, except the driving wheel, is rubbered.

- The track consists in a continuous rubber belt, reinforced to avoid elongation while maintaining a certain elasticity. The metallic driving and guiding elements are detachable. Various movable paddles can be adapted to the rubber reinforced belt to suit various types of terrain.

- Each rolling wheel is pulled by a suspension arm articulated around an arbor swivelling into the hull.

- Suspension is affected through rubber blocks stretching more or less under the effect of the dynamic strains imposed upon the driving wheel.

Electrical equipment:

12 or 24 volts as required.

Dashboard includes:

- a mileage indicator,
- a revolution counter,
- a time indicator,
- an ammeter,
- water temperature,
- oil temperature,
- oil pressure,
- fuel tank gauge,
- fuses, as well complementary light indicators and the hand drives for the various electrical apparatus equipping the vehicle.

Lights and signals:

Standard.

Experimentation of the HB. 40 in the French Alps (January 1966).
Climbing a slope in deep snow (percent of grade: 40 %).

E.G.I.G. 1967. HB.40 towing 1 wannigan and 1 sledge on the Greenland Ice Cap.

REPORT ON THE MODEL KD-60 OVERSNOW VEHICLES

Eizaburo Nishibori*

1. Preface

The Japanese observatory works which had been operated for the I.G.Y. were suspended in 1962, leaving behind the footworks of the Sixth Expeditions in Antarctica, but from the scientific point of view on the Antarctic observations as well as from the international faith of Japan as one of the signatories of the Antarctic Treaty, the learning circles and the political area cried for the necessity of reopening of the expeditions. In 1963, after one year of suspension, it was decided that the Antarctic observations should be reopened in 1965 as a permanent work.

Till the sixth expedition, ten vehicles including the types KC-20 and KD-20 manufactured by Komatsu Manufacturing Co., Ltd. had been used for land transportation in Antarctica. These vehicles were successful in the cargo transportations from the ship to the Syowa Station and also in the field trips in the vicinity of the base. In 1961 the Japanese could go as far as S lat 75 degrees by using these vehicles.

It became urgently necessary, however, to develop a larger snow vehicle of better quality, cold-resisting, fit for high elevation and with more space for crew accommodation, because the plans were under way for expeditions to the inland of Antarctica and the polar region, where the high land of 4,000 meters above sea-level and the temperature of -60°C might be encountered.

The Antarctic Snow Vehicle Design Engineering Committee appointed by the Ministry of Education of Japan, decided the design criterion for snow vehicle for expeditions in Antarctica.

The National Defense Agency, which was asked to take charge the transportation problem, made its Technical Research Institute conduct various kinds of experiments and researches on a snow vehicle to meet the demands of the Ministry of Education, and drew up a basic plan for its construction.

In accordance with the request of the Agency, Komatsu Manufacturing Co., Ltd. started to develop a new type of snow vehicle on the basis of the ideas already adopted into the large sized snow vehicle of Model KC-50, which had been constructed on the order of the Defence Agency. After various studies Komatsu Manufacturing Co., Ltd. completed the first large sized snow vehicle Model KD-601 in the spring of 1965. The vehicle, after a small remodeling, was sent to the Syowa Station in Antarctica with the seventh expeditions in the fall of the same year. After another remodeling to said type, two vehicles (KD-602, 603) were sent to the base in 1966 and three (KD-604, 605, 606) in 1967.

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At the base the newly developed vehicles, Model KD 60 were used for the observation trips, proving their efficient capability.

Their largest operation was the round trip of about 2,500 km between the Syowa Station and the American Base at Plateau spending three months from November, 1967.

In this traverse operation three large-sized vehicles consisting of one KD-601 type of 1965 and two of KD-60 1603 type of 1966, and one small-sized vehicle KC-20 were deployed and attained good results, which offered the dawn of hope for realization of the future expedition to the polar region.

In this report will be treated the following matters: the efficiency and the means of operation of the three large-typed snow vessels and the other remodelled, newest ones, called KD-604, 605 and KD-606 which were used successfully for the observation trip of approximately 2,500 km and other problems obtained during the trip.

2. From the Development to the Completion

2.1 Desirable Efficiency

According to the results of examination of the report on the trip to Lat. 75° S operated by the fifth Japanese Expedition and the informations concerning the Antarctic operations by foreign countries, the following points were decided to be necessary for the efficiency of the snow vehicles to be used for the traverse operation to the polar region. The final plan of the fundamental design of a snow vehicle was thus made on the basis of these points.

(1) Cold-resistance:

To have cold-resistance in the following meteorological conditions:

Mean Temperature; 0°C - 48°C
Lowest Temperature; - 60°C

(2) High Altitude Capability:

To have ability to clim and run on a plateau of 4,000 m above sea level with two sledges of 5,700 kg in the total weight.

(3) Wireless and Observation Facilities:

To be equipped with wireless communication apparatus which can communicate with the Syowa Station and the foreign stations in the vicinity and to be sound- and vibration-proof.

To have ability to carry out observations of various kinds within the vehicle by using batteries.

(4) Space for accommodation of crew:

To have heating and ventilation facilities so that the five month traverse operation between the Syowa Station and the polar region may be carried out comfortably. To have adequate facilities for living and cooking in the cabin.

(5) Traverse Operation on Snow and Ice, and Maintenance of Vehicles:

To have capacity to haul sledges on various kinds of snow, crevasses, Sastrugi, ice, soft granular snow, and have facilities to repair or adjust parts in the cabin except track frame groups.

2.2 Basic Researches:

The basic researches have been conducted mainly by the Technical Research Institute of the National Defense Agency for designing the snow vehicle which would meet the requirements stated above.

(1) Engine and Exhaust Turbo Charger:

The diesel engine manufactured by Isuzu Motors Co. was selected after various kinds of tests for starting of the engine at low atmospheric pressures and temperatures and for its 500 H durability. For the purpose of raising its capacity at low pressures and temperatures, the exhaust-turbo charger manufactured by Air-Researches was selected in view of the satisfactory results of its tests for efficiency and of capability, and weight.

(2) Test of Metalic Materials:

Twenty-four kinds of metalic materials were chosen from among the main materials used in the snow vehicles and others available for the construction of a vehicle. Of these metalic materials Charpy Impact Tests were conducted at the temperature of -20°C to -60°C to find out the changes of absorption of energy. Regardings the welding materials, tests for cold brittleness under these extremely low temperatures were carried out on their welded parts. Taking into consideration the results of the tests and the conditions of the places where the materials would be used, the materials of the most superior quality were selected.

(3) Test of Non-Metalic Materials:

In order to examine the low temperature resistance of non-metalic materials to be used for snow vehicles, such as packings, oil seals, hoses, etc., rubber hardness tests, resilience test and rubber bend tests were conducted at the temperatures of various degrees, -60°C at the lowest, and according to their results the most appropriate ones were selected.

(4) Tests for Large Snow Vehicle (Model KC-50):

In 1964, in Nayoro City, Hokkaido, various kinds of tests on Model KC-50 were carried out to conduct tests on its travelling capacity, maximum draw-bar pull, turning radius, stress and vibration, etc. at the place where snow conditions and geographical features had been artificially constructed modelling after the conditions in Antarctica.

(5) Suspension and Shock-Absorbing Spring:

The torsion rubber system, which had been already adopted in the model KC-50, and the torsion bar system used in the track-laying vehicles, were compared in the test conducted by using the model of the original size. As the results of tests, the torsion bar system which was made of spring steel of superior quality at the low temperatures, was adopted.

(6) Track:

Tests were conducted for the materials and shapes of track. As to the materials, several kinds of steel plates of high tensile strength were selected for the tests of chemical analysis, hardness, micro-structure of the welded parts, and impact test at low temperatures.

From the tests, it was found that, as the material, 80 kg/mm^2 high tensile strength steel and, as the form, channel typed track were favorable.

2.3 Test of Proto-type Vehicle:

The proto-type vehicle which was completed embodying the results of the researches and experiments was tested in February, 1965, under the sponsorship of the National Defense Agency in Nayoro City, Hokkaido. After the running test and the 2,000 km endurance test, the trial vehicle was disassembled to receive more detailed examinations for each of the parts. The high efficiency of the vehicle was certified, but several slight defects found at the tests furnished with valuable information to the reconstruction of the vehicle.

2.4 Reconstruction of Proto-type Vehicle:

According to the results of 2,000 km travelling test and the dis-

Table 1. Komatsu KD-60 snow vehicle specifications.

Model	KD-601	KD-602	KD-603	KD-604	KD-605	KD-606
Overall length	5,470 mm (216 in)					
Overall width	2,700 mm (106 in)					
Overall height	2,780 mm (109 in)					
Minimum road clearance	340 mm (13 in)					
Weight of vehicle	8,500 kg(18800 lb)	7,050 kg(15600 lb)	6,750 kg(14900 lb)	7,400 kg(16300 lb)		7,100kg(15700 lb)
Standard pay load	500 kg(1100 lb)		800 kg(1770 lb)	500 kg(1100 lb)		800kg(1770 lb)
Gross weight	9,000 kg(19900 lb)	7,550 kg(16700 lb)		7,900 kg(17400 lb)		
Grand pressure (loaded)	0.21 kg/cm^2(3.0 lb/in^2)	0.18 kg/cm^2 (2.6 lb/in^2)		0.19 kg/cm^2(2.7 lb/in^2)		
Maximum travel speed	25 km/h (16.7 mile/h)					
Hill climbing avility	25°					
Maximum drawber pull	3,700 kg(8100 lb)					
Engine type	water cooled diesel engine					
Engine Horse Power	105 PS/2400 r.p.m.					
Transmission	five speed forward, one speed reverse. synchro-mesh in 2nd, 3rd, 4th and 5th.					
Steering system	separate track speed control					
Fuel capacity	120 l (32 gal)			200 l (53 gal)		

Fig. 1 KD601 GENERAL VIEW

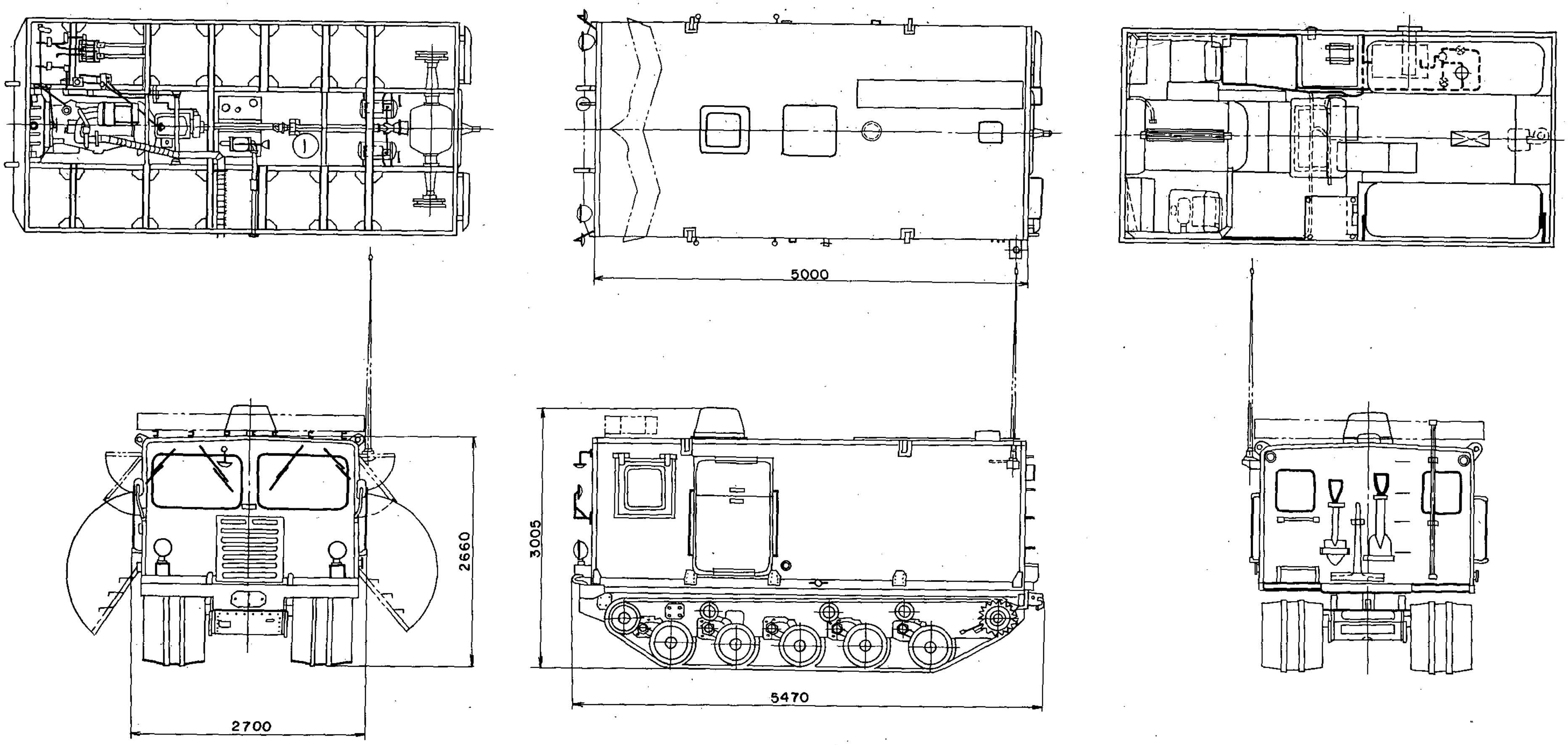


Fig.2 KD602 GENERAL VIEW

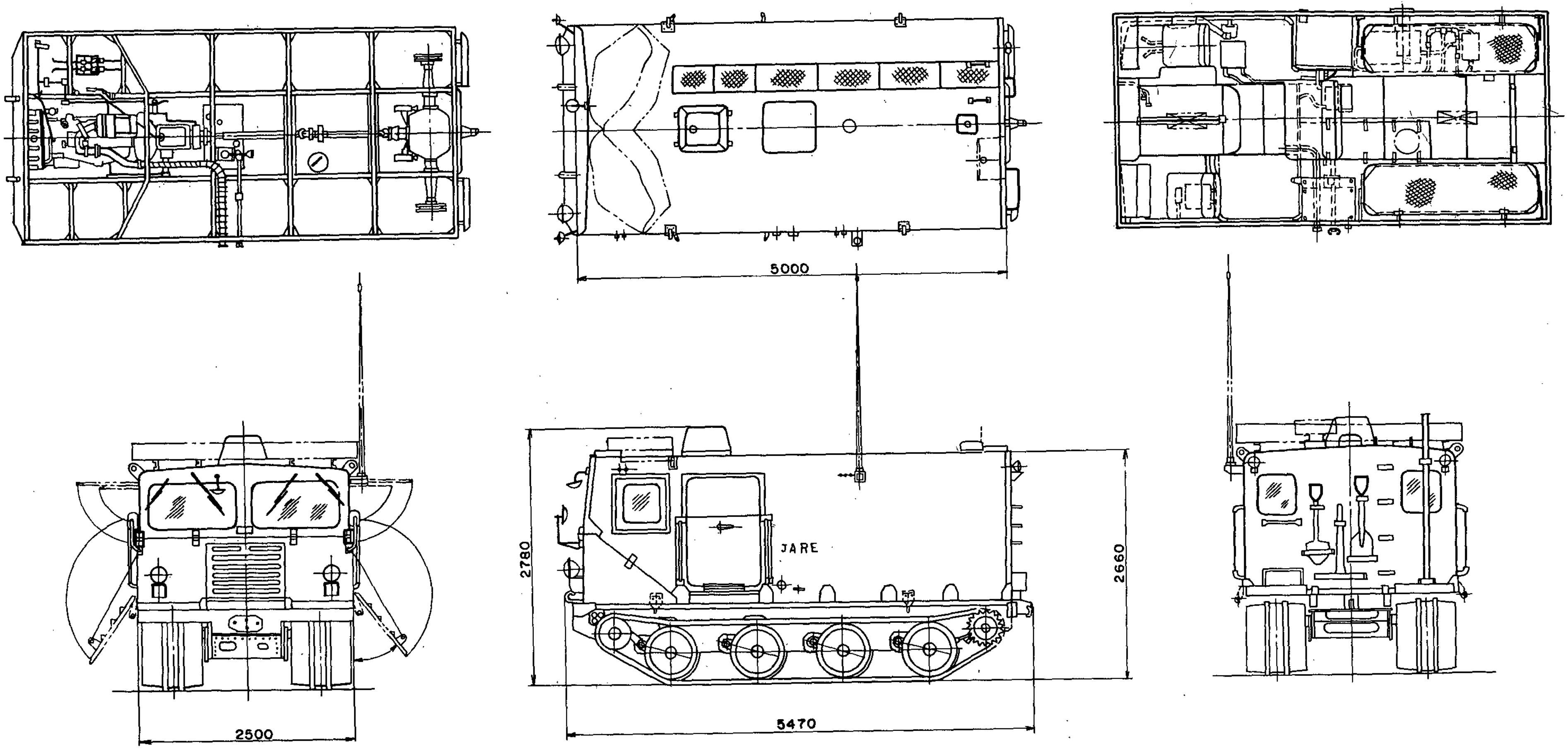


Fig.3 KD603 GENERAL VIEW

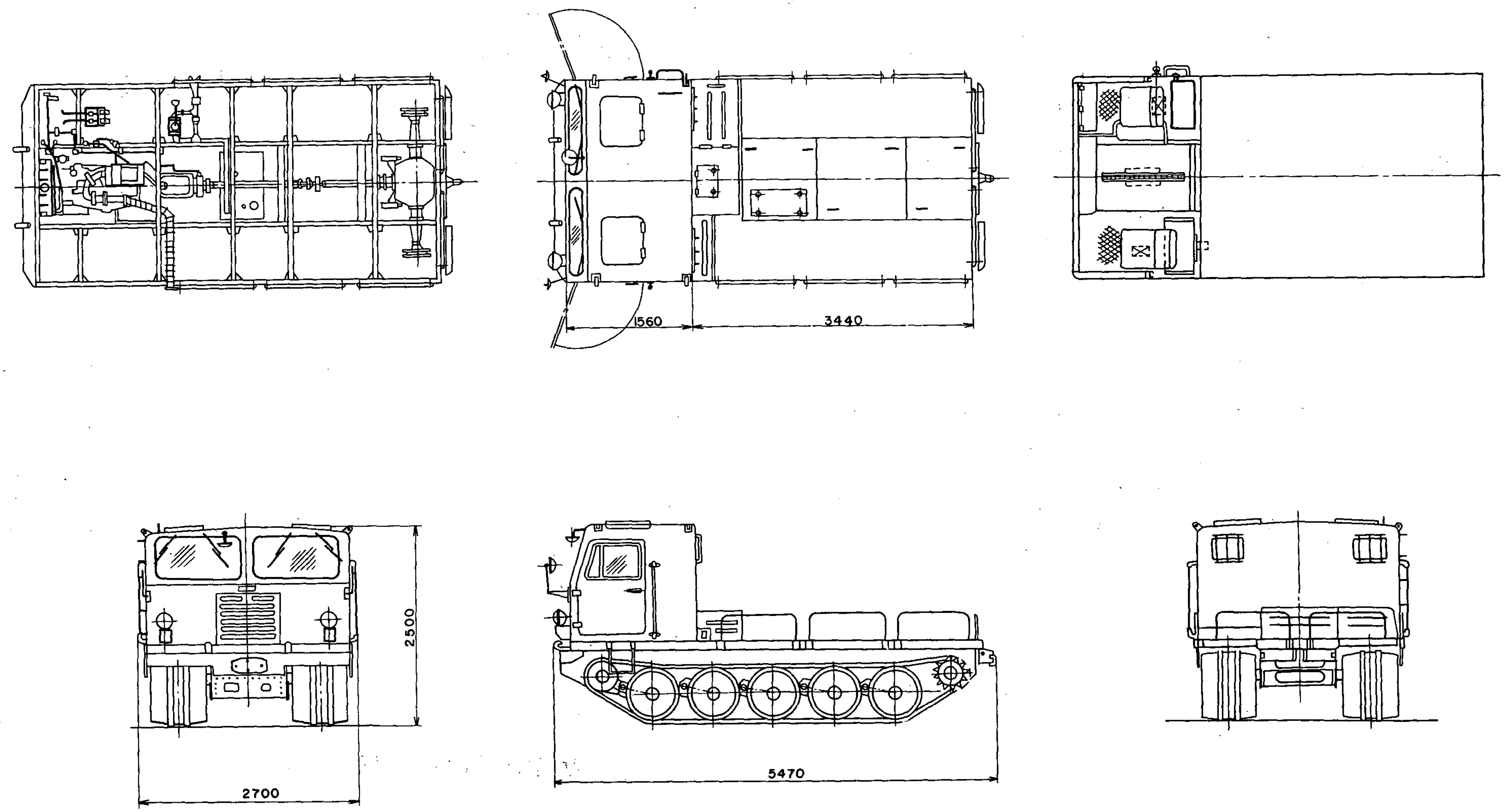


Fig.4 KD604, 605 GENERAL VIEW

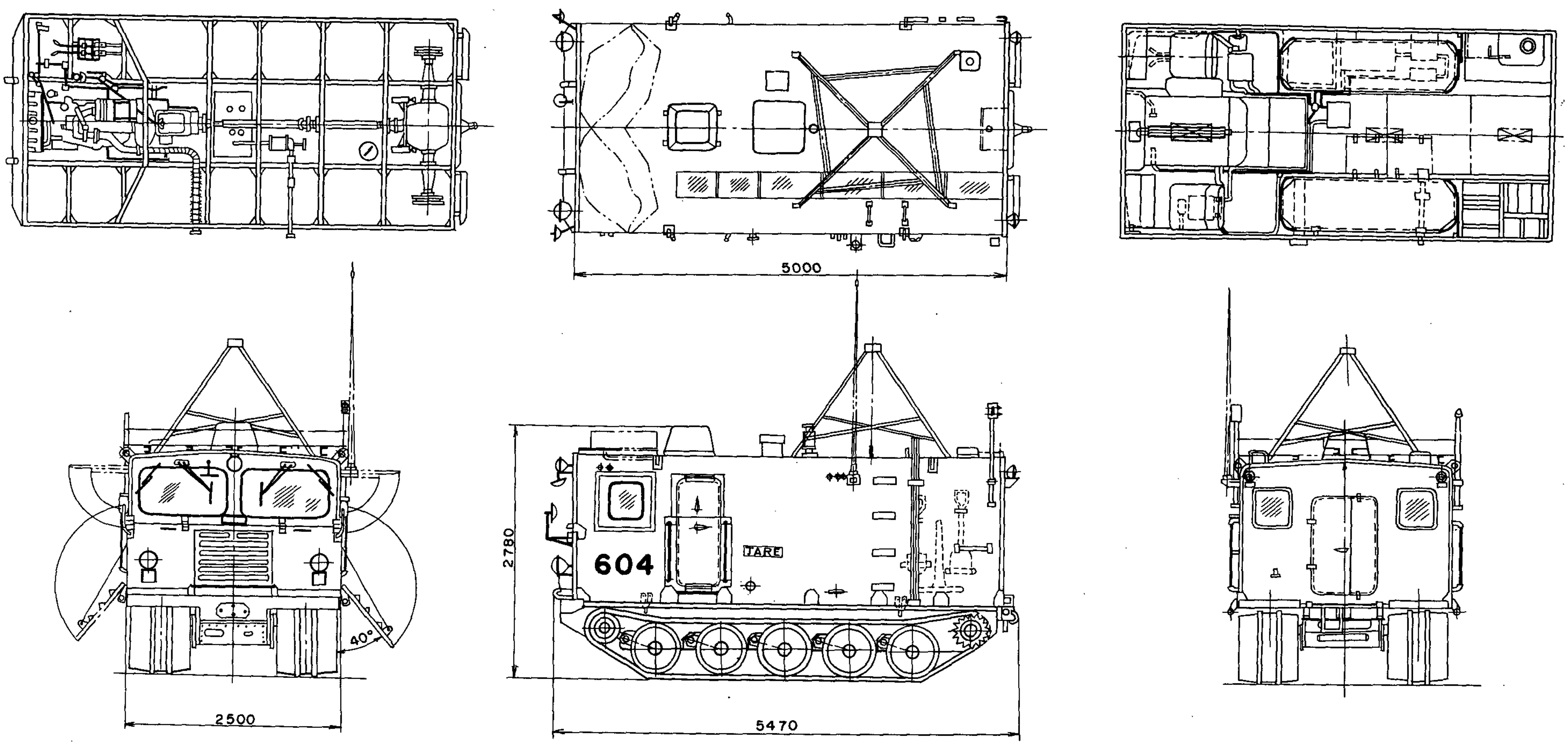
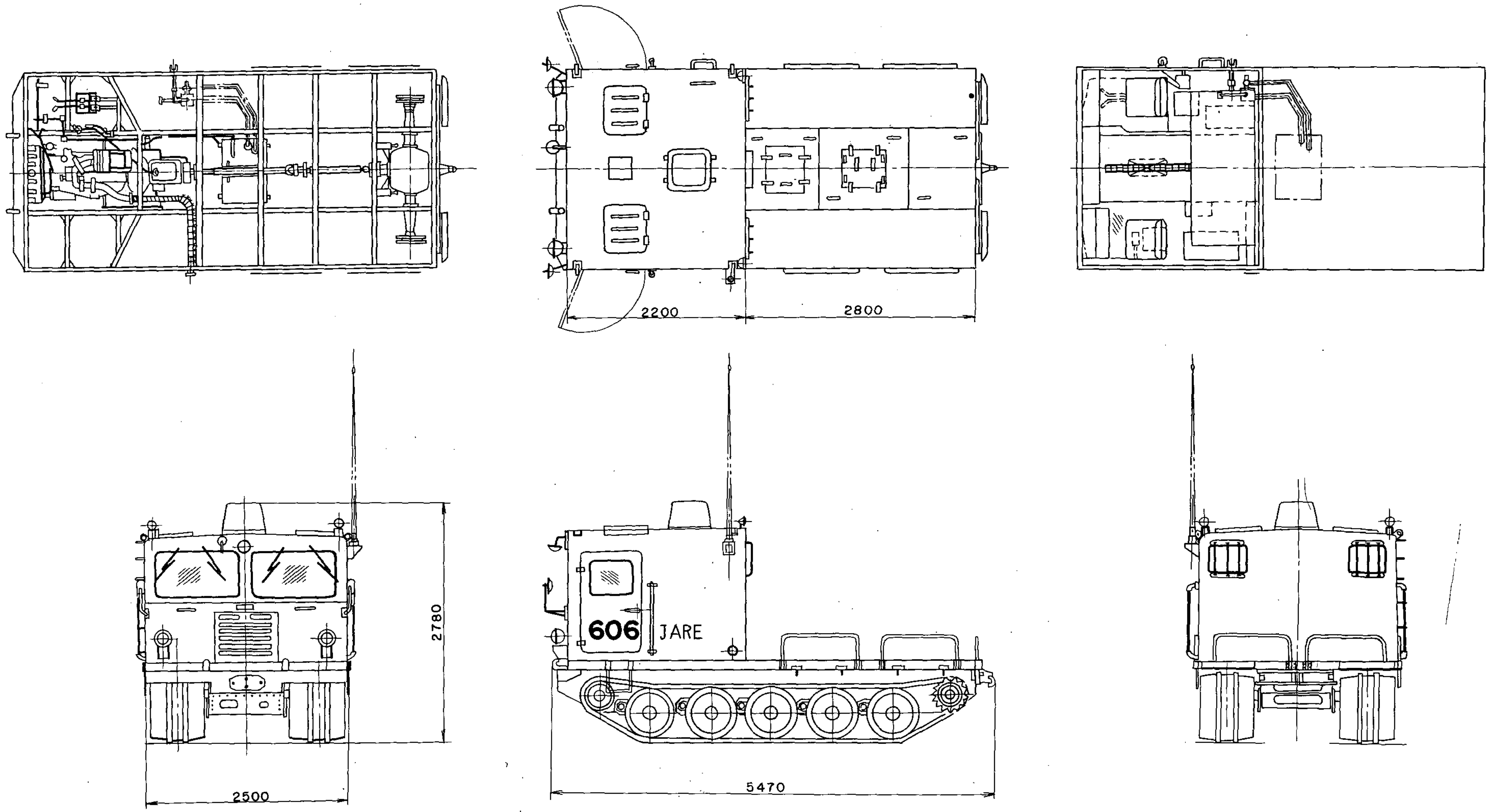


Fig.5 KD606 GENERAL VIEW



assembly test, the first proto-type vehicle was reconstructed mainly for the following reasons:

1. Improvement of travelling equipment and accommodation space.

2. Readiness of repairing and lightening of weight.

The newly improved vehicle was named Remodelled KD-601 which was delivered in 1965 to the seventh expedition. The whole form of the vehicle is shown in Fig. 1. Since Remodelled KD-601 was a little heavier than the original plan, the second vehicle (KD-602) was reconstructed in 1966 so as to be slightly lighter. The road wheels of the medium size were changed into those of the larger size made of alminium alloy. The idlers, differentials, frames, cabins, etc. were also made of alminium materials to reduce weight. Thus two vehicles of this type were constructed, of which one was of the bus-type with the seat capacity of four and the other one was of the two passenger truck-type with shelves, where goods could be laid on. The bus-typed vehicle was named KD-602 and the truck-typed vehicle KD-603, of which the forms are shown in Figs. 2 and 3 respectively. The vehicle of the third type was made in 1967, but was remodelled after the second type and given more space and maintenability. Two bus-typed vehicles and one truck-typed were constructed; the former was called KD-604, 605 and the latter KD-606, which are shown in Figs. 4 and 5 respectively. All new snow vehicle specifications are shown Table 1.

3. Specialities

The specialities of those types of snow vehicles are as follows:

3.1 Superior Cold Resistance:

(1) Starting at low Temperatures:

The basic researches on engine starting at the low temperatures were conducted in the laboratory. In order to start the engine easily even in the severest cold in Antarctica, it was necessary to secure all three of the following requirements:

(a) Utilization of Heat of Engine Coolant:

The engine pre-heater is equipped inside the cabin of the vehicle. The coolant heated by combustion of diesel oil is circulated through the engine to warm it by the water pump installed in the pre-heater.

(b) In order to reduce the starting resistance, the lubricant is warmed by the 600 W heater installed in the oil pan.

(c) Warm air from the engine pre-heater is blown against the starter to make it to start easier.

(2) Materials against Low Temperature:

In the basic studies, the chemical components and micro-structures of the materials and their heat treatment and welding method, etc., which would give effects on the materials at low temperatures, were examined to select the most suitable metalic materials exhibiting high cold resistance. As far as the materials of vehicle construction are concerned, model KD-60 is quite different from model KC-50.

From the results of the basic studies on the non-metalic materials, the cold resistant rubber was used for oil seal and O-ring.

(3) Heat Insulation:

The inside of the frame work was covered with Urethane-resin lining of about 20mm in thickness to keep the power lines warm. The cabins were constructed of double-walls, between which the adiabatic material of 50 mm in thickness was inserted. In order to keep out the over-heating of the engine and the rise of the temperature of oil indifferential gear case during the traverse, the removable lids were equipped at some places of the frame,and to keep out snow from being blower in during the stops of the vehicle, the lids were also equipped on the radiators and the exhaust pipes.

(4) Oils and Grease:

For the use in Antarctica, all of the grease, engine oil, gear oil, diesel oil, hydraulic oil, brake fluid were specially refined.

3.2 Superior Capacity on Plateau:

To make the snow vehicle with sledges traverse without difficulties over the high land of 4,000 m above sea-level under the atmospheric pressure of about 0.6 kg/cm^2 the exhaust charger was carefully selected.

3.3 Method of Observation and Observation Apparatus:

The Japanese expeditions made the observation trips in the vehicles with almost all of the apparatus aboard. The apparatus loaded on each of the vehicles are shown in Table 2. These apparatus were installed so as to be made removable according to the purposes of observations.

The following matters were carried out during the traverse between the Syowa Station and the Plateau Station. There were slight differences

Table 2. Observation equipment for antarctic inland traverse.

o : seted up

x : can set up

Equipment \ Model of vehicle	Snow vehicle (KD-60)						Sledge	
	601	602	603	604	605	606	Caboose	iron sledge
Radio equipment (SSB 50W)	o	o		o	o			
All waves radio equipment		o		o				
Tranceiver	o	o	o	o	o	o		
Beam compass	o	o		o	o			
Gyrocompass	o	o		o	o			
Wind speed and direction meter				o				
Temperature gauge		x		o	x			
ETL		o			x		x	
VLF					o			o
Ice radar							o	
Astro-compass				o	o			
Height indicator		x		o	o	o		
Earth auger						o		
Wild theodolite				o	o			
Barometer				o	o			
Psychrometer				o				
La Coste-Romberg gravity meter		o			x			
E.P. magneto meter					x		x	
Glaciology instrument		o						

among the observation methods according to the purposes of the traverses, but the following methods will be taken up also in the future.

(1) Altitude measurements:

Since the altitude measurements were important not only to know the topography of the continent but also to lay the foundation for other observations, the Japanese expeditions tried to take measurements as often as possible and make their observation readings accurate.

On the way to the Plateau Station they erected flagpoles every 2 km and there took measurements by using a barometer. On the way back they proceeded along the poles, taking simultaneous measurements at the intervals of every 2 km between two points.

The calculation of the altitudes obtained by means of such measurements was performed without making corrections for the changes of the atmospheric pressures, and the temperatures were corrected by using the value which was considered as the average on the day of measurements. Accordingly, they were unable to obtain highly accurate results of the observations.

(2) Meteorological Observation:

In order to know the terrestrial meteorological conditions, they observed four times a day temperature, direction and speed of wind, atmospheric pressure, cloudiness,shapes of clouds, range of vision and weather.

(3) Guasi-seiomological Observation:

Guasi-seismological observations were taken at various places as far as Lat. 75° S at intervals of about 50 km to study the depth of the continental ice.

By setting the pickup on the snow, boring the ice, setting off dynamite in the hole, they caught the waves of elasticity by the apparatus installed in the vehicles. They adopted the two point refraction method for the observation. The taperecorders and oscillographs were installed in the locker of the cabin. These apparatus were protected against the shock with Urethane-resin foam of 50 mm in thickness.

(4) Gravity Measurement:

As a supplementary means for studying the depth of the continental ice and for the purpose of studying variations of gravity between the Syowa Station and the Plateau Station, the Lacoste and Romberg were used for measurements. Taking into consideration a case where the gravity measurement could not be carried out of the vehicle owing to the bad weather, an observation hole was provided in the cabin, from which ground surface was reached.

(5) Terrestrial Magnetism Measurement:

In order to study the distribution conditions of the terrestrial magnetism and to make use of them for the traverse operation, they measured the declinations and the dips of the terrestrial magnetism at interval of every 50 km by using the EP magnetometer.

(6) Researches on Surface Layer of Snow:

In order to study the properties of snow near the surface layer and estimate the quantity of snowdrifts, they measured the hardness of the surface of snow at some intervals, and the density of snow by making use of the core of boring and collected samples. They dug pits to measure the temperature and the density of snow, and on the other hand, by the use of the boring hole, measured the temperature of snow and estimated the annual average temperature.

(7) Researches by Using Snow Stakes:

In order to study the conditions of snowdrifts and the movement of the glacier, they erected the snow stakes to measure the height of the drifted snow and measured the correlative and absolute positions. In order to know the condition of snowdrifts in more detail, it was considered that reexaminations would be necessary.

(8) Research of Sastrugi:

In order to study the direction of the prevailing wind direction at places, they measured the direction and the shapes of Sastrugi.

(9) Geochemistry:

In order to study the distribution of materials, they collected snow at intervals of about 50 km to make its analysis.

(10) Astronomical Observation and Azimuth Determination:

The determination of the correct points for observation being the most important work for the traverse work, they measured them with great care.

They carried out solar observations at intervals of about 1° latitude by the use of altazimuth and also magnetometers as a supplementary instrument.

3.4 Wireless Apparatus and Equipments for Traverse:

The wireless apparatus was installed in the vehicles to keep contact among them, or between the vehicles and Syowa Station or other bases of the foreign countries in the vicinity. Model 50WSSB transmitters and all-wave receiving apparatus were used for such purposes. For the source of electricity, were used batteries of 24V. These equipments were supported on rubber mounts to prevent troubles due to vibrations, and in order to prevent noises all the electric apparatus such as heaters and wiper motors, which are apt to become sources of noise, were equipped with noise-preventive devices. To keep contact among vehicles were used 0.5W transceivers, which were kept in the cabinets covered with Urethane-resin to protect them from vibrations due to vehicles. The transceivers were easily recharged by the use of batteries for vehicles. For the wireless apparatus and transceivers the whip antenna were commonly used, having been which were installed on the side of the vehicle.

As the equipments for traverse, the beacon straight drive guiding apparatus and gyro-synchro-compasses were installed in the vehicles.

The becon straight drive guiding apparatus is an apparatus which checks whether the vehicle is proceeding straight or not, by changing electric waves into signal sounds, which are transmitted from the rear vehicle. All the vehicles were installed with the brackets for becon antenna, so as to make any of the vehicle can be used for as a front or a rear vehicle. The gyro-synchro-compass is a machine which responds to the terrestrial magnetism by the flux-bulb installed in a vehicle and shows the terrestrial magnetic azimuth. Since the indicater was installed at the center of the instrument board, the compass direction was easily perceived and the change of direction was carried out without any difficulty.

In order to maintain the precision of the flux-bulb, which was apt to be influenced by the vehicle made of steel, it was installed 1,300 mm above the roof of the vehicle held by the support made of aluminium.

3.5 Operation of Vehicles and Maintenance:

(1) Traverse on Ice:

At the starting point for the ascent of the Antarctic Continent in the vicinity of Syowa Station there lies an area of ice. Especially at the point 3 km from the sea shore there is a steep slope of ice area with a gradient of $4^{o}50'$, and the snow vehicles slipped often. Therefore spikes were installed on the tracks of the vehicles to prevent them from slipping, by such means as shown in Fig. A.
A spike consists of rubber and a pin, both of which are removable.

The 2nd-type vehicle with these spikes did never ship when it drew up the sledges of 3.5 tons in weight on the slope. The vehicle Model KD-602, 603 with these spikes, which drew the sledges of 5.5 tons in weight, slipped four times on the first steep slope, but did not slip on the other slopes.

(2) Traverse in Crevasse Area:

When the vehicles traversed the dangerous area of ice where there were many crevasses, one of the crew of the leading vehicle got out of the car and confirmed the safety of the surface by using a sonde pole to pass the vehicles. The sonde pole is a kind of a rod of alminium of about 2,000 mm long, at the end of which a piece of steel is fixed to it. The pole was installed on the front part of the vehicle. As the crossing ability of the vehicle over the crevasse was about 2,000 mm, there was not any difficulty in crossing over narrower crevasses.

(3) Traverse in Sastrugi Area:

The area covering from Lat. 70° S. to 74° S is the Sastrugi area. The Japanese expeditions could not reach the inner part of the Continent without passing this area. In order to the vehicles pass easily the sastrugi area the following countermeasures were taken:

(a) All of the ten road wheels of the vehicle (in the case of the 2nd type vehicle, eight wheels) were constructed under the independent suspension system so as not to be influenced by the road surface. In the gap between the chassis and the cabin, rubber was inserted to absorb the vibration of minor frequency.

The stop-gap between the chassis and the cabin is shown in Fig. B. The galvanized copper plate on the outside helps to make complete electric oonnection between the chassis and cabin, and also was useful for protecting the wireless apparatus from noises.

(b) Ground pressure was made as smaller as possible to avoid difficulties in passing over soft snow on the top of Sastrugi, and on the other hand the minimum ground clearance was increased to have a greater sinking rate. The ground pressure of each vehicle was between 0.20 and 0.18 kg/cm^2. The minimum ground clearance was 340 mm in height and the capacity of crossing ice bank was 300 mm in height.

(4) Traverse on Soft Granular Snow:

Since there was an area of soft granular snow in the south of Lat. 75° S, they took the same counter-measures as described in the above (b). During the traverse between Syowa Station and the Plateau Station, they found, when they crossed the area of soft granular snow, that the vehicles sank deep and slipped often and that their drawing capacity fell remarkably. In order to traverse in such an area with less difficulty, the weight of the vehicle should be lighter to make its ground pressure smaller, and the position of the pintle hook and the center of gravity should be reexamined.

(5) Landing of Vehicles and Overland Transportation:

In view of the ice breaking capacity of the Fuji, Japanese observation vessel, and also of the geographical conditions of Syowa Station, when the snow vehicles were unloaded, they had to traverse on the thin ice to Syowa Station or the nearest Continent. If the ice was too thin for the vehicles to traverse, it would have be necessary to transport them by helicopters. In order to be able to traverse over the ice on the sea, it was desirable to make the vehicles as lighter as possible. For this reason the vehicles were so constructed as to separate the cabins from the chassises, whenever necessary and run by themselves. The chassis without the cabin was lighter by 2,000 kg and its ground pressure became 0.13 kg/cm, so that the chassis could traverse on the thinner ice than the complete vehicle.

When the chassis could not traverse by themselves, it could be separated into six sections, each of which weighting 2,500 kg light enough to be carried by a helicopter.

(6) Repair and Adjustment Coordination of Vehicles:

Because of severe cold, the vehicles were constructed so that repair and adjustment might be carried out within their cabins. Greasing and draining were done outside the vehicle, but the adjustment of those relating to the power line and control, such as engine, transmission, propeller-shaft differential, was carried out in the cabin.

As the batteries were installed in the cabin, the inspection of the specific gravity and electrolyte were conducted inside the cabin. Battery charging could be done in the cabin by using the plug receptacle protruded outside the cabin. The plug receptacle for the inspection lamp was installed in the cabin that inspections were easily carried out in the evening or on objects in the dark places.

(7) Hauling and Winch:

At the back of the vehicle a pintle hook was fitted to haul a sledger of about 11 tons in weight. The pintle hook having a spring buffer in itself could absorb a certain amount of shock at the time of starting and during the traverse. At the front of the vehicle a hook was fitted for towing and a winch of 2,500 kg in capacity was installed with a wire-rope of 60 m in length.

3.6 Accommodation:

During the traverse between Syowa Station and the Antarctic polar region extending over a long period of about five months the foundation of life such as observation, sleep, diet, etc. depends solely on the facilities of a snow vehicle.

In order to improve the roominess, efforts have been made on the following points:

(1) Heating:

The circuit of heat is shown in Fig. C.

The engine pre-heater consists of a burner which warms water by using diesel oil and a water pump. When the engine starts it can warm the engine cooling water and when the engine stops it can warm the cabin by turning the three-way cock.

When the engine in motion, the circuit of heat is set up as shown in the figure and the engine cooling water runs through the tank to warm the cabin. To supply the insufficiency of head of the cooling water, the water pump of the engine pre-heater is put in motion. If the temperature in the cabin is not high enough, the diesel oil burner of the engine pre-heater way be put on to warm the cooling water.

In order to warm the cabin while the engine is not in operation, the engine cooling water is made to circurate to warm the cabin, by setting the three-way cock, and by operating the gasoline burner and the water pump of the engine pre-heater.

The floor and the walls of the cabin are made of the double plates of aluminium alloy and between them an adiabatic material of 50 mm in thickness is inserted. The ceiling is made double, aluminium alloy plate for the outside and hard board for the inside, between which an adiabatic material of 50 mm in thickness is inserted to keep warm.

The windows of the front, the both sides and the rear of the vehicle are made double, the outer ones of which are fixed, while the inner ones removable. Between the two plates of glass warm wind can be blown in to defrost.

Fig. A

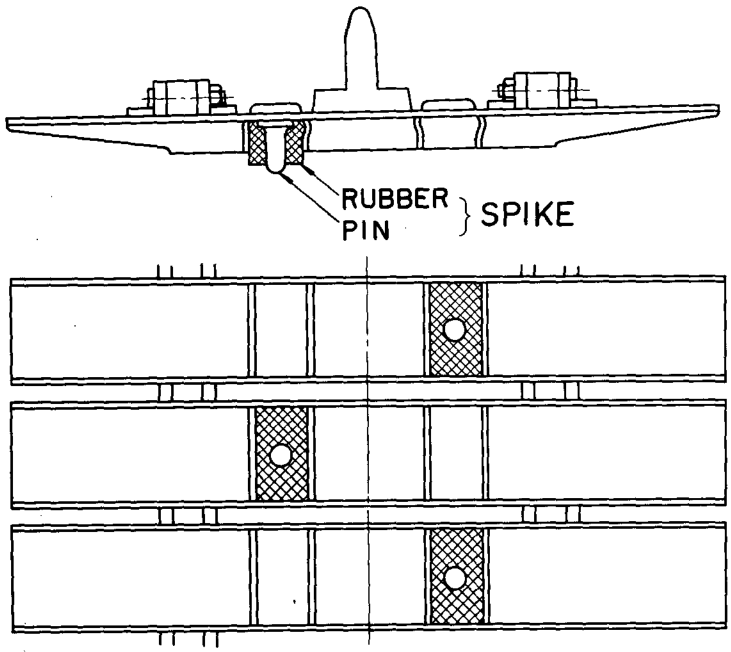


Fig. B

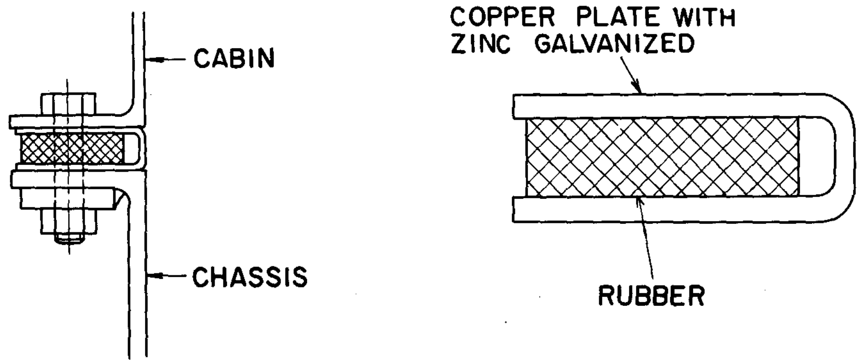
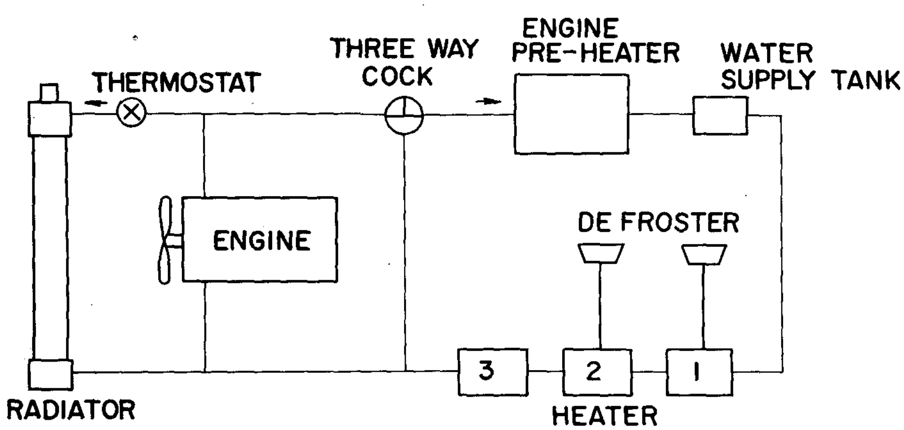


Fig. C



(2) Bedding:

In the standard vehicle of buss type beds for four persons are provided. These beds are double decked and are set at the right and left sides of rear part of the cabin. The upper bed is made of canvas and of bascule type. The lower bed, which is placed on the lockers, is made of steel with the cushion of 20 mm in thickness.

(3) Water Supply and Storage:

The water making apparatus was installed at the rear part of the vehicle of the third type, by making use of the engine cooling water.

On the water making apparatus was fixed the water storage tank to which water was sent from the water making apparatus by the pump with an electro-magnetic valve through piping connected between the water making apparatus and the storage tank. The water making apparatus has the capacity of 6 l and the storage tank has the capacity of 20 l.

(4) Kitchen-table:

In the bus-typed vehicle there is a kitchen table at the rear part of it. The surface of the table is covered with a stainless steel sheet, on which a small kitchen range can be placed. Under the table is fixed a cupboard in which some amount of food stuff can be stored.

(5) Ventilation:

The exhaust ventilator was installed just above the kitchen table to discharge the air polluted by cooking, and also the waste gas produced by rapid charging of the battery was discharged through the pipe connecting the battery box with the same ventilator. At the front part of the cabin there was fixed an intake fan with filter at the inlet to keep off powdery snow.

(6) Emergency Exit:

An emergency exit with doors which can be pulled open inwards was provided at the center of the ceiling of the cabin for getting out quickly in case of emergency.

4. Traverse between the Syowa Station and the Plateau Station

For the purpose of finding the route to the South Pole, storing fuel, making tests of the vehicles and so on, a round trip for observation covering 2,500 km was made between the Syowa Station and the Plateau Station for about three months from November, 1967.

The results of the trip are as follows:

4.1 Route:

As shown in Fig. 6.

4.2 Traverse:

The traverse to the Plateau Station covering 1,331 km and back to Syowa Station covering 1,165 km, or the total of 2,496 km, was recorded by the tachometer. The difference between the distances of outward and homeward traverses seems to have been caused by the fact that on the outward way the vehicles traversed a longer way and what is more owing to the upward slopes they slipped more as they were hauling heavier sledges. The quantity of fuel consumed and the traction load of each vehicle are shown in Figs. 7, 8 and 9.

In the case of the vehicle of KD-601 type, the average quantity of fuel consumed on the outward way was 2.47 l/km and on the homeward way 1.81 l/km and the average speed was 4.64 km/h.

4.3 Organization:

The observation party was composed of nine persons, including Dr. Torii, as a leader of the party. The persons in charge of snow and ice observation and meteorological observation, one wireless operator, one doctor and two persons in charge of machinery participated in the party. Three large-type snow vehicles of model KD-60 and one smaller type snow vehicle of model KD-20 were used. Each of the large type vehicles hauled, as a rule, one large sledge, two medium size sledges and one caboose. The smaller type vehicle of model KC-20 was used as the leader and scouter.

The organization of one train was as described above. According to the condition of snow and others, the volume of load for each vehicle was changed.

The weight of the traction load of each vehicle shown in Figs. 7, 8 and 9 includes the weight of the sledge.

Three large type vehicles traversed under the organization are shown in Fig. E.

4.4 Problems during Traverse:

(1) Vehicles at the Low Temperature:

The engine starting did not experience any trouble during the traverse.

The engine pre-heater could raise the water temperature up to 35°C - 40°C, by its operation for one hour, when the outdoor temperature was around -30°C--35°C, and thus the engine could start easily. The utilization of the remaining heat such as blowing the warm wind up the starter, warming up the lubricating oil by using the oil pan heater, was not necessary. Heating in the cabin was satisfactory. When the outdoor temperature was around -30°C -- -35°C, the room temperature at around -10°C — -15°C was raised up to 5°C — 8°C by one-hour heating.

The color of paint on the outside of the vehicle had a great influence on the temperature in the cabin. When the sunshining time was longer, the temperature in the vehicle of KD-601 type painted OD was warmer by 3°C — 5°C in comparison with the temperature in the vehicle of KD-602 type painted blue or KD-603 type painted green.

The lowest outside temperature during the traverse operation was -42°C. No part of the vehicles went wrong even in that temperature. The superiority of the vehicles against the low temperatures was demonstrated.

(2) Efficiency on the Plateau:

During the traverse operation, the vehicles went up to the place of 3,624 m above the sea level in the Plateau Station. Except increase in fuel consumption rate no serious problem occured.

(3) Observation:

Without any mishap to the meters, which are commonly apt to be affected by vibrations, the observations as had been reported in Part 3.3 were smoothly carried out.

(4) Wireless Apparatus and Others for Traverse Navigation:

The vehicle of KD-601 type was equipped with the 50W SSB communication apparatus and a whole-wave receiver, and that of KD-602 type with the 50W SSB apparatus only. In addition each vehicle was equipped with the 0.5 W transceiver to keep contact with the other.

With the SSB communication apparatus they could make contact with the Syowa Station, the Molodyozhnaya Station and the Plateau Station without any difficulty. Especially with the Syowa Station they could keep telephone contact almost all of the way.

They could also communicate with the Plateau Station on telephone, but in case of communication with more distant places, it seemed necessary to change the antena and use the morse codes.

The SSB apparatus was equipped with a whip antena, with which it could communicate while traversing.

When the atmospheric conditions were not so good or the signal sounded very weak, being disturbed, by noises, they exchanged communications by stopping the engine.

On account of the weak output of the transceivers they had to receive communications by making gain as large as possible. In that case the noises due to the vehicle influenced greatly. It was observed that the maximum limit of the transceiver for communication was about 5 km — 6 km.

The vibrations due to the vehicle did not cause any trouble to SSB wireless apparatas or to transceivers.

The traverse navigation was guided by the use of gyro-synchro-compasses loaded on the leader vehicle of KD-602 type, but the compasses were not always dependable, so they were corrected every 2 km by using the portable compasses.

(5) Traverse Operation and Arrangement:

On the ice area at the entrance to the Continent spikes were fixed to the vehicles as shown in Fig. A.

Since one snow vehicle, Model KD-60, even though large type, could not haul a train of heavy sledges, 2 small type vehicles, KC-20 and KD-20, helped to haul a part of the train as far as the point F16 in Fig. 6.

In the crevasse area the vehicles proceeded finding a safe route by using sonde pole.

The direction of Sastragi from Lat.70°S to 75°S is shown in Fig. F.

The leader vehicle which depended only upon the gyrocyn compasses poked its front part often, occasionally several times a day, into the soft snow lying to the leeward of Sastrugi and could not proceed. It repeated chargings to get out of the place. The following vehicles could narrowly kept away from the site of soft snow at Sasturgi, but it was very difficult operation for the vehicles hauling the heavy sledges to take a long way around the Sastrugi, so sometimes they also had to make chargings like the leader vehicle. The vehicles bumped heavily, but did not get out of order. In the south of Lat. 74°S, there was an area of the soft granular snow stratum. The surface of the area was hard to a certain depth but it seemed that there lay a stratum of soft granular snow of several meters in depth. When the vehicles traversed over such an area with the sledges, their sinking speed became great and the vehicles slipped oftener and lost their pulling capacity remarkably.

In the north of Lat. 74°S each of the vehicles, KD-601 type and KD-602 type could haul the sledges of about 8 tons in weight, but near the Plateau Station could pull only 2 on 3 tons of goods. For that reason they had to leave some of the fuel on the way to cut the weight to be pulled.

The small type vehicle, model KC-20, and the large type one, KD-603, of truck type, did not lose much of their pulling capacity, since they had the center of gravity at the rather forward part of the bodies and their ground pressure was less and in addition they had more wheels.

As the land around there was over 3,000 m above the sea level, the vehicles slipped oftener and consumed more fuel, at the rate of over 3 l/km.

During the traverse operation eight of the personnel drove the vehicles in turn every 10 km. Simple works, of the vehicles such as greasing, etc. were done by all of the personnel in cooperation, and larger repairs were done by the two mechanics. They gave the vehicles two overhaulings, one at Lat. 75°S and the other at the Plateau Station, according to, the directions for repair published by Komatsu Manufacturing Co., Ltd. There was no problem in the overhaulings.

(6) Accommodation and Daily Life:

The daily program of the party was as follows:

Time	Description
09:00 - 10:00	Heating for about one hour after getting up.
10:00 - 11:00	Breakfast
12:00 - 12:30	Starting of trip after astronomical observations

Time	Description
13:00	Astronomical observation by the vehicle of KD-602 type
15:00 - 15:30	Regular exchanges of communication with the Syowa Station, the Plateau Station and the Fuji, Japanese observation vessel.
23:00 - 23:30	Arrival at the destination
24:00 - 01:00	Dinner

All of the personnel took breakfast and dinner, gathering in the caboose. At lunch time they took sandwiches by turns. The drinking water was made by melting snow in the cabin. The vehicles were not equipped with water-making facilities. Toilet facilities, were installed in the carboose.

Traverse was conducted in the afternoon when the atmospheric conditions were quiet, and they took sleep in the morning. Owing to the sun shining through out the day, it was bright in the cabin, and so when they went to bed they had to pull curtains over the windows of the cabin.

(7) Spare Parts

The Japanese Expeditions who could not expect the cooperation of airplanes had to carry with them a large amount of spare parts. They made traverse operations with spare parts of about two or three tons in weight loaded on the sledges.

5. Postscript

Three years elapsed since the first snow vehicle had been developed and during this period six vehicles were completed.

As the traverse operation in the Antarctic region, the observation trip to and from the Plateau Station was the first. Before that time, several trips around Syowa Station had been made and in Japan several experimental trips had been operated in order to collect materials on the conditions of the vehicles for their improvement. The data and experiences obtained during the traverse operation to and from the Plateau Station would be valuable and useful for the future advancement. The old-resistance ability of the snow vehicles, which was one of the greatest problems for the traverse was verified with favorable results. It is clear, however, that the shortage of pulling power of the vehicles and the increase of their fuel consumption on the soft granular snow in the south of Lat. 75°S experienced, for the first time, by the Japanese expeditions presented a big problem to be reserved for future solution.

To the Japanese Expedition which aims to go to the South Pole, there are left some difficult problems related to the proposed traverse on the deep, soft granular snow area, such as reduction of vehicle weight, lowering of height of pintle-hook, etc. In addition, to pass across the sastrugi belts safely, development of powerful track shoes is required. On the others hand, there remains the problem of better cabin accommodation during the traverse operation under the several atmospheric conditions, which will conflict with the loading capacity of vehicle. Solution of these conflicting problems is left to be solved in the near future.

If we can make planned experiments on the snow vehicle in the polar region in the light of the results obtained during the traverse operations to and from the Plateau Station, we shall be able to get more useful and clearer information than we can have through the tests conducted in Japan, and construct a far better snow vehicle than we have now.

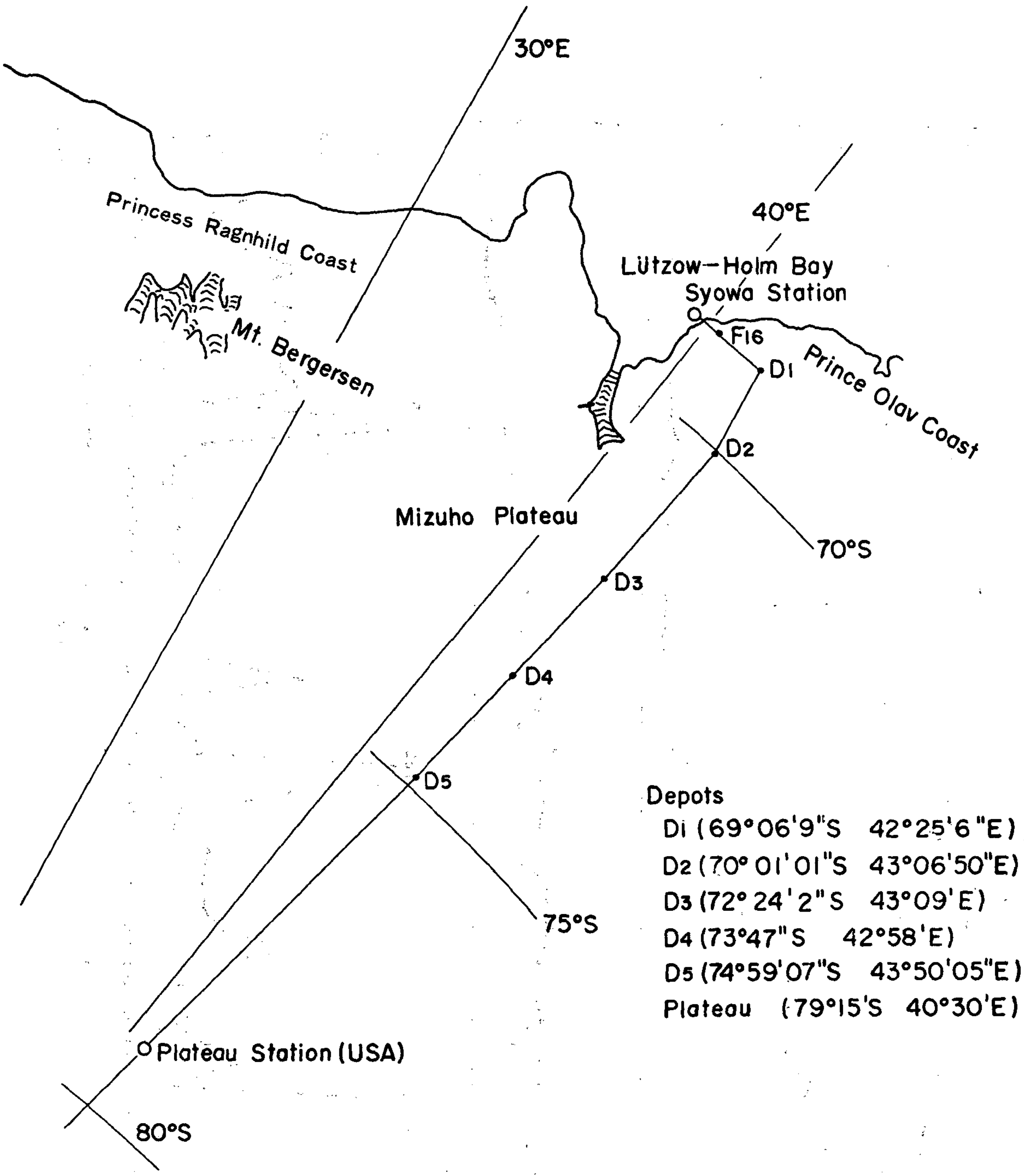


Fig. 6. Traverse route between Syowa Station and plateau Station.

Fig.7(1/2). Performance curve of model KD-601.

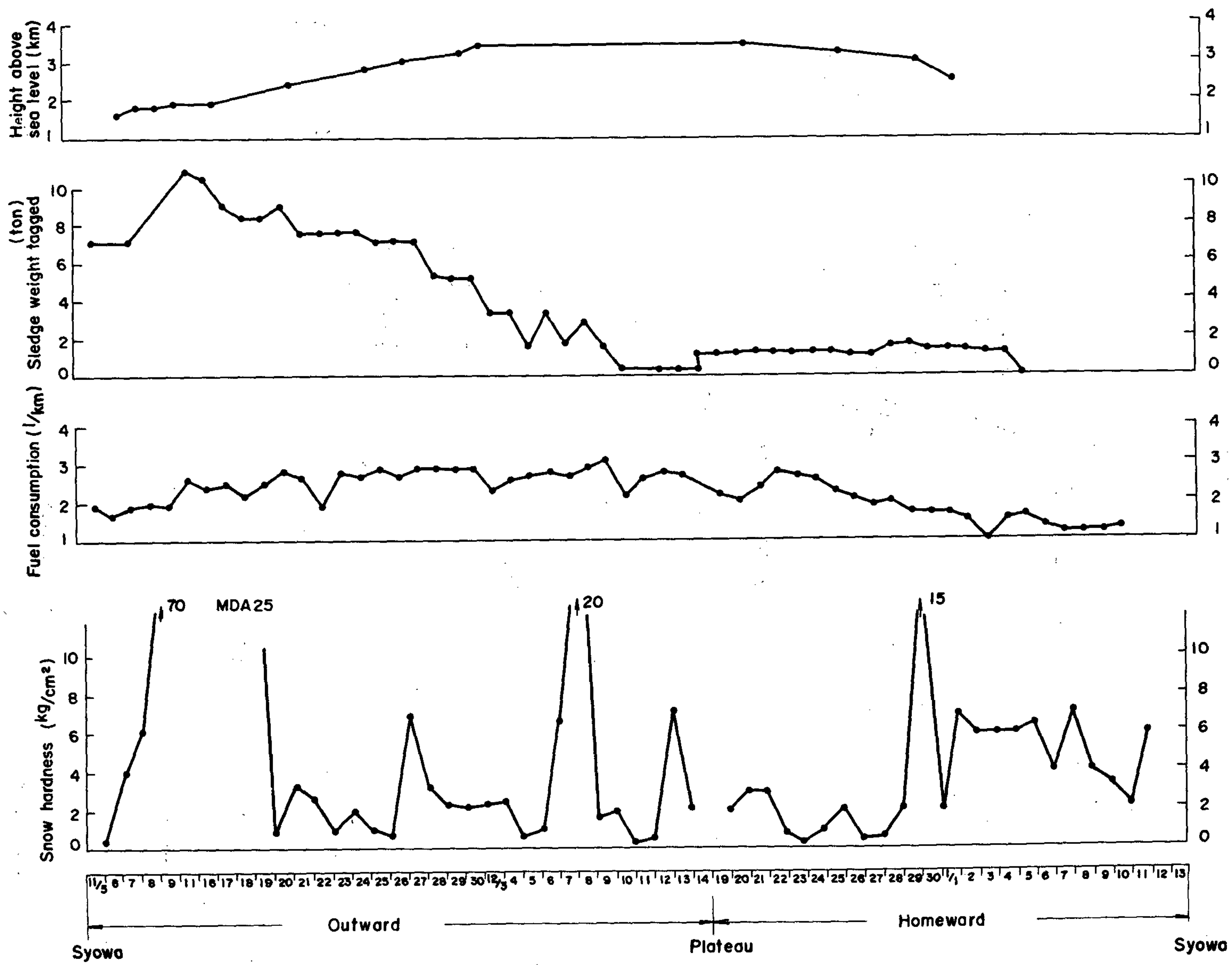


Fig. 7 (2/2).

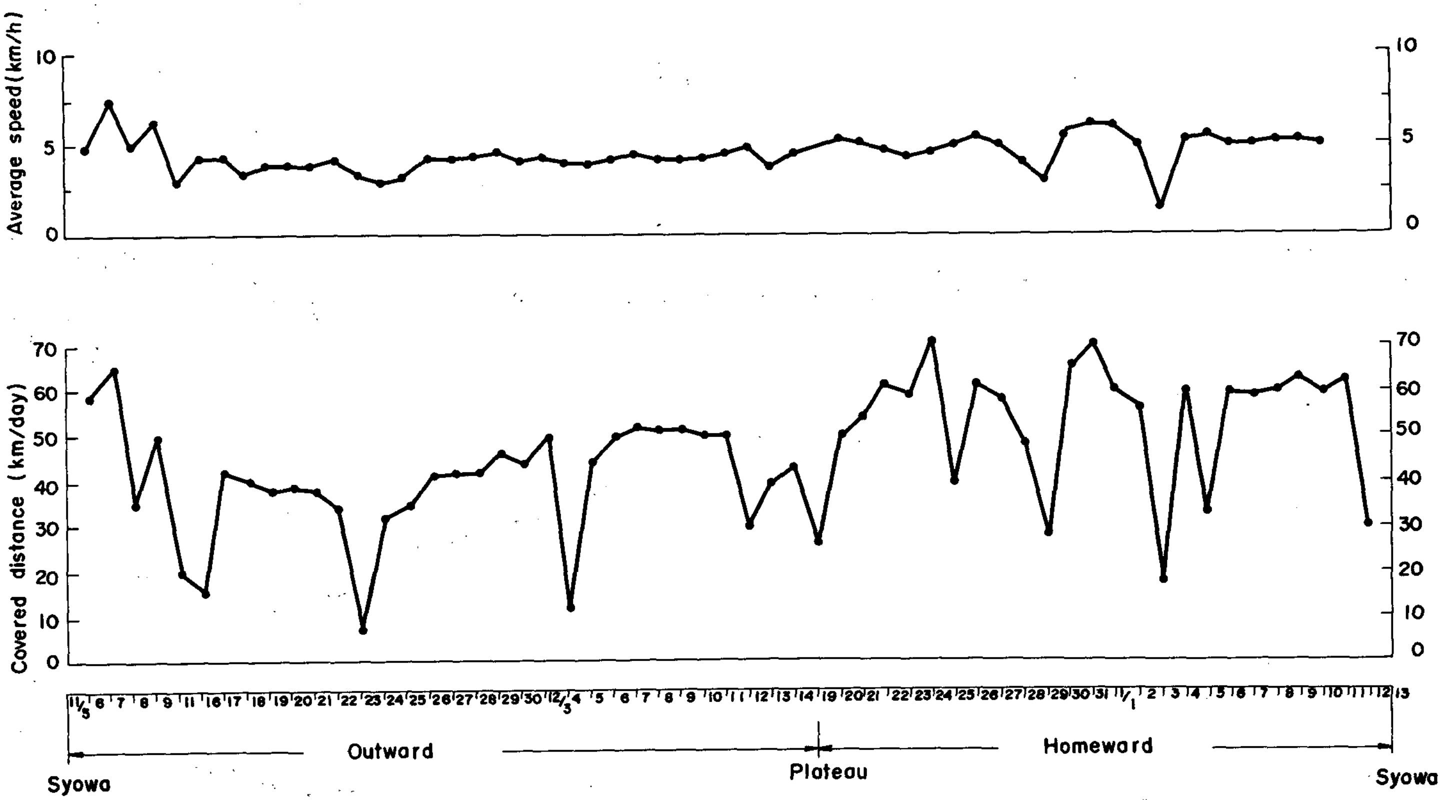

Average speed (km/h)
Covered distance (km/day)
Outward
Homeward
Syowa
Plateau
Syowa

Fig. 8. Performance curve of model KD-602.

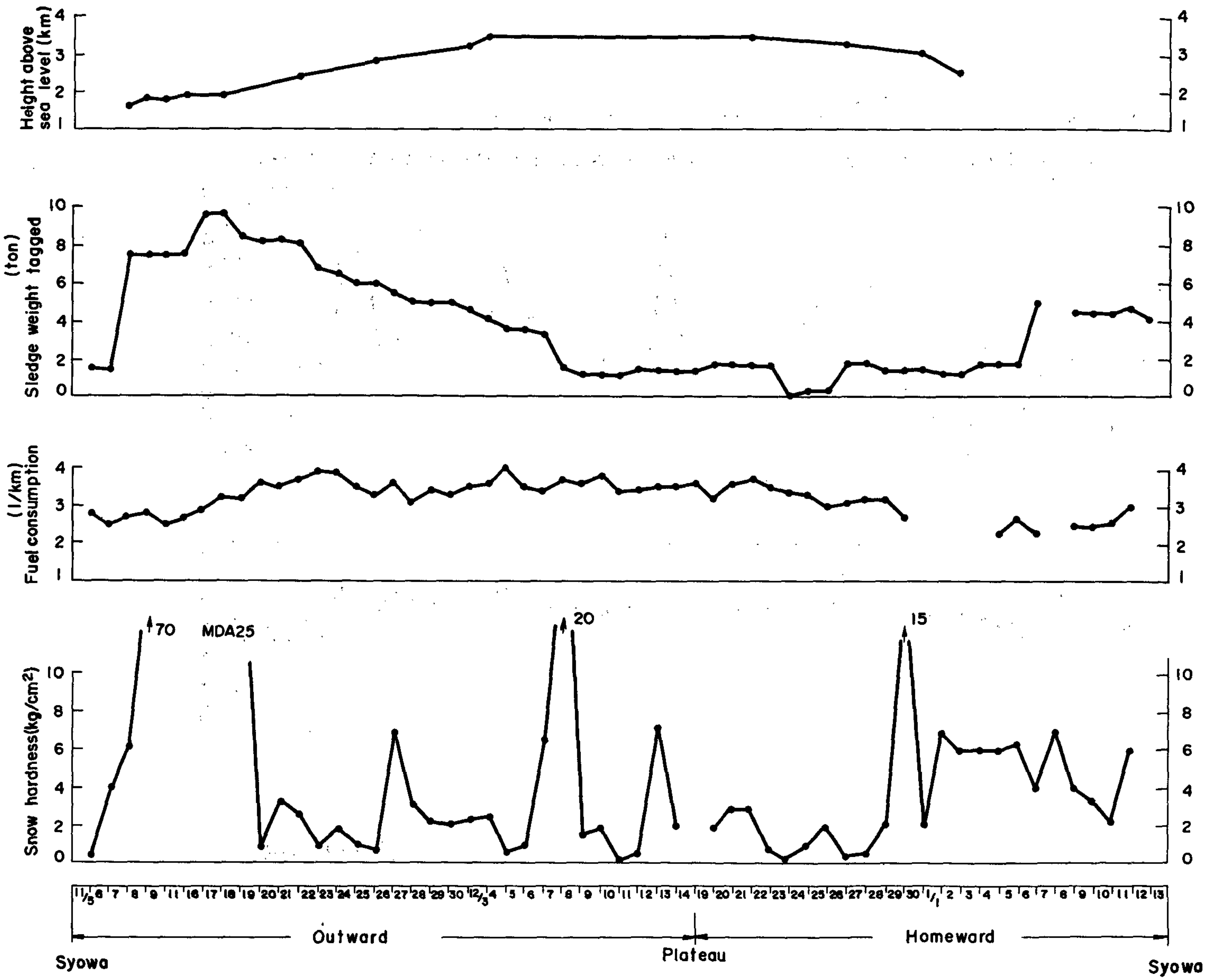


Fig. 9. Performance curve of model KD-603.

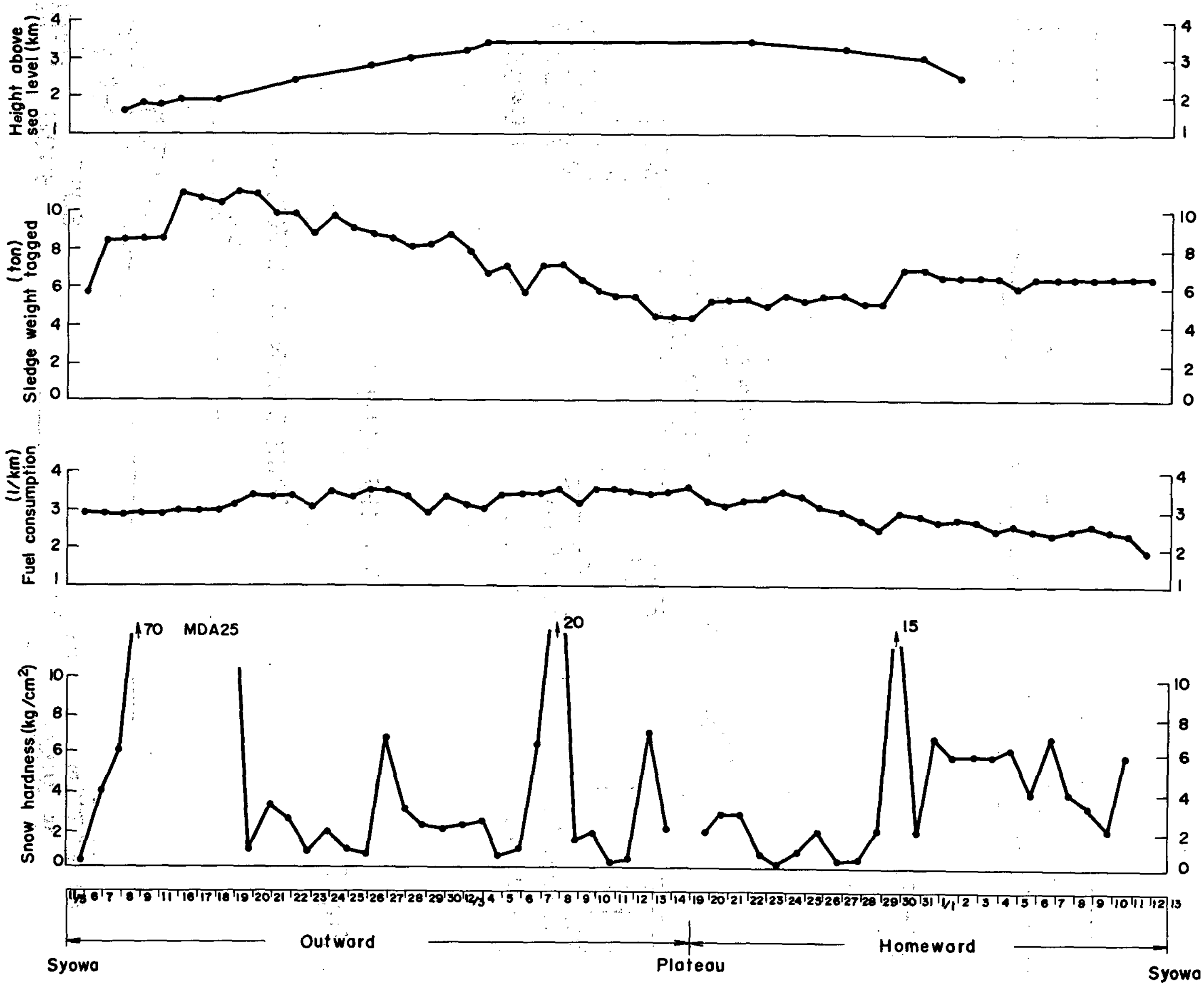
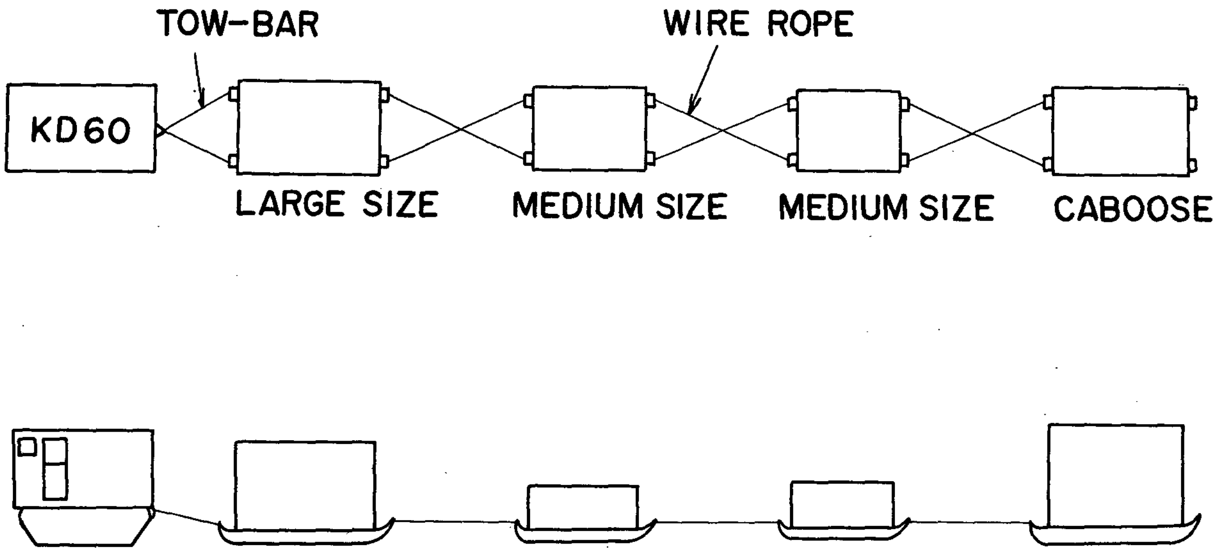


Fig. D



Fig, E

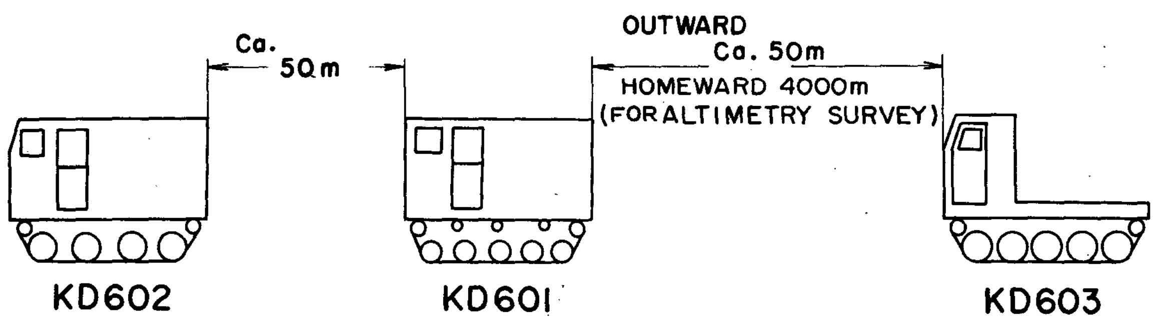
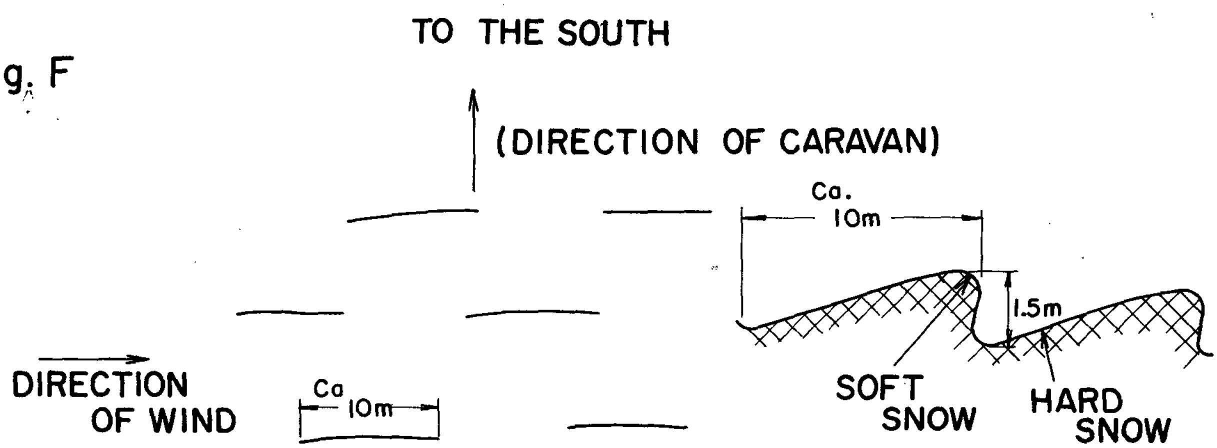
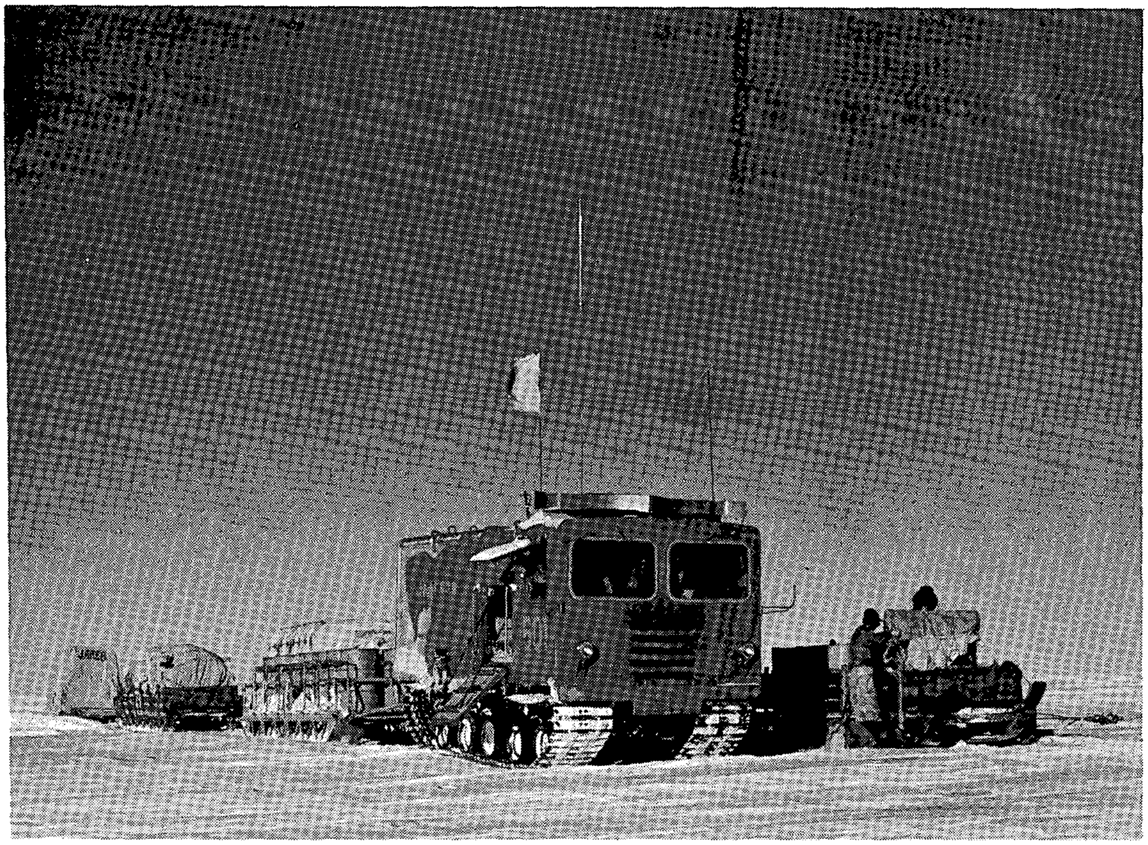
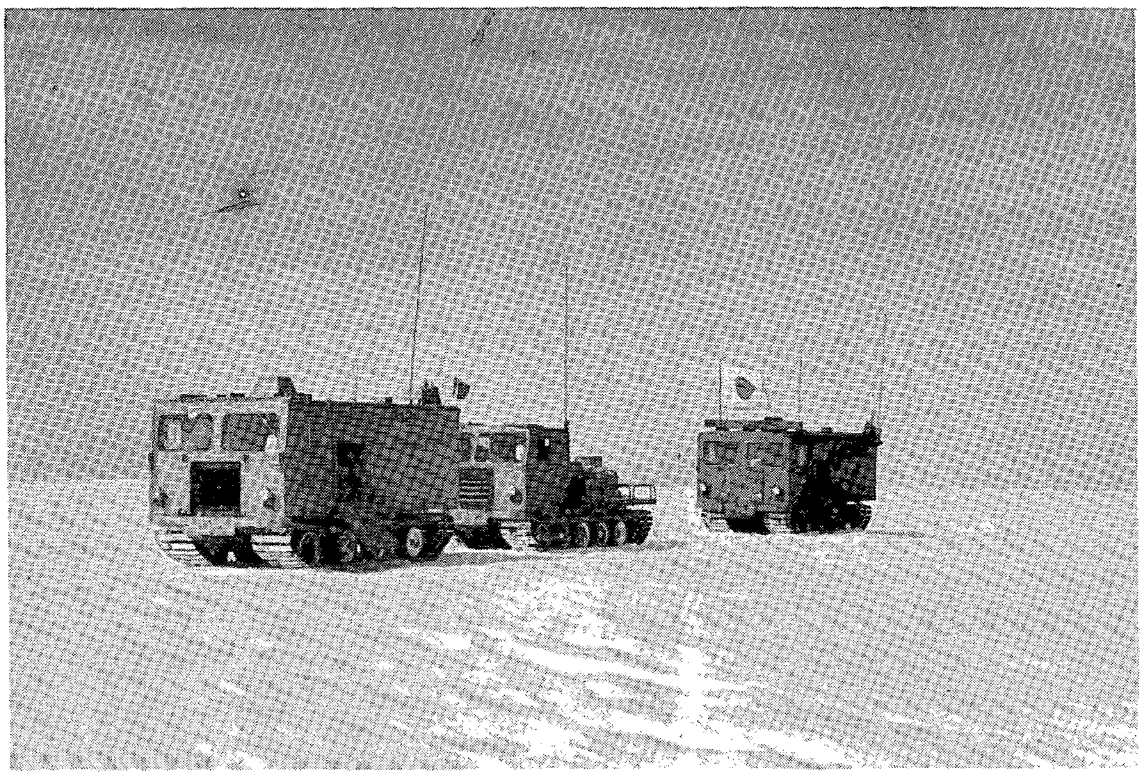


Fig. F





Japanese oversnow vehicle KD-60.



Japanese oversnow vehicle KD-60 (From left to right; No. 602, 603, 601)

HUMAN AND MECHANICAL FAILURES IN TEMPERATURES BELOW MINUS 60 DEG F.

R. B. Thomson*

During the ANARE Wilkes - Vostok Traverse of 1962-63 temperatures down to minus 82 degrees F were encountered. Temperatures below minus 60 degrees F were common at an elevation well in excess of 10,000 ft. It is considered that this temperature of minus 60 degrees F could well be termed the "cold barrier" for humans and mechanical equipment for it was found that major problems rapidly developed below this temperature. Such problems included the following:

1. Solidifying of fuels, oils, lubricants and low temperature coolants.

2. Rapid metal fatigue. Particularly the failure of welds.

3. Crystallization of synthetic materials following earlier hardening at warmer temperatures.

4. Hardening of natural rubber resulting in immobilizing vehicles equipped with rubber tracks and failure of insulated cables through cracking, splitting and consequent loss of insulation.

5. High heat losses which render normal Antarctic methods of pre-heating vechiles for starting purposes quite useless.

6. Extremely difficult working conditions for personnel. Man becomes an easy victim to severe frost bite. Clothing proves somewhat inadequate and artificial means of heating body extremities and air to be inhaled are necessary. Problems such as eyelids freezing shut, and difficult breathing due to the accumulation of exhaled air forming ice on the face present serious difficulties.

7. Failure of pressurized kerosene burning stoves and heaters due to the inrush of extremely cold air which is sufficient to cool the jet surround to such an extent that ignition fails and the flame is extinguished.

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* Antarctic Division, D.S.I.R., New Zealand.

8. Freezing of electrolyte in batteries reducing power output to zero.

9. Failures in Electronic equipment - transistors - dry cells.

10. Excessive contraction to glass causing cracking of vehicle windows, care should be taken to keep optical equipment, camera lenses etc warm.

EFFECTIVE METHODS OF NAVIGATION UNDER VARYING CONDITIONS ON THE ANTARCTIC PLATEAU

R. B. Thomson*

Problems of navigation commonly experienced are caused by, -

(a) Absence of topographic features.

(b) Whiteouts.

(c) Overcast sky obscuring the sun.

(d) Ineffectiveness of a magnetic compass.

During the ANARE Wilkes - Vostok Traverse (1962-63) precise navigation was maintained under extremely difficult conditions using the following instruments, -

(1) Astro compass

(2) Theodolite (for accurate astro fixes)

(3) Pioneer vehicle compass

(4) Mirror System - modified from that described by H.P. Black, Page 660 Antarctic Logistics Symposium Report, 1962.

(5) Weasel Speedometer (distances)

(6) Prismatic compass

Of these simple instruments or systems used, by far the most effective under <u>all</u> conditions was (4) the Mirror system. This system used correctly provided a means of steering and maintaining a straight course well within 1 degree accuracy. Modifications made to Black's original design include, -

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* Antarctic Division, D.S.I.R., New Zealand.

(a) Larger mirrors.

(b) Heavier frames and bracing to eliminate vibration.

(c) More delicate sighting rods fore and aft to give greater precision.

(d) The driving mirror was provided with an electrically heated back pad. This kept the mirror surface free from accumulation of falling or blowing snow.

(e) Pioneer vehicle compass was mounted on non-ferrous extension rods protruding from the front of the vehicle but in direct line with the mirror sighting rods. This allowed direct magnetic course headings to be made conveniently and a means of checking the mirror system course.

Points to Note

(a) It is essential that the driver of the second vehicle (which the driver of the navigation vehicle is sighting on through the mirrors) is instructed to and does follow closely the track of the first vehicle.

(b) The greater the distance between the vehicles, the greater the accuracy. High accuracy was achieved in good conditions with a spacing of 3 - 4 miles but quite good accuracy was still obtained in whiteouts with distances of 50 - 100 yards.

(c) The driver must concentrate intently on the driving mirror and reduce to a minimum the slightest deviation of the reflected image which is in fact the straight course. Although this action is tiring for the driver, failure to keep his eyes on the mirror could mean a deviation and a resultant bend in the desired straight course.

(d) The mirror system provides a means of maintaining a straight course, - not a course heading. This latter must first be obtained preferably using the astro compass mounted on the vehicle. A magnetic declination can easily be obtained by comparison of astro and magnetic compasses and the magnetic compass then used for convenient course checking. The distance permissible between these compass checks depends on surface and prevailing weather conditions, and the strength and state of the magnetic field.

(e) This method was also used successfully at night using the reflected image of the following vehicle's headlights.

Conclusion

The simple mirror device provided to the Wilkes - Vostok Traverse a means of obtaining a straight course under difficult conditions when often all other means would have failed. It is considered that this method should find wide use on the featureless Plateau of Antarctica.

Summary

The problem of navigation for surface transport on the Antarctic Plateau is dealt with in this paper by evaluating the mirror system as used by the author during the Wilkes - Vostok Traverse of 1962-63.

FIELD USE OF MOTOR TOBOGGANS

A. J. Heine *

From 1956 to 1964 dog teams were used extensively in the New Zealand field programme of reconnaissance geology and surveying. With the change of emphasis to intensive geological work, usually from a number of base camps, the motor toboggan has proved to be more suitable than the older method of transport. The present pattern is that the geologist and field assistant range out from the camp to examine rock outcrops up to a twenty mile radius. This would not be so easily done with a dog team as they cannot safety be left alone for any great length of time. Although there is a greater safety margin in crevasse country with dog team, careful navigation by experienced field assistants has so far avoided any serious crevasse accidents with the motor toboggans.

The following table shows the extent of New Zealand's use of motor toboggans; all toboggans being made by Polaris Industries Inc., Roseau, Minnesota, USA.

SUMMER	NO. OF TOBOGGANS USED AND MODEL NO.		AREA OF OPERATION
1962/63	2	K95-D	Scott Base - Mawson Glacier; 300 miles travelled.
1963/64	2	K95-D	Shackleton Glacier; approx. 500 miles travelled - 1 toboggan abandoned.
1964/65	2	K95	Nimrod Glacier; exploration area 600 - 7500 feet a.s.l.

* Antarctic Division, D.S.I.R., New Zealand.

SUMMER	NO. OF TOBOGGANS USED AND MODEL NO.		AREA OF OPERATION
1965/66	2	K95	Campbell-Priestley Glacier area; up to 9000 feet a.s.l., 475 miles travelled.
1966/67	2	K95	Upper Mariner Glacier; up to 11,600 feet a.s.l., 560 miles travelled.
1966/67	2	K95	Aviator - Campbell Glacier area; up to 11,000 feet a.s.l., 340 miles travelled.
1967/68	3	K95	Eastern side of Rennick Glacier; 700 miles travelled.

In addition to the above operations a K95 toboggan has been used on the McMurdo Ice Shelf Project; miles travelled approximately 1000. Toboggans have also been used by biologists working in the general McMurdo Sound area.

Details of Toboggan, Model K95:

Engine: Kohler, Model K241, 4 cycle, Rope start.

Transmission: Salsbury torque converter with automatic clutch. Hand selector for forward-neutral and reverse positions.

Dimensions:
Length, overall - 124 inches
Width, overall - 36 inches
Gross weight - 550 lbs
Weight per sq in of bearing surface - .192 lbs
Towing capacity - 1000 lbs approx.
Speed - up to 12 mph depending on snow surface, slope, etc.
Fuel consumption - about 8 miles per Imp. gallon of petrol.

Factory Modifications:

After two seasons' use the original model K95-D was replaced by the K95 Ranger "Sno Traveller" model, and this type of toboggan has been used by New Zealanders over the past four summer seasons. The following factory modifications were carried out before delivery of the 1962 order:

(a) Addition of ice spikes to the track cleats.

(b) Addition of heavy draw-bar and rear track winch.

(c) Addition of preheater shield for air intake.

(d) Grooving of steering skis.

Modifications at Scott Base:

Following the 1964/65 summer season, a number of modifications to the Model K95 toboggan were made at Scott Base. These included:

(a) Track framework chassis re-welded and heavier gussets welded into the framework.

(b) Front drive sprocket adjustment arrangement strengthened with heavier braces to the main framework.

(c) Engine mounting system changed - holding bolts now tightened and wired in place so that they cannot vibrate loose.

(d) Remove all brackets from the side skis so that the tool box and spare fuel jerry-can cannot be carried in that way.

Modifications (a) and (b) were also made in the "Polaris" factory to subsequent New Zealand purchases of this model in 1966.

Performance of Toboggan, Model K95:

Although the motor toboggan can be driven in the field by a system of remote control ropes, it has been the practice by New Zealanders to adopt the following procedure:

One man sits in the usual driver's position but at times of potential crevasse danger either sits sideways or stands on a side runner. He must be careful not to fall off the machine and so lose control. He is joined to the second person by a climbing rope. The second person, who carries an ice axe, either skis near the rear of the sledge or sits on the rear of the sledge. In the event of the toboggan breaking through a crevasse bridge, the driver throws himself clear. The second man at the same time stops, drives his ice axe into the snow and adopts a suitable belay position. Care must be taken to see that the rope cannot snag on projecting gear tied to the sledge or catch in moving parts of the toboggans.

The model K95 "Polaris" motor toboggan has given satisfactory service on New Zealand field trips provided the following procedures are carefully followed:

(a) Carry no gear on the side skis as any extra weight while driving over rough surfaces soon causes splitting of the skis.

(b) All welds on the machine should be checked at the end of each season and re-welded if necessary. Particularly check the engine mount welds as vibration and cold temperatures seem to easily crack existing welds. Any welding done should be well annealed.

(c) When the surface is rough and hard (i.e. sea ice) the machine speed should be kept to about 5 - 6 miles per hour.

(d) Reduce to a minimum the weight carried in the front cargo compartment of the toboggan.

"Polaris" "Super Voyager", Model 2500:

Following the discontinuation of manufacture of the model K95 toboggan, two "Super Voyager" model 2500 machines were purchased in 1967. These machines have been used on the McMurdo Ice Shelf and on a short expedition to Mount Erebus; the route rising to 8300 feet above sea level. Experience with these new toboggans braws the following comments:

(a) The model 2500 toboggan is equipped with a 15 h.p. J.L.O. 2-cycle engine, Type L3721. This engine has not been as easy to service, adjust and operate as the Kohler K241, while the wire pull start is not considered as suitable as the more conventional rope start of the Kohler. The J.L.O. engine is also harder to control at slow speeds.

(b) The toboggan has no forward-neutral-reverse gear box and at times of difficulty in the field, i.e. crevasses and rough terrain, it is a distinct disadvantage to have a machine without a reverse gear. This disadvantage is not so apparent on the McMurdo Ice Shelf and the machine has been satisfactory in this area.

(c) The jockey-wheel suspension system required rebuilding using heavier steel tubing to enable it to withstand rough Antarctic conditions.

(d) The dimensions of the model 2500 are:

Overall length	- 97"
Overall width	- 45"
Weight	- 450 lbs.

(e) Although the model 2500 has no side skis and is similar in design to the old model K95-D used in 1962-64, the wide rubber track is satisfactory in soft snow. However, the steel track cleats have no ice spikes on the ends (as does the model K95) and is less stable while traversing steep ice slopes.

(f) The toboggan is steered by a direct link between the front skis and the handle-bars. Over long distances and rough terrain this system is very tiring for the driver, and the chain and sprocket reduction steering system on the model K95 is much superior.

Summary

Motor toboggans have been used by New Zealand field parties during the past six summers. Their characteristics and performance in different field conditions are described.

A LANDROVER FOR ANTARCTIC USE

R. B. Thomson *

The performance, modifications and conclusions arising from this experience are dealt with in this paper.

A long wheeled base (109") Landrover was transported to Scott Base in 1963. The only modifications or extras to the vehicle and standard equipment consisted of, -

(a) Two recirculating type vehicle heaters connected in parallel with the vehicle radiator. One directed heat to the driver and wind-screen, the other to the passengers in the rear.

(b) Radiator water temperature gauge and oil pressure gauge.

(c) Rear power take-off.

(d) Hand Throttle.

(e) Capstan Winch.

(f) Radiator Muff.

The vehicle was originally equipped with 750 x 15 mud grip tyres and has since been fitted with 820 x 15 sand tyres.

Performance

Equipped with road tyres, mud grips or chains this vehicle could only be relied upon to traverse compacted snow roads or rock surfaces. When starting on snow surfaces the rough tread or chains would immediately dig into the surface crust through to the underlying soft snow and the vehicle would usually sink up to its axles.

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* Antarctic Division, D.S.I.R., New Zealand.

The fitting of sand tyres (low pressure 820 x 15) resulted in a marked improvement on snow surfaces. These smooth tyres did not disrupt the surface crust, allowing the vehicle to traverse all but very soft snow surfaces.

Engine power has proved more than adequate for all conditions encountered.

Starting - No difficulty, although generally the vehicle has been housed inside a warm garage.

Transmission and drive - The standard 4 speed gear box plus the secondary box which provides 'high" or 'low' ratios gives all desirable engine wheel revolution ratios.

Suspension - The heavy leaf type springing, minimum of moving parts and rugged construction gives reliable service with little maintenance.

Oil and fuel consumption - Oil consumption, negligible. Fuel consumption in heavy conditions and low ratio approximates 8 miles per imperial gallon. Under more favourable conditions 15 mpg can be relied upon.

Carrying capacity:	Personnel	- Total of 9 (3 in front seat, 6 in rear seating)
:	Goods	- 2,000 lbs

Performance of "Extras"

All the extras fitted (a, b, c, d, e, f above) were found to be advantageous.

(a) Heaters and demisters quite adequate.

(b) These gauges provided an added means of checking engine behaviour.

(c) A "Linwelder" electric welder (20-200 amps) was fitted to the rear of the vehicle and run from this power take off. This rig has been very successful and used extensively.

(d) A necessity for setting idling speeds high enough to retain engine heat and for the operation of the power take-off and winch.

(e) Not essential but proved very useful.

(f) Very necessary during colder and winter operation.

The Landrover is used throughout the year and has proved capable of traversing 90 per cent of the surfaces encountered within the area of Scott Base, thus this vehicle has become the most used by New Zealanders.

Conclusions

Maintenance has been less than one third of that required by any of the tracked vehicles.

It is considered that equipped with the extras and fitted with low pressure sand tyres as mentioned, this vehicle has the versatility, dependability, and low maintenance requirement to be worthy of consideration at any Antarctic Base where a personnel/work transportation vehicle is required.

Summary

A Landrover has been successfully used by New Zealanders under varying Antarctic conditions for a period of five years.

The performance, modifications and conclusions arising from this experience are dealt with in this paper.

THE USE OF HOVERCRAFT IN POLAR REGIONS

Vivian Fuchs *

In recent years remarkable progress has been made with the development of hovercraft, and today there are numerous types in practical use for both civil and military purposes. Nevertheless, the choice for use in the polar regions remains among the smaller forms, since the larger cannot be carried on board ship and are not yet sufficiently developed to be ocean-going themselves.

For present purposes I would like to take the Saunders Roe SR. N5 and SR. N6 as examples since they are of appropriate size, have a practical load-carrying capability, and the former is the subject of the film I propose to show.

In 1965 writing in the Polar Record (Vol. 13, No. 82, P. 3-5) I commented upon some of the advantages and the possible difficulties of using hovercraft in polar regions. In brief these were:

Advantages

1. The ability to move safely and uniterruptedly across sea ice and leads of open water.

2. The ability to move directly from sea ice or water onto land.

3. A high speed potential over inland ice.

4. The very low ground pressure when travelling over soft surfaces and snow-bridged crevasses.

5. The lack of vibration of the surface when crossing bridged crevasses.

* British Antarctic Survey, London, England.

Disadvantages

1. Insufficient directional control in cross winds.

2. The liability to hull damage by ice pressure ridges.

3. The difficulty of negotiating steep slopes, either up or down.

4. The problem of extrication should the hovercraft become lodged in a crevasse.

5. The possible formation of ice in the air ducts, on the fans and on the skirt.

6. The difficulty of excluding drift-snow from the mechanical system when at rest.

In February and March 1966 an SR.N6, which is a slightly extended form of the SR. N5, carried out trials in Sweden. The range of temperatures during the operating time was +10° C to -14° C and the coldest night temperature was -24° C. The total distance run was 588 nautical miles over varying types of water, ice and snow surfaces.

Over smooth ice or snow surfaces ground speeds up to 75 knots were attained. Over rough ice with irregularities up to 1½ feet (0.5 metres) it was possible to cruise at 35 knots. Although the walkways and some of the surfaces collected a layer of snow or ice, none accumulated on the plenum chamber or skirts. At the temperatures encountered de-icing fluid sprayed onto find, rudders and elevators prevented ice accumulation. It was thought that at lower temperatures this might not have been so successful.

The main skirts showed no sign of wear, but they regularly froze to the surface when at rest. This presented little difficulty as they could be freed by running the engine and a little help with a shovel or ice axe. A layer of ice also formed inside the skirt, making it appear even stiffer than it really was.

This was removed by jumping on the skirt before starting each morning. At temperatures below - 10° C the skirt material became stiffer than normal and the skirts would not inflate properly until the engine had been run for 10 or even 20 minutes and air had flowed throught them. Patience was the only cure when starting in the morning.

The engine air intakes were also sprayed with de-icing fluid and despite this, when operating over snow or slushy ice they quickly became 70% blocked. However, the engine performance was not affected, and it was concluded that the blockage was not as severe as it seemed. Nevertheless, it appears to me that in certain conditions of prolonged operation this might be the cause of periodic failure.

A trial installation was made for ducting warmer air from the plenum chamber to the engine air intake, and this satisfactorily kept snow from the engine intake filters. It was not used all the time because exhaust fumes sucked into the plenum chamber passed into the compressor, causing a need for more frequent engine washing and a loss of power. In spite of this such a system is clearly desirable in the event of filter blockage becoming a serious problem.

I now turn to the SR. N5, the trials of which took place in northern Canada and are shown in the film. These trials were made in the vicinity of Tuktoyaktuk and on the Mackenzie River during the period 21st April to 14th May 1966. The temperatures were continuously below - 20° C in April, and in May they reached a maximum of +4° C.

Here, as with the SR.N6, the skirts became hard, and in these lower temperatures cracks appeared at the folds which allowed water to soak into the fabric. When this subsequently froze it began to separate the various laminations. Apart from this the skirts provided the greatest cold weather maintenance problem; since stiffening prevented any satisfactory repairs at temperatures below -20° C, these had to be carried out in an heated workshop.

It is of interest that even at the lower temperatures the air intakes did not clog excessively, and that by removing the exhaust extensions the fan was enabled to suck warm exhaust gases into the plenum chamber and the skirts. This repeated the experience of the SR.N6 trials in Sweden.

On one occasion the craft was blown sideways into an ice block which ripped open two panels of the plenum chamber, and it was concluded that some form of encircling inflated fender would prevent such damage.

The broad conclusions of the trials were:

1. The common types of ice and snow presented no problem.

2. Skirt wear on ice and snow was very small.

3. Places could readily be found to cross pressure ridges but comparative lack of directional control was troublesome.

4. The craft was limited in capability for overland routes but could traverse gently undulating country.

5. Winds above 20 knots may be expected to restrict operations, particularly in confined spaces or over rough surfaces.

6. The present fuel capacity is too limited for long range polar work, the present range being of the order of 145 nautical miles (270 km).

I have not mentioned a number of design problems such as the length of skirt, the materials used for fittings, ventilation, heated windscreens etc. Much information was gained about all of these and it seems clear that the problems encountered can easily be solved.

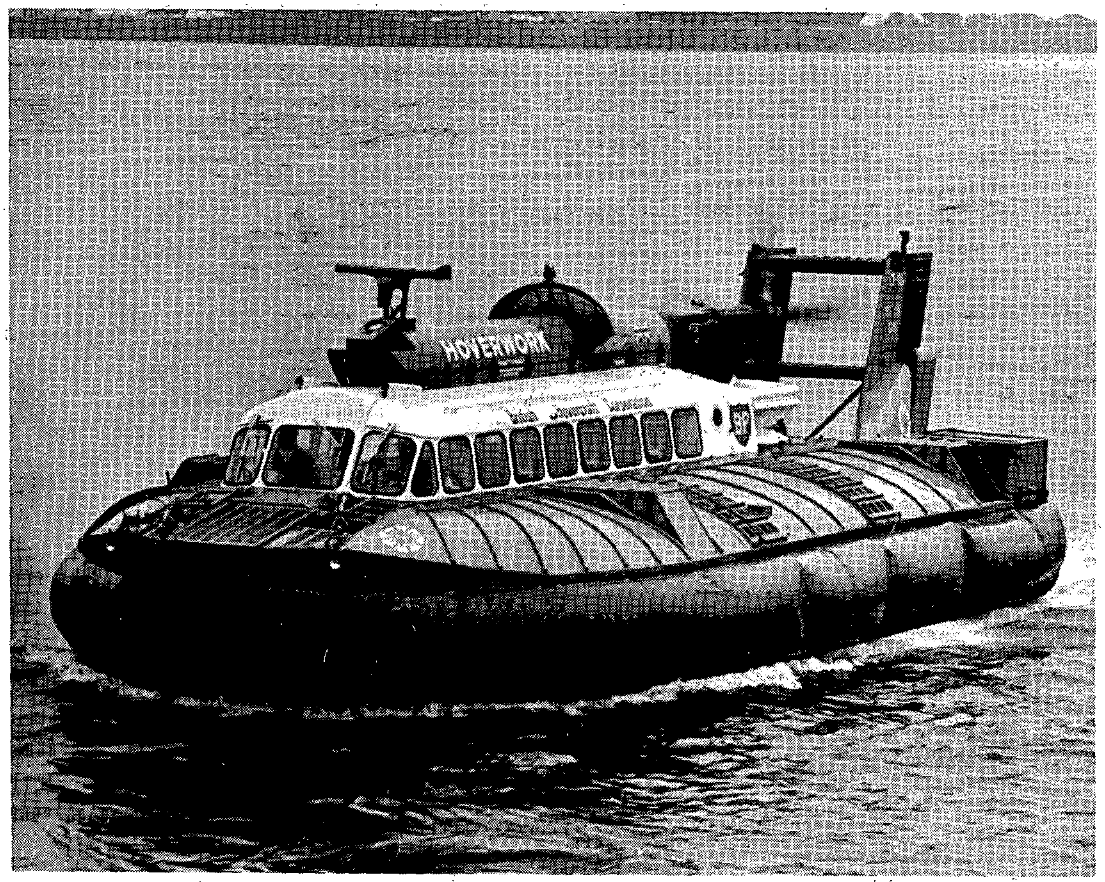
Apart from these Swedish and Canadian trials, an SR.N6 has recently been operating in the Falkland Islands and a pertinent point has emerged. When travelling in a confined space where frequent crossings of a meandering stream had to be negotiated the craft lost its air cushion by becoming perched across the stream bed. It was then extricated by tractor and manhandling with great difficulty.

This points to the problem of crossing areas of deeply incised sastrugi, which would allow the cushion to be lost where the skirt was suspended above the surface. At present it is not apparent how this could be overcome, nor is it known what height or frequency of sastrugi could be negotiated.

To sum up, it seems that in this type of craft we have something which, with minor modifications, could already be used in the Antarctic. At the same time it does not seem that hovercraft are yet ready for inland use. They should be regarded as practical only for coastal or ship-to-shore work. It is also certain that they will be expensive to operate, on the grounds of fuel consumption alone, at the low speeds one may expect to achieve.

Summary

The use of hovercraft in polar regions has been under active consideration since 1963. Trials of various models of hovercraft have been carried out in Greenland, Sweden and northern Canada which have shown that they have a large potential use in polar transport. The lessons learnt from these trials are considered with reference to desirable design characteristics of hovercraft for use in a polar environment.



SRN-5 Hovercraft

VEHICLE ROAD SYSTEMS ON SNOW AND ICE

W. H. Beard,* E. H. Moser,* and N S. Stehle*

Abstract

Rapid ground transportation is required for effective operation of high-activity polar stations. Such stations, however, may be located were snow, ice, and frozen ground are contiguous, and special vehicles and road-building techniques, consequently, are required to service outlying facilities and work centers.

McMurdo Station, Antarctica, is located on a land mass, its principal airfield is located on shelf ice, and additional runways and other facilities are located on sea ice. Prior to 1965, the Naval support units used only tracked vehicles and sled trains for ground transportation in this area. The development of adequate roads of snow and ice has permitted adoption of a wheeled transportation system, greatly improving ground travel and materially decreasing maintenance of ground transportation equipment.

This paper describes the equipment and techniques currently used to build roads on snow and ice surfaces, discusses equipment currently being developed to improve these techniques, and describes the wheeled vehicles used on these roads. High-quality snow roads for wheeled vehicles weighing up to 75,000 pounds are built by processing a layer [illegible] to a depth of 24 inches and compacting this pulverized mass into a 16-inch snow pavement. Heavy-duty snow roads around McMurdo are normally elevated 2 to 3 feet above the natural surface to minimize snowdrift during the first year of use. Temporary snow trails for wheeled vehicles weighing up to 10,000 pounds are built by packing the surface snow with low-ground-pressure snow tractors. These trails are suitable for supporting construction work, servicing low-demand outlying work centers, and emergency use of lightweight wheeled vehicles. Traction and serviceability of roads over ice are improved with a 4- to 6-inch layer of chipped ice. A special ice-cutting drum is used to produce chipped-ice covers for these roads.

Wheeled vehicles ranging in size from 4-man jeeps to 20-ton truck tractor-trailer combinations have been fitted with high-flotation tires for use on the snow and ice roads at McMurdo. Improvements are underway to develop vehicles to meet the traffic demands of a high-activity transportation system operated on snow, ice, and frozen ground at McMurdo.

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Introduction

Dependable roads over snow, ice, and frozen ground are needed for wheeled transportation systems at antarctic stations. This need is particularly urgent at locations where rapid ground movement of personnel and cargo over contiguous areas of snow, ice, and frozen ground is essential for effective and efficient operation of the Station. By 1963, the volume of summer traffic at McMurdo Station, which is located on Ross Island and is the principal logistical support point for United States research in Antarctica, necessitated development of a vehicle road system to meet the transportation demands at this complex. At that time, conventional wheeled vehicles were used for ground transportation on the Island, and tracked carriers and sleds were used principally for ground transportation to the airfields and other support facilities on the sea ice, glacier ice, and deep snowfields south of the Island. This composite system was both slow and ineffective. Transfer points were required to change from one system to the other at the edge of the Island and the travel speed of the tracked transportation system ranged between 1 and 5 mph, depending on the carrier and the trail conditions.

This paper presents the equipment and techniques developed by the Naval Civil Engineering Laboratory (NCEL) for building high-strength snow roads and low-strength snow trails in the McMurdo area, and for improving ice roads in this area. It also describes the high-flotation-tired vehicles used on these roads and trails. Based on these developments, the Naval Support Forces, Antarctica (NAVSUPPFORANTARCTICA) is now operating a wheeled vehicle transportation system throughout the McMurdo complex. Not only is fairly rapid ground travel presently available throughout the McMurdo area but also maintenance and repair of the ground transportation equipment has been materially decreased.

McMurdo Complex

The McMurdo complex (Figure 1) includes McMurdo Station on the southern tip of Ross Island, Williams Field southeast of the Station on the Ross Ice Shelf, the annual sea-ice runway south of the Station on McMurdo Sound, and Outer Williams Field southwest of the Station on glacier ice. Other temporary facilities are located from time to time on these outlying areas of snow and ice.

Prior to 1965, the island roads on the frozen ground around McMurdo Station were poorly drained, rough surface roads with grades up to 25%. Since that time, well-drained, smooth roads with grades below 10% have been built in McMurdo Station and between the Station and Scott Base, the principal New Zealand station in Antarctica. The improved roads were built with volcanic ash and weathered volcanic rock scraped from the nearby hillsides. All of these roads require little maintenance and are suitable for fairly high-speed traffic.

Between 1955 and 1965, all off-island ground travel to outlying facilities in the McMurdo area was by tracked carriers and tractor-towed sled trains. They traveled over unimproved flagged routes on the snow-covered sea ice of McMurdo Sound and the drifting snowfields on the Ross Ice Shelf. Since 1965, a 2-lane, 15-mile-long, elevated snow road has been used for wheeled traffic between Scott Base, Williams Field, and Outer Williams Field (Figure 1). In addition, each summer, a 2-lane, 2-1/2-mile long, sea-ice road has been used for wheeled traffic between Cape Armitage and the annual sea-ice runway on McMurdo Sound.

Snow-Compaction Equipment

Snow is deposited on the surface in particle form and, depending on previling conditions, its density ranges from 0.01 to 0.20 gm/cc. In time, these particles change from flakes to granular crystals, resulting in a coarse-grained material having a density of 0.30 gm/cc or more. Continued metamorphism produces glacial ice.[1] Hardening, or sintering, is the natural metamorphic process whereby the individua snow crystals become bonded to each other by ice bridges. Consequently, the advancement of snow as a construction material and the development of snow-compaction equipment has been directed toward accelerating the natural metamorphic processes occurring in snow[2].

The initial NCEL snow-compaction experiments resulted in the development of a small, size 1, wide-track snow tractor for towing the compaction equipment. This basic design was used by NCEL and others to develop a size 2 snow tractor (Figure 2) for snow compaction, and a large, size 6 snow tractor for general construction and sled-train use in Antarctica. These tractors are evenly balanced over the tracks and, depending on size, their ground-bearing pressure ranges from 3 to 5 psi. All are capable of useful work on very soft snow.

The need to develop strong, thick snow pavements for heavy wheel loads led to the development of a power-driven snow mixer for processing snow to a maximum depth of 32 inches. This development was based on a processing technique for accelerating the metamorphism of snow that was advanced by the Russians during World War II. The current NCEL snow mixer (Figure 2) is a towed-type unit consisting of a ski-mounted carrier fitted with a single, 8-foot-wide, 42-inch-diameter, paddle-tine rotor. For uniform cutting and good depth control, the rotor is located midway between the front and rear skis. A full-width rear ski is used to screed and level the processed snow.

Other equipment developed for compacting snow includes an 80-foot-long ski-mounted snowplane (Figure 3) with a 12-foot-wide adjustable blade for grading and leveling snow. A 5-ton, 8-foot-diameter, 8-foot-wide snow roller (Figure 4) was developed for compressively compacting natural and processed snow. Development of the snow roller was based on experiments in Greenland which showed that the effective depth of roller packing on natural snow was 8 to 10 inches, regardless of the size and weight of the roller.

In additon, a side-casting snowplow suspended in a ski-mounted carrier (Figure 5) was developed to elevate snow roads in Antarctica. Two special drags were developed for finishing and maintaining these roads; one was a snow-leveling drag to spread equipment windrows and light drift, and the other was a snow-finishing drag with cylindrical bottom skids to produce a smooth, flat finish on compacted snow. A standard 13-ton, pneumatic-tired roller (Figure 6) is used as a surface-hardening roller for compacted-snow roads.

High-Strength Snow Roads

The basic NCEL technique [3] for producing a high-strength snow road for heavy wheeled vehicles consists of processing and compressively compacting the top 24 inches of surface snow along the roadway into a 16-inch-thick finished snow pavement. Other techniques[4] are available to improve the surface of a snow road and to prolong its useful life.

Snow roads capable of supporting cars, buses, and heavy trucks at speeds up to 45 mph can be built on almost any type of snow terrain provided the grades are not too steep and the turns are not too sharp. All changes in direction should be made with long, sweeping curves. A 1-lane snow road should be 15 feet wide, and a 2-lane road should be 30 feet wide.

To minimize maintenance problems because of drifting snow, all high-strength snow roads on snowfields subject to drift must be elevated above the surface. At McMurdo, snow roads elevated 2 to 3 feet above the natural surface remain relatively drift free about 1 year. As this appears to be a practical limit for elevating snow roads, these roads must be reelevated and paved annually for continual heavy-duty use with a minimum of maintenance.

Careful workmanship is essential when constructing high-strength snow roads. General operation of the special equipment is fairly simple, but training is necessary for proper use, good performance, and high-quality production. Because of equipment width limitations, overlapping equipment lanes are required to build snow roads over 8 feet wide; 2-foot overlaps are used to avoid between-lane misses which result in low-strength areas.

High-strength snow roads at McMurdo are built by elevating the roadway with a snowplow, rough grading the fill with a bulldozer, and fine grading the surface with a snowplane. The graded surface is then packed with the snow roller to achieve a uniform work surface for the snow mixers. Two snow mixers are used in tandem for each processing lane on the roadway, with the width of the road controlling the number of lanes. Two snow mixer passes are required to pulverize and blend the snow into a high-strength pavement suitable for heavy wheeled vehicles. The first pass is made at a cutting depth of 24 inches and a relatively slow rotor speed, about 1,500 peripheral feet per minute, to break up the snow mass and initiate pulverization. The following pass is made at a cutting depth of 20 inches and a fairly high rotor speed, about, 6,000 peripheral feet per minute, to obtain a maximum of fines in the processed material. Since the snow particles begin to form bonds within minutes after processing, the second mixer pass is made immediately behind the first. The average travel speed of the mixers is about 100 fpm when processing snow at these cutting depths. After processing, the freshly pulverized snow pavement is packed with the snow roller.

Three to five days later, depending on the prevailing temperatures, the snow pavement is rolled with the pneumatic-tired roller to increase surface hardness. Following this rolling, the road is ready for traffic. With proper scheduling, a 6-man construction team using the special equipment and techniques described in this paper can build about 1/2 mile a day of elevated, high-strength snow road in good weather.

The growth and ultimate strength in snow pavements is dependent on the prevailing air and snow temperatures. Snow can be compacted in temperatures to -40° F, but temperatures between 25 and -20 °F are best for good processing and high early strength. Snow temperatures below 15° F produce marked strength increases in snow pavements, but this gain is rapidly lost when the temperature returns to 15° F. Old compacted snow will withstand above-freezing temperatures for limited periods without deteriorating, but the top few inches of the pavement may become soft and easily damaged by traffic. Summer temperatures at McMurdo Station range between 10°and 25° F, with infrequent peaks to 40° F; these temperatures permit building and maintaining good-quality snow roads.

Strength growth in processed-snow pavements at McMurdo in snow temperatures between 20 and 25° F is rapid compared to blown and rolled snow under the same conditions. As shown in Figure 7, the strength, or bearing capacity, in a 16-inch-thick mixer-snow pavement as determined by confind shear is about 150 psi 10 days after processing. Based on numerous traffic tests on compacted snow with various aircraft and wheeled vehicles, this strength is more than sufficient for continuous traffic at 45 mph by heavy vehicles with tires inflated to 75 psig.

Strength in a 16-inch-thick layer of side-cast blown snow, however, is less than 20 psi 10 days after casting and rolling. This strength is sufficient for safe travel only at speeds up to 25 mph by light vehicles with high-flotation tires inflated to 10 psig. Tests also showed that repeated traffic on a mixer-snow pavement increases its overall strength about 25% over that of a snow pavement without traffic.

The present snow-compaction equipment is being modified to improve the quality of high-strength snow pavements and to minimize operator errors during processing. Currently, a single-pass snow paver with tandem rotors 3 feet apart is under development to ensure that the two processing passes are made consecutively. This paver will not only improve the quality of the snow but also eliminate one tractor, one snow mixer, and two operators used in the present snow-paving technique.

Low-Strength Snow Trails

During the antarctic summer of 1963-64, it was observed that a 10,000-pound vehicle with high-floatation tires inflated to 8 psig could travel over windpacked snow at temperatures below 10° F, and over tracked-equipment trails on soft drift and windpacked snow at temperatures above 10° F. These observations led to the development of a simple technique for rapidly constructing reliable 8-inch-thick snow trails for light vehicles using a minimum of manpower and equipment. This advancement eliminated the need to construct expensive high-strength snow roads to temporary facilities on the Ross Ice Shelf, and also provided an inexpensive means of rapidly reestablishing wheeled transportation to Williams Field and other outlying facilities following severe storms.

Tests[5] during the summers of 1964-65 using a 10,000-pound vehicle with high-flotation tires inflated to 8 psig showed that a 1-pass snow trail built with a size 2 snow tractor and a snow roller was passable 1 day after construction. Two days after construction, the trail was suitable for repeated traffic with the test vehicle at speeds up to 35 mph. The load-carrying capacity for this trail was 11 psi 1 day after construction and 16 psi 2 days after (Figure 8). These tests showed that a 1-pass snow trail built with the size 2 snow tractor alone required 3 days of strength growth to provide safe support for the test vehicle, and a 3-pass trail built with this tractor provided only marginal support for the test vehicle 1 to 4 days after construction (Figure 8). It was observed that there was noticeably less rolling resistance on the tractor-roller trail because of the smoother surface imparted by the roller.

Tests during the summer of 1965-66 in air temperatures near 25° F showed that single-pass trails constructed with a size 6 snow tractor and 2-pass trails constructed with a size 2 snow tractor will safely support a 10,000-pound vehicle with high-flotation tires inflated to 10 psig 1 day after construction. Also, single-pass trails constructed with the size 2 snow tractor and snow roller will support this vehicle 2 days after construction. The test vehicle traveled over these trails with ease at speeds up to 35 mph. With or without a roller, 1 mile of a 15-foot-wide snow trail can be constructed in about 2 hours using one pass with a size 6 snow tractor or about 4 hours using two passes with a size 2 snow tractor.

To achieve a fairly smooth surface, trails over rough snow should be graded with a snowplane prior to compaction. Trails are usually depressed about 3 inches below the surrounding surface after compaction; consequently, they are subject to light drifting in normal wind conditions and to complete burial in severe storms. For continued use, snow trails should be dragged about once a week to spread and level the accumulated drift snow and, after severe storms, they should be leveled with a snowplane and recompacted. Usually such a trail can be reopened to traffic within 8 hours.

Ice Roads

Roads on ice have the load-carrying capacity to support cars, buses, and trucks with high-pressure tires, provided the ice is solid and at least 3 feet thick. High solar radiation and near-thaw temperatures during summer, however, promote ice deterioration. At McMurdo, pot holes form in the surface of the sea ice on McMurdo Sound (Figure 1), and surface and subsurface melt pools form in the glacier ice at Outer Williams Field.

During the past two summers, the sea-ice road across McMurdo Sound has been protected to a limited degree with a 1 - to 2-inch-thick snow cover. In contrast, a 4- to 6-inch-thick cover of finely chipped ice produced with a paddle-type pulvimixer has been used since 1957 to protect the annual sea-ice runway located in this area. The chipped-ice cover not only provides ample protection to the runway but also improves traction on the ice surface.

During the summer of 1965-66, NCEL built a mile of experimental road at Outer Williams Field across glacier ice riddled with surface and subsurface melt pools. A 6-inch layer of coarse chipped ice produced with an experimental pick-type ice chipper was used to surface this road, which was successfully trafficked with a 75,000-pound vehicle 2 days after construction. The condition of this road improved with time even though the surrounding ice continued to deteriorate until the onset of winter. This was attributed to the high albedo, or reflective power, of the chipped-ice and the insulative value of the air entrained between the chipped-ice particles.

Chipped-ice surfaces for roads on sea ice and glacier ice must contain particles large enough to resist traffic and wind as well as provide reflectivity and insulation. Currently, NCEL is developing a self-propelled ice chipper to produce this type of ice.

Vehicles for Roads on Snow, Ice, and Frozen Ground

During the summer of 1960-61, a 3-mile-long experimental snow road was built on 4-foot-thick natural snow on the sea ice west of McMurdo Station. After construction, this road was depressed about 10 inches below the surrounding surface; consequently, it was soon buried with drift snow, and abandoned. However, before this occurred, it was trafficked daily for a 10-day period with 2-1/2-ton dump trucks fitted with standard truck tires inflated to 75 psig. The trucks traveled over the road at speeds up to 30 mph but their high-pressure grip -tread tires abraded and badly rutted the top 6 inches of compacted snow.

This test road led to the improved snow-compaction equipment and techniques discussed earlier and to the development of vehicles fitted with tires better suited for use on connecting roads over snow, ice, and frozen ground. Various types of vehicles fitted with low-pressure, high-flotation tires were developed to meet the traffic demands of a rapidly expanding wheeled-transportation system at McMurdo.

In 1963, NCEL converted a 1-ton, 4-wheel-drive, pickup-type military power wagon[6] to an all-road vehicle for transporting personnel and light cargo over the various roads and trails in the McMurdo complex. Low-pressure, high-flotation tires on this vehicle reduced the tire-inflation pressure from 45 psig to 8 to 10 psig.

At a tire-inflation pressure of 10 psig, the power wagon at a gross vehicle weight of 10,000 pounds can travel over high-strength snow roads and fairly smooth snow trails at speeds up to 35 mph without damaging the road surface. The vehicle performs equally well on ice roads and on the new improved island roads. On the original island roads, however, its travel speed was between 5 and 10 mph because of steep grades, sharp turns, and numerous pot holes.

The Naval Support Forces, Antarctica, started acquiring 1-ton power wagons with high-flotation tires in 1965 for the transportation system at McMurdo. By 1968 they had a substantial fleet of these vehicles.

In 1964, NCEL converted a commercial 4x6 truck-tractor and a 20-ton semitrailer[7] to an all-road vehicle for transporting heavy cargo on the off-island roads in the McMurdo complex. Low-pressure, high-flotation tires on this combination vehicle reduced the tire-inflation pressure from 75 psig to 20 psig.

At tire-inflation pressure of 20 psig, the combination unit at a gross weight of 75,000 pounds was satisfactory on the relatively flat snow and ice roads around McMurdo, but frequent tire failures occurred on the steeper island roads regardless of the gross vehicle weight until the tires were inflated to 30 psig. At this tire pressure, the combination unit can haul all types of material, including large boxed cargo (Figure 9) and fuel over the various roads in the McMurdo complex at speeds up to 45 mph. Repeated traffic on the snow roads at a tire-inflation pressure of 30 psig, gross weights above 60,000 pounds, and speeds above 25 mph abrades the top 2 inches of compacted snow but otherwise causes no damage to the high-strength snow roads. Frequent maintenance with the snow-finishing drag is required to maintain a good surface on the snow roads subjected to this type of traffic.

The Naval Support Forces, Antarctica, started acquiring a fleet of these truck-tractors and trailers in 1965 for moving cargo and fuel between McMurdo Station and Williams Field. By 1968, they had acquired eight truck-tractor units and 12 trailers.

Other vehicles converted to high-flotation tires for use on roads over adjoining areas of snow, ice, and frozen ground include a 20-passenger-cargo van,[8] a 4-passenger jeep, and a standard 5-ton military dump truck (Figure 10). Two passenger-cargo vans are currently used to move personnel between McMurdo Station, Williams Field, and Outer Williams Field, and two jeeps are used for operational control. Only one military dump truck at McMurdo is presently fitted with high-flotation tires. Its improved performance not only on the snow and ice roads but also on the island roads indicates that more vehicles of this type will be fitted with high-flotation tires in the future.

Summary

Prior to 1965, all cargo and most personnel traveling by ground transportation between McMurdo Station, Williams Field, and other outlying facilities in the McMurdo complex were moved off-island by tracked vehicles and tractor-towed sled trains. In contrast, during the 1966-67 summer season, 650 tons of dry cargo and almost 700,000 gallons of fuel were hauled directly from McMurdo Station to Williams Field on wheeled vehicles. An additonal 220 tons of dry cargo and about 200,000 gallons of fuel were hauled by sled train because a gasoline shortage curtailed use of wheeled vehicles early in the summer season. Also, about 10,000 passengers were carried in wheeled vehicles compared with 3,000 during the previous summer. During the summer of 1967-68, all ground transportation in the McMurdo complex was by wheeled vehicle.

A recent analysis of the changeover from a composite wheeled and tracked transportation system for the McMurdo complex to an all-wheel transportation system indicates that the speed of surface travel has increased about 60%. The number of operating personnel required for the transportation system has been reduced about 40%, the lost equipment time for maintenance and repair has been reduced about 70%, and the replacement cost for transportation equipment has been reduced about 50%.

Development of a wheeled transportation system on snow, ice, and frozen ground in the McMurdo complex shows that:

1. Snow and ice roads suitable for cars, buses, and heavy trucks can be built on deep polar snowfilds, sea ice, and glacier ice, provided the grades are not excessive and the turns are gradual.

2. A fairly precise sequence of events and quality control during construction are required to produce dependable high-strength snow roads.

3. Processed snow must be used for high-strength snow roads suitable for continuous traffic with heavy vehicles, but equipment-packed snow trails can be used for light vehicles, provided they are fitted with high-flotation tires inflated to 10 psig or less.

4. Snow roads must be elevated above the surface for continuous use with a minimum of maintenance but snow trails can be built on the surface.

5. Vehicles fitted with low-pressure, high-flotation tires must be used on snow roads to avoid excessive wear and damage to the road surface; vehicles fitted with these tires also perform satisfactorily over roads on ice and frozen ground.

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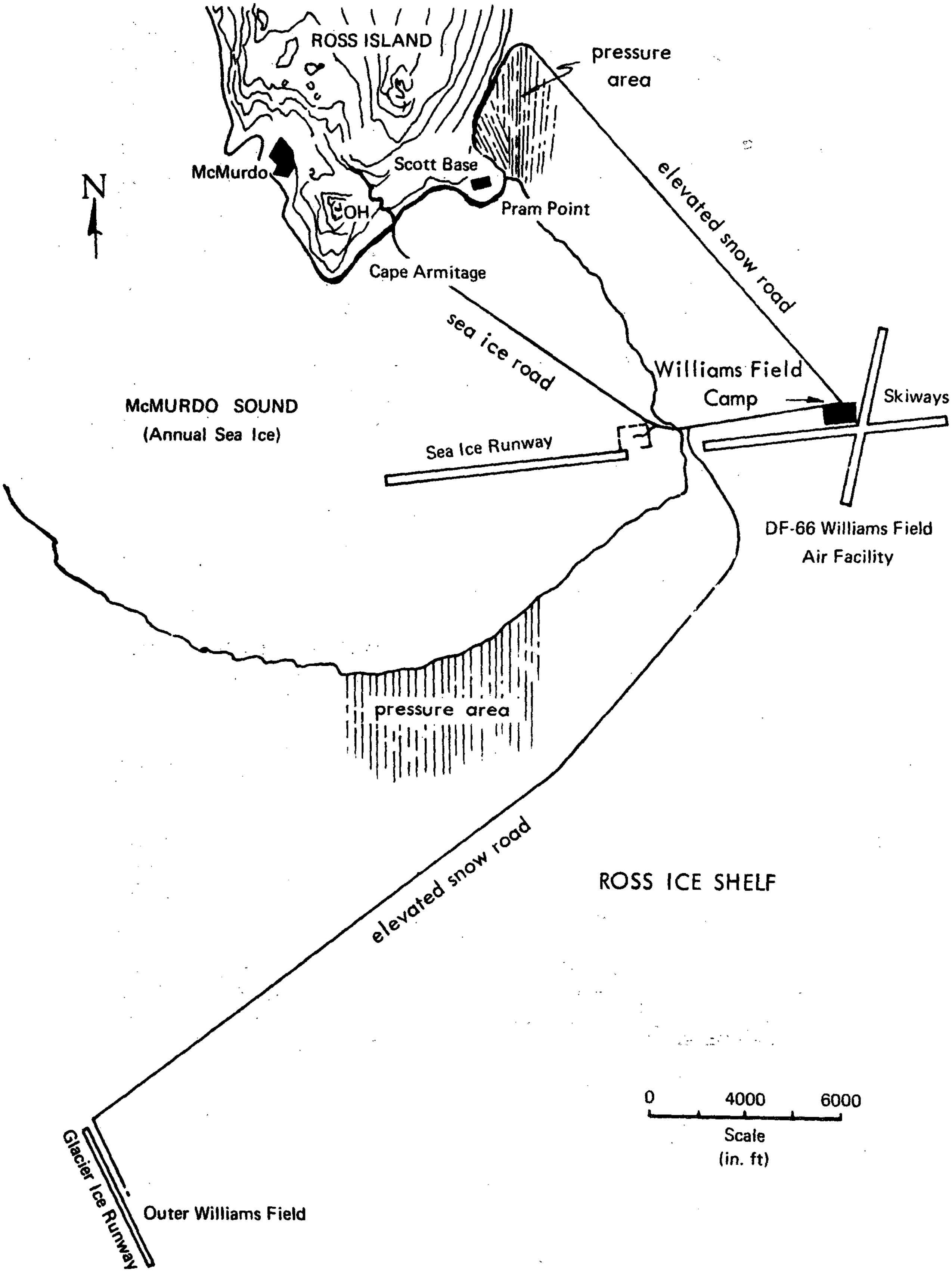


Fig. 1. Map of the McMurdo Station complex.

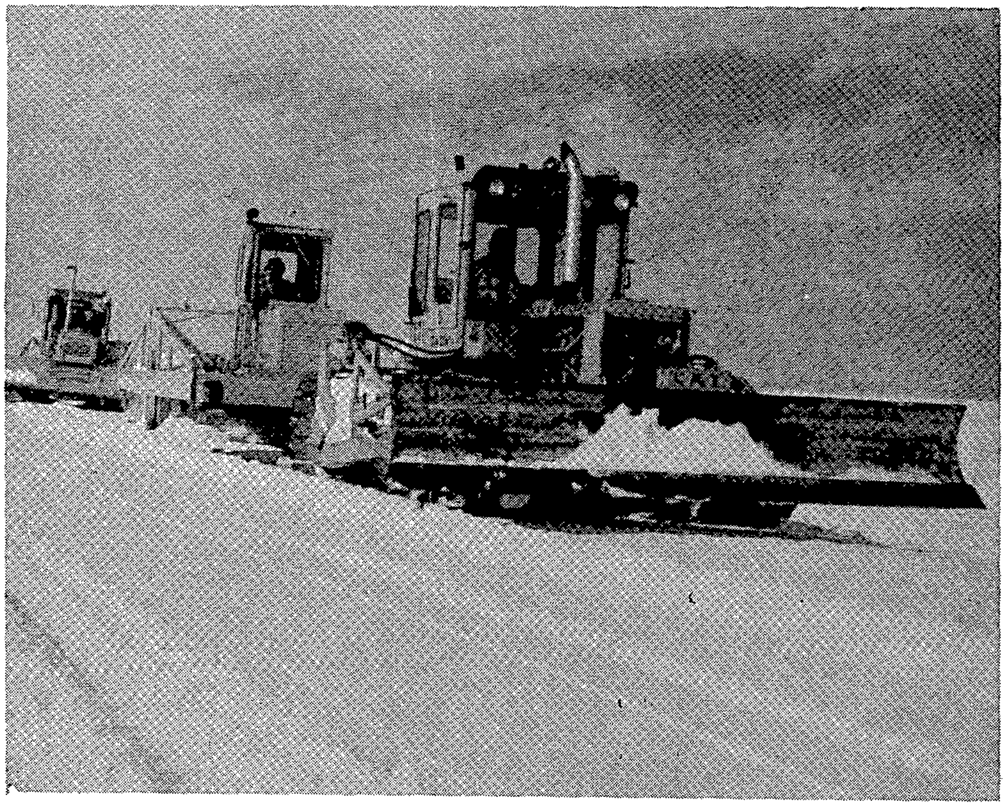


Fig. 2. Size 2 now tractors towing snow mixers in tandem; note smooth surface of processed snow in foreground.

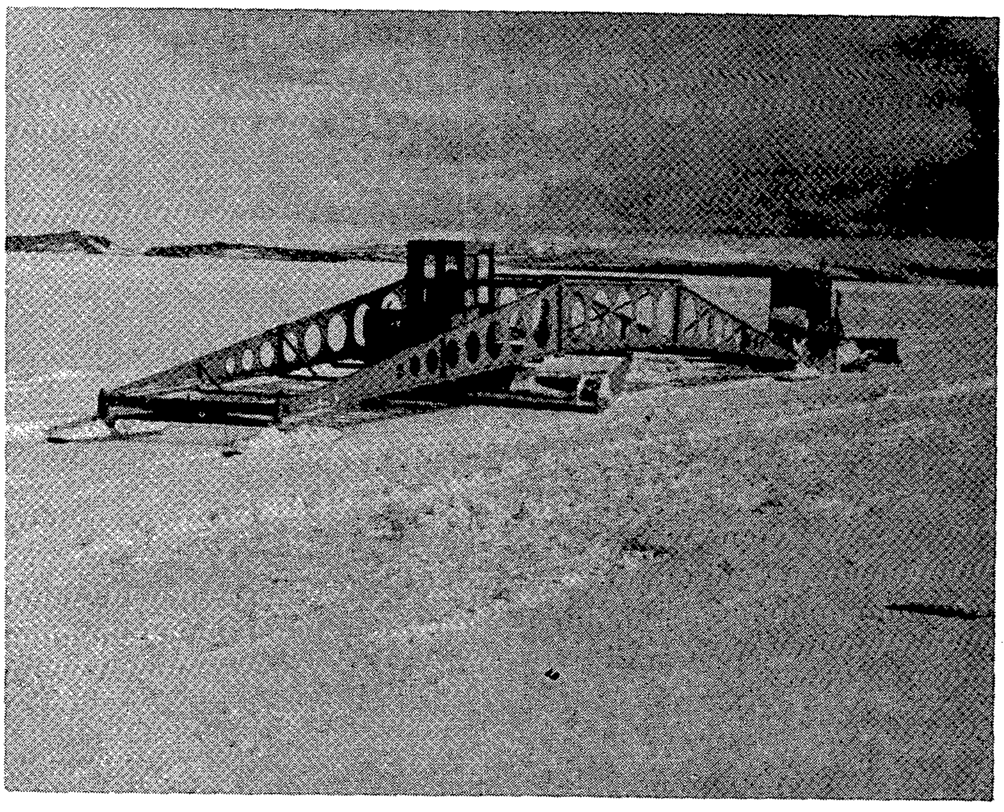


Fig. 3. Snowplane used to grade and level snow surfaces.

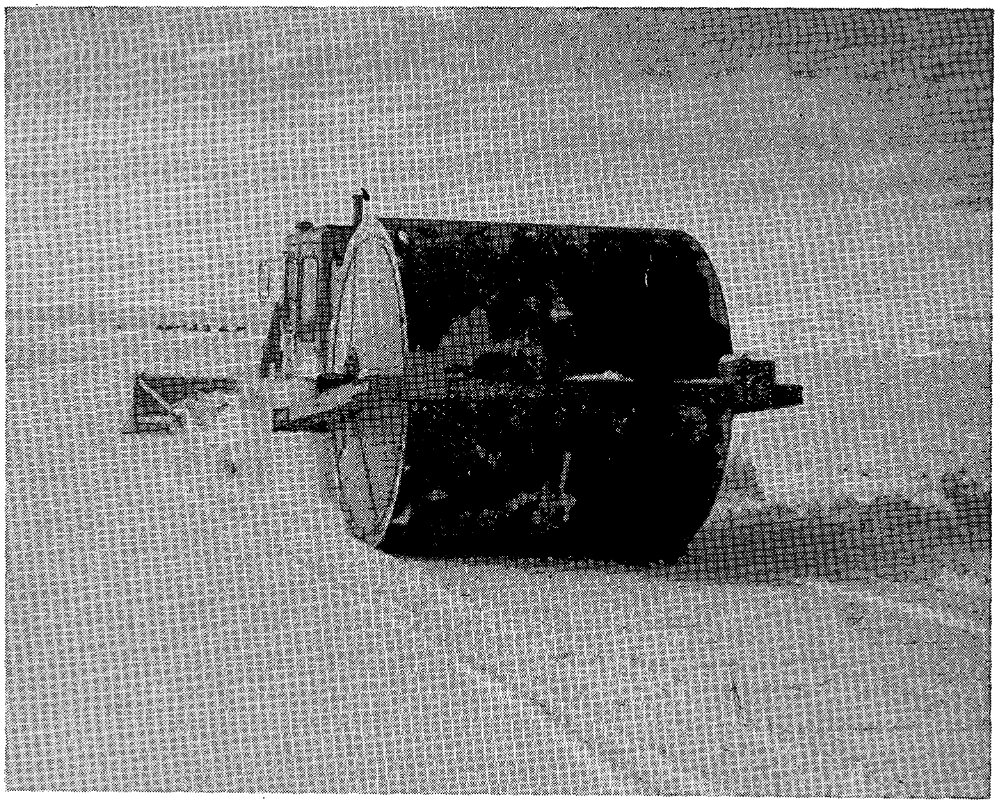


Fig. 4. Eight-foot-diameter roller used to compressively compact snow.

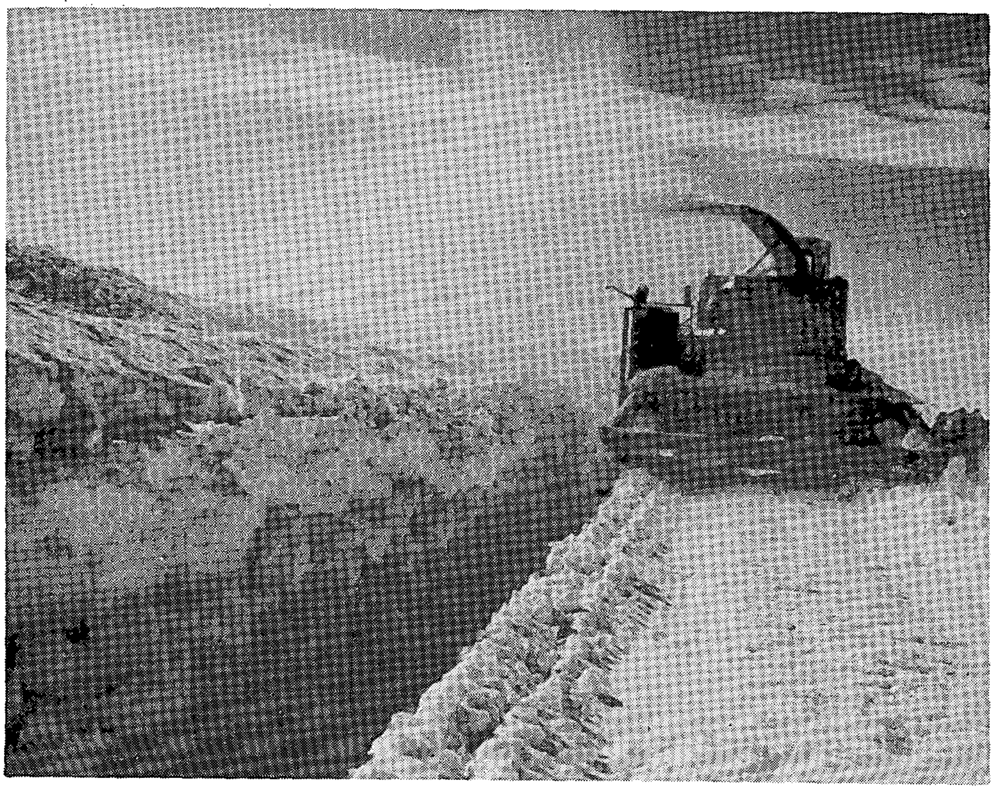


Fig. 5. Snowplow side casting snow for elevated road.

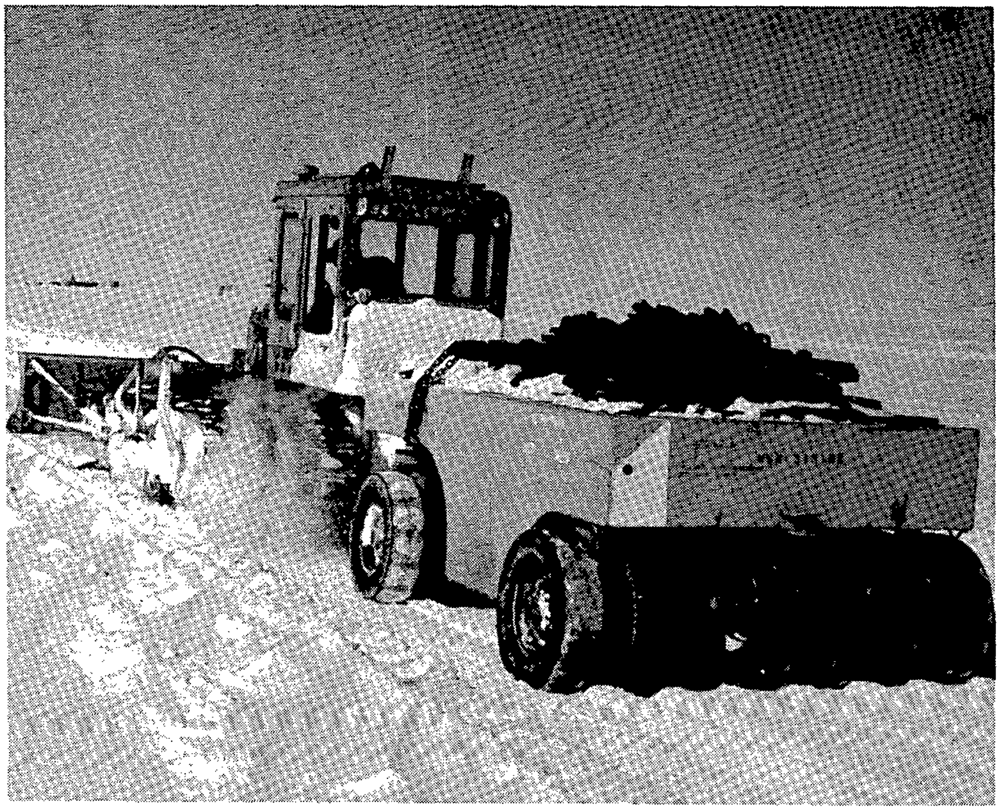


Fig. 6. Pneumatic-tired roller used to increase surface hardness of compacted snow roads.

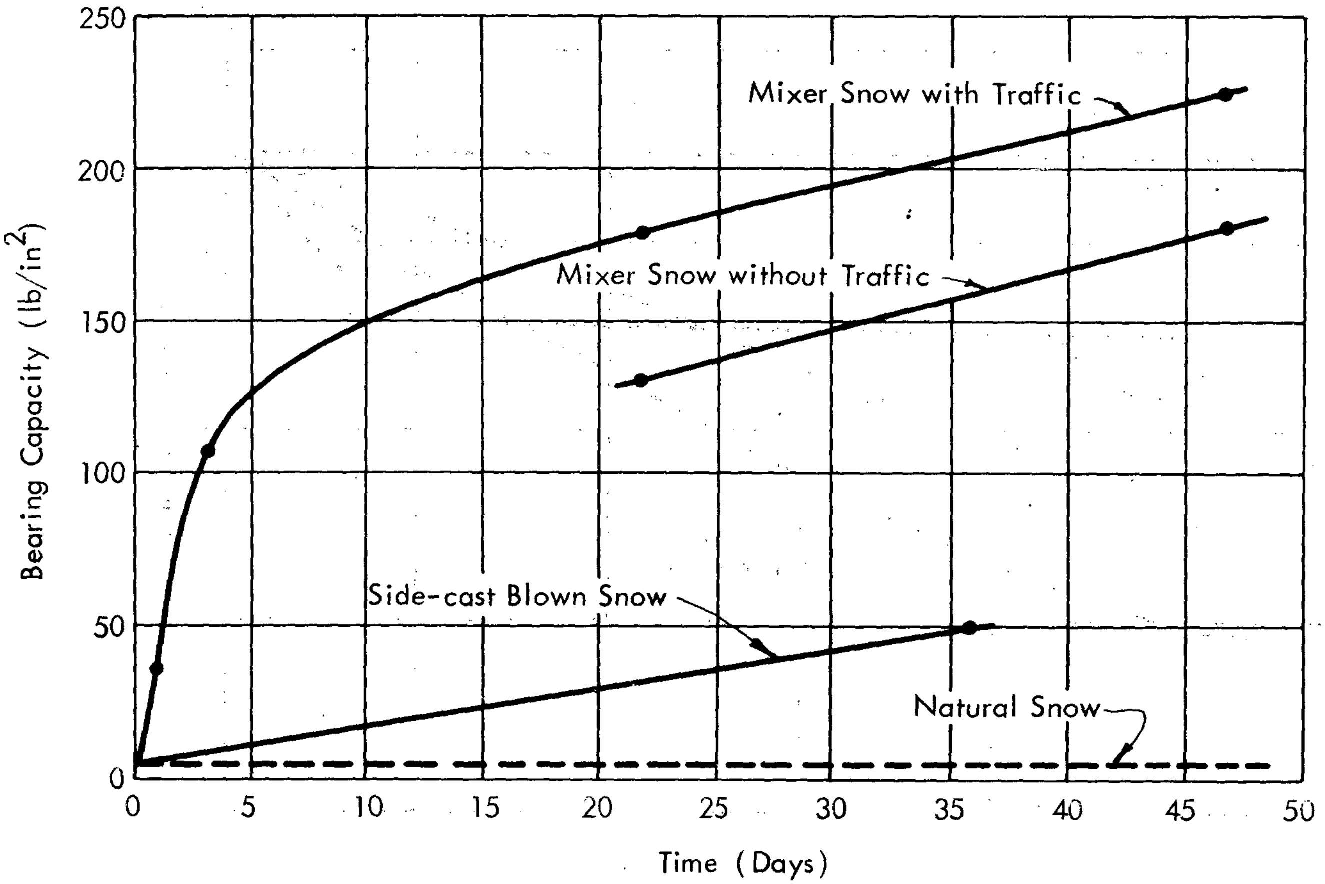


Fig. 7. Strength growth in three types of 16-inch-thick processed snow layers on the Ross Ice Shelf, Antarctica.

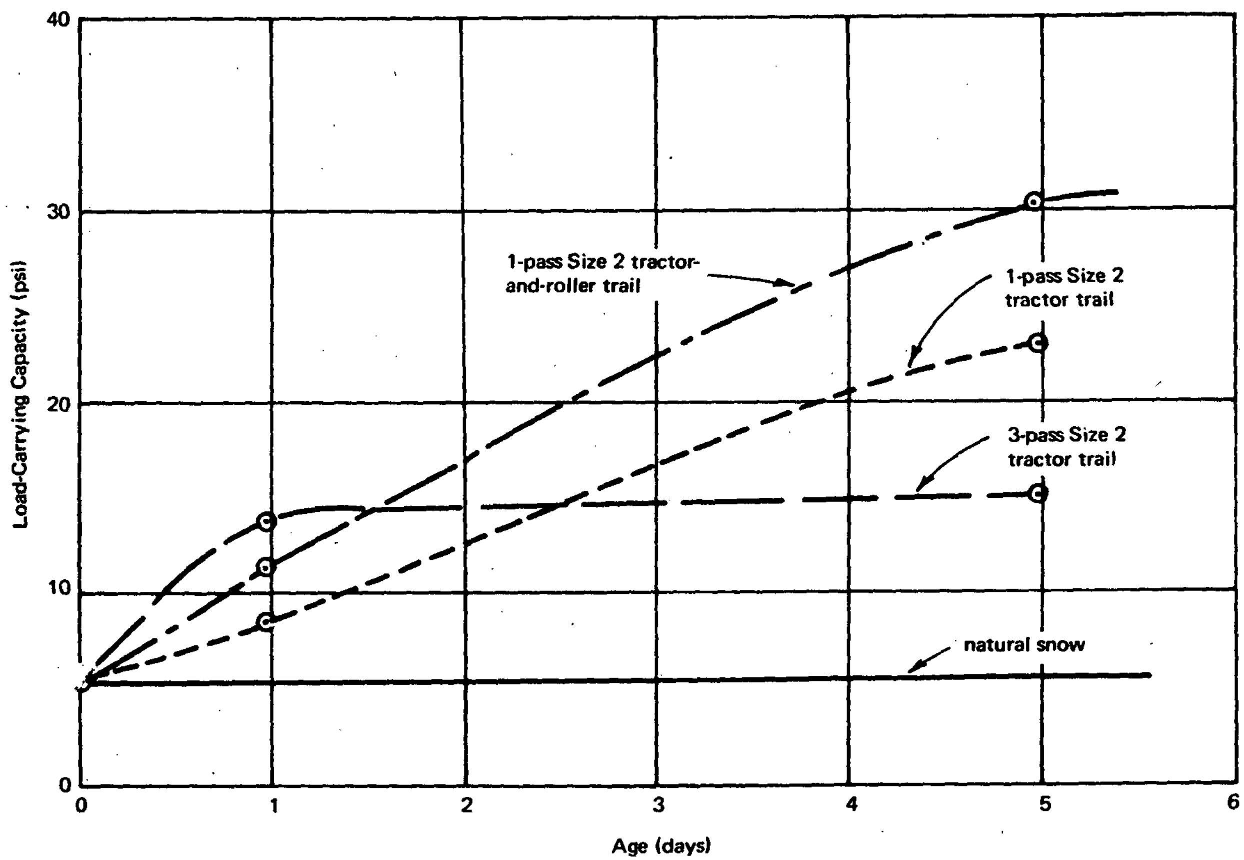


Fig. 8. Strength increase with time for the top 8 inches of the snow trails.

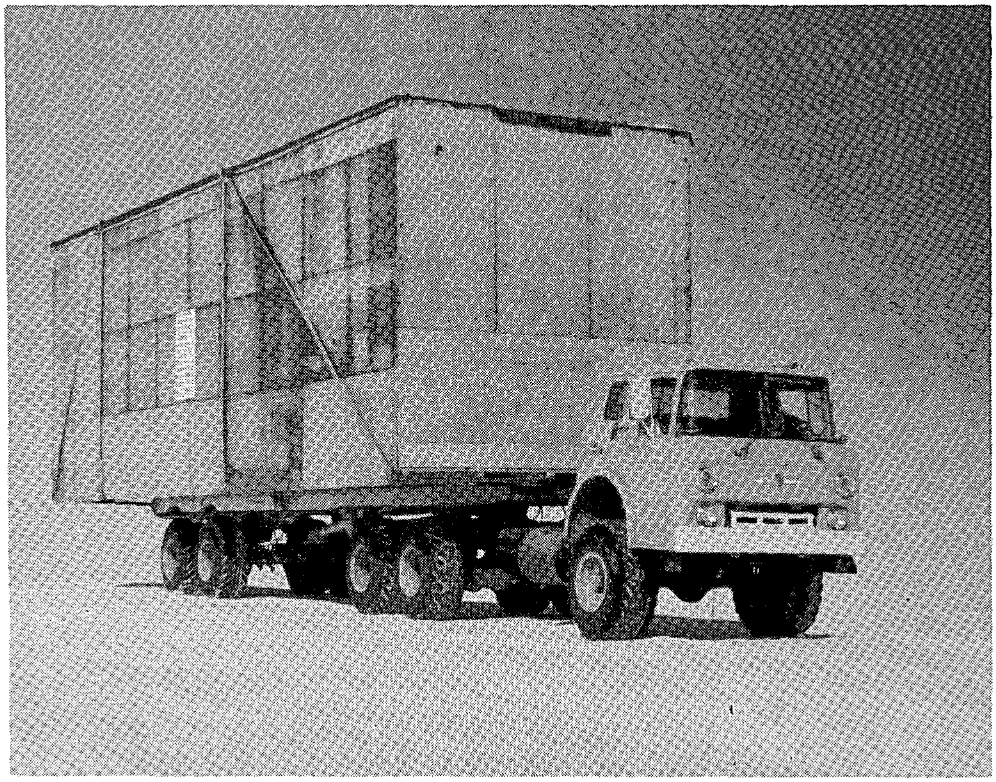


Fig. 9. Truck-tractor and 20-ton semi-trailer hauling cargo from McMurdo to Williams Field on elevated snow road.

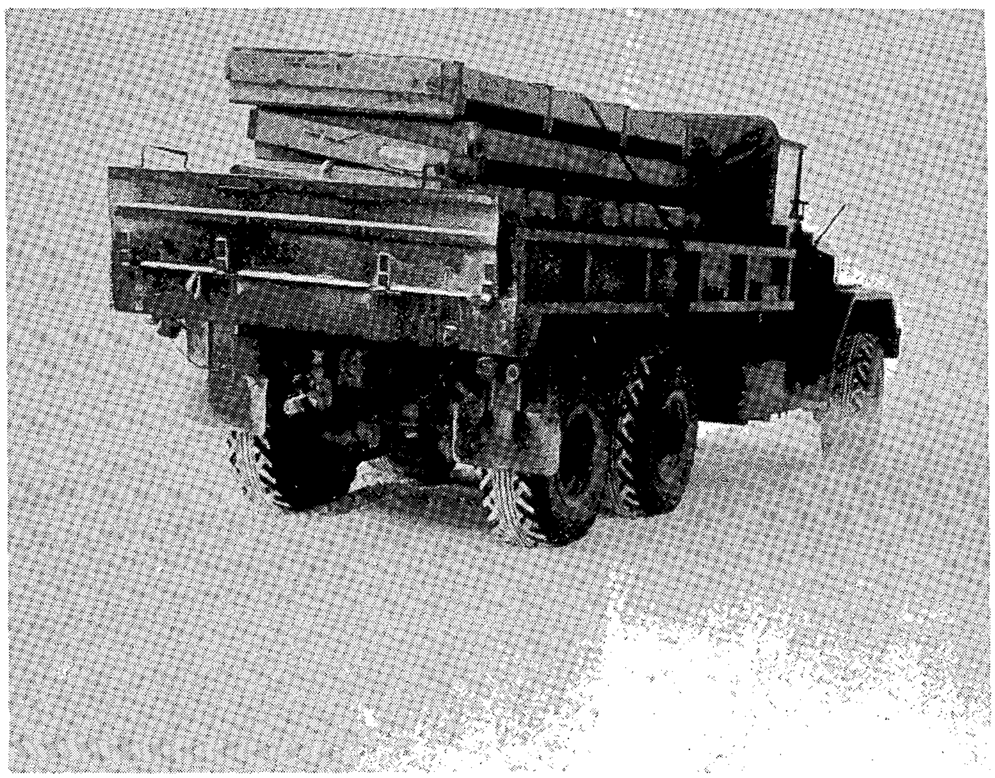


Fig. 10. Five-ton military cargo-truck with high-flotation tires.

3. AIR TRANSFORT, INCLUTING AIRFIELDS

SPECIAL PREPARATION OF THE C-47 AIRPLANE FOR ANTARCTIC FLIGHT

Ricardo Alfredo Ferluga

Summary

This is a report of the modifications introduced on the TA (Antarctic Transport) license 05, used on Antarctic flights to adapt the material according to operational necessities.

Modifications made are the following:

1) Engine preparation to operate at extreme cold temperatures.

2) Installation in the fuselage of one additional fuel tank.

3) Installation of a periscopic sextant.

4) Radar installation.

5) Modifications on the instrument panel.

6) Installation of a N1 type magnetic compas.

7) Installation of a Marbore turbine on the rearpart of the fuselage. This should give additional power for take-off and emergencies.

The preparation of the airplanes were planned and made by the technical department of the Argentine Air Force.

* * *

Our problem was to increase the power of the C-47 equipped with skys and which operate in the Antarctic Zone, not due to the Antarctic flight itself, but to the six hour flight over the stormy Drake Strait. That's why in 1962 a C-47 was modified installing DC-4 engines in it which allows it to reach an increment of 500 BHP. In 1964, we decided to place an additional reactor to the C-47 and, to prevent this reactor from presenting additional resistance, we decided to place it within the tail cone, out of the normal place in the inferior part of the central plane.

A preliminary plan was prepared for the installation of a 600 kg drive reactor. With it, an additional engine for normal flight would practically have been obtained, but the development had to be conditioned to the elements available, and thus a Marbore II reactor, pertaining to the Morane Saulnier "Paris" airplane, was installed.

Broadly, the modification consisted of:

1) Section of the contral internal part of the fixed horizontal plane of the tail and redesign of the supporting structures, transforming the original multi-spars in bi-spars.

2) Design of two circular joists in the tail cone zone in order to transmit the power which passes from the stabilizers to the cone through the supporting structures.

3) Structural door opening in the inferior area of the tail cone, with the two circular joists placed in front and at the back of the door opening; this door was constructed to be used in the introduction of the reactor and unit maintenance.

4) Design of the fixture joints of the reactor within the tail cone.

5) Design of the air inlet conductor and of the drive back air inlet, with remote control, so that when the auxiliary plant is not used there will be no further resistance.

6) Redistribution of the depth commands and of the steering and depth compensator.

7) Design of the reactor's commands.

8) Design of the starting system.

9) Design of the instruments board and of the transmission lines (command cabin-reactor).

10) Design of the reactor's fuel feeding system.

11) Weight and balance.

12) Computations of the performances anticipated for flights with skys and in normal confinguration.

For the structural calculus, notes from Airplanes Project and Calculus Division of the Superior Aerotechnical Institution of the Argentine Air Force were used.

For the performance calculus, notes from Aerodynamics, Stability and Control Division were used, with further addition of the C-47 and Merbore II reactor Manuals.

Displacement of the center of gravity.

The center of gravity of the C-47 airplanes must be found between the 11 and 28% of the CAM, therefore the margin of displacement allowed is 60 cm.

The introduction of the reactor within the tail makes the center of gravity displace 22 cm back. Normally, the center of gravity of the empty C-47 is found at 13% of the cam; the inclusion of the reactor makes it move at 19% of the cam. The same weight and rolling rules of the airplanes are used for its rolling.

Tension line of the reactor.

Due to the fact that the tension line coincides with the longitudinal axis of the plane, it was not necessary to anticipate any compensation for the reactor's performance.

Aerodynamical shape.

It doesn't change; it is the same as the original C-47's; even when the reactor is not in operation, its air inlet is drawn back according to the normal side lines.

Increase of the ascensional speed.

Starting from the classic formula =

$$W_{asc} - W_{desc} = W_{ad}$$

$$W_{asc} = \frac{Nm\ 75}{W} \quad ; \quad W_{desc} = W_{desc} = \frac{V}{C_l/C_d}$$

Wasc = Ascen. speed

Wdesc = Desc. speed

Wad = Avail. Asc. speed

For the use of the reactor, the only thing that changes:

$$W_{asc} = \frac{Nm\ 75}{w} + \frac{T}{w}$$

T = Traction reactor

In this way the curves of ascensional speed in function of the altitude for different configurations have been obtained.

Briefly, an additional Wad of 1.3 m/sec average at sea level has been obtained.

The rules of air navigability for the C-47 establish a maximum take off weight (sea level Temp. St) of 12,200 kg. If having reached the V1 it is necessary to stop a motor, it is possible to continue the ascension with the remaining motor only, under conditions which for the C-47 are from 1.1 to 1.2 m/sec. As a result, if at a take off with a functioning reactor it is necessary to stop a motor, it will be possible to continue the ascension at 2.4 of 2.5 m/sec. This demonstrates that we can increase the take off weight until reaching security conditions equal to those established in the rules of air navigability. The value obtained for the take off weight in those conditions is 14,500 kg. Therefore an increase of 2000 kg of the pay load can practically be obtained, which means that it has been 100% increased for normal conditions of the C-47 operations.

We shall give an example:

A C-47 flying from Buenos Aires to Cordoba, may transport 2000 kg of pay load, taking off with 12,200 kg. The C-47 with the additional reactor may transport in the same trip 4,000 kg of pay load with a take off weight of 14,500 kg.

14,500
12,200
2,300 kg of increment in the take off weight
300 kg modification weight and fuel and lubricant remnants.

2,000 kg of increase in the pay load, that is 100%

It is not necessary to perform the flight with the reactor functioning throughout the trip, it may be used for taking off and for reaching the cruising altitude and then it may be stopped, continuing the trip until the descent with the two normal motors. Only at this stage is the reactor started anew by way of security against a possible frustrated landing. It must be noticed that due to the structural resistance the C-47 may be operated with a weight of up to 14,800 kg. As a result, the increase in the operational weight due to the addition of the reactor, is comprised in the limits of the structural resistance.

Decrease of the take off run.

The calculation was made employing the conventional formula:

$$T = R + D + \frac{wa}{g}$$

T = Traction

R = Resistance to runway

D = Aerodynamic resistance

W = Weight of the airplane

A = Acceleration

The propeller traction in function of the speed and the reactor traction in function of the speed, were calculated by means of schedules. This means that the total traction.

$T = Th = + Tc$ — Th = Propeller traction

Tc = Reactor

by increments, and having in mind:

$\text{Speed} = a_c t$

$\text{Space} = 1/2\ a_c t^2$

clearing the formula, we obtain the space values (runnings). Then a comparison is established between the take off space values (runnings) for the same operating conditions as the original C-47, and we reach the conclusion that the decreases of the take off runnings for operations with reactor are of the kind of 17% for the same conditions.

Cruising performance.

Drive Combinations Curves have also been created for the combined flight operation with conventional engines and reactor and the schedules for the reactor operation and an engine with propeller feathering.

Briefly:

The addition of the reactor provides the following advantages to the airplane:

1) To increase 100% the pay load.

2) To reduce 17% to the take off runs in a same flying condition.

3) To increase the operating ceiling to 7,000 ft for a same flight configuration.

4) To increase 35% the ascension range also for the same flight configuration.

5) It is possible to take off with the reactor form any runway and it is possible to stop it or start it again in flight according to the operational necessities.

6) During a flight with stopped reactor the aerodynamical resistance does not increase due to the fact that the drawing back of the inlet does not produce any change in shape.

7) The experiment did not cost anything as far as economical values are concerned, since available elements were used and the handwork employed has been payed out of the normal budget.

Besides the installation of the reactor in the tail, other works were performed so that the airplane might have the operating conditions required.

1) Engines.
   a) The oil radiators were installed in the superior part of the racelles to avoid snow accumulation and the operation of the sky-wheel.

   b) Pressure, temperature and electric quantities transmissors were installed.

   c) An additional oil tank was installed to receive recharging in flight.

   d) The pipes, pumps and oil tanks were protected in order to make them operative at low temperatures.

2) Installation of supplementary tanks.
   a) Four supplementary tanks of 750 ls. each were installed in the command cabin. The fuel of those tanks is transferred to the main tanks by means of two pumps.

   b) An auxiliary oil tank with pumps was installed to feed the left or right engine.

3) Installation of sky-wheel and mechanism for JATOS.

   a) Sky-wheels with stabilizers and follower sets were installed for retraction operation of the landing gear set.

   b) A ramp for four JATOS of 1000 pounds each with a system of dropping of each served unit was installed.

4) Place for the navigator.

   A place for the navigator was installed and equipped with the following elements:

   a) Common instruments - Speedometer, Altimeter, chronograph - RMI Indicator with ADF No.1 and No.2 signaling - Temperature gages.

   b) Master indicator of N1 Gyrosyn Compass C-2 for free or slave, use PPI of meteorological radar, drift meter and sextant periscopic.

   Studies were made in the installation of the Bendix doppler.

5) Instrument board.

a) The pilot and co-pilot's panel was modified in order to introduce other instruments in it; N1 Gyrosyn Compass C-2 repeator, fuel fluxmeter.

b) A small auxiliary reactor's instruments panel was constructed with pyrometer for T-4, tachymeter, monometer, fire detectors, bomb command keys with warning lights and reactor's drive back air inlet command keys with warning lights.

6) Other additional system.

a) The reactor's starting box was exclusively designed to be applied to the C-47 and it was placed within the command cabin.

b) The reactor's starting system was also designed so that a single crowbar may allow the starting operation to be effected. Two relays are attached to the crowbar, one of them to operate the first speed, and the other is a mechanical device which opens the fuel by-pass cock whenever the crowbar is turned.

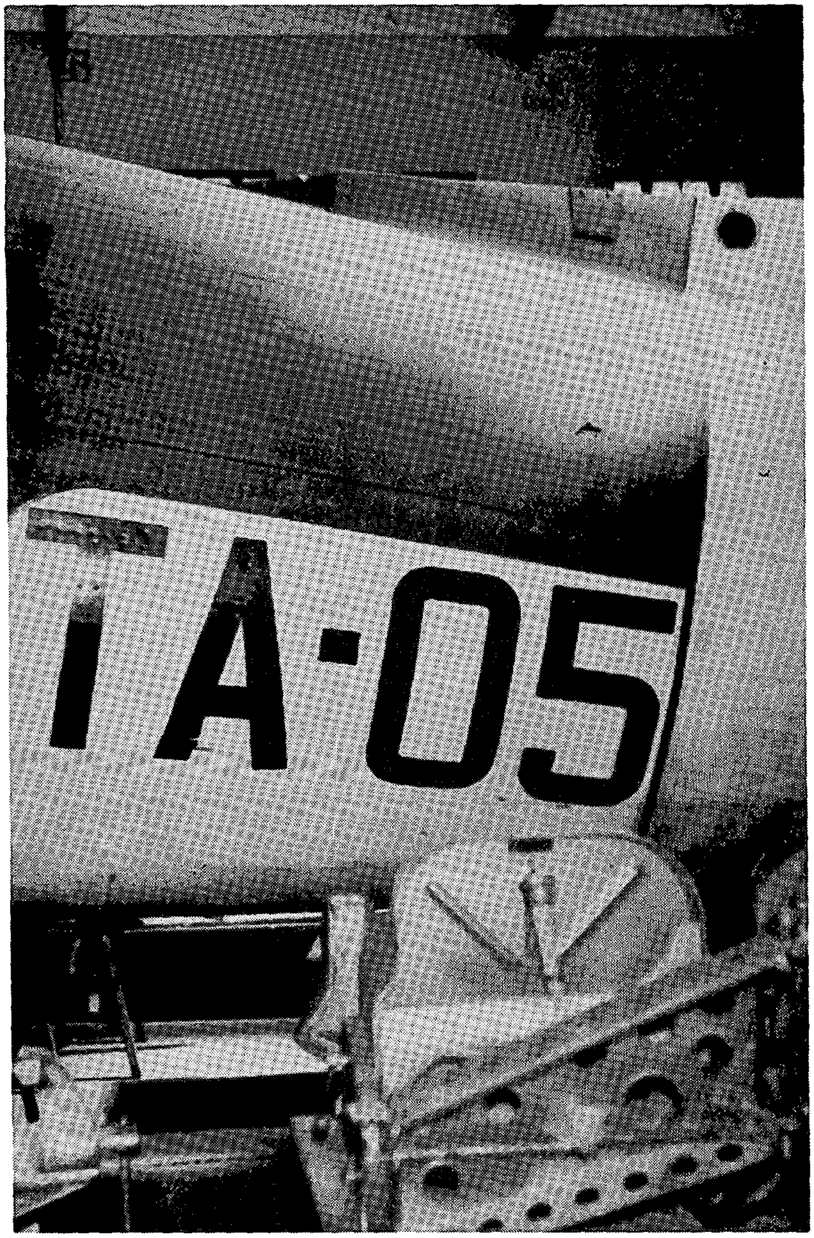
c) The reactor's accelerator was installed in the control tower near the engines' accelerator.

d) A heating system of the automatic pilot's servos was prepared to allow its operation at low temperatures.

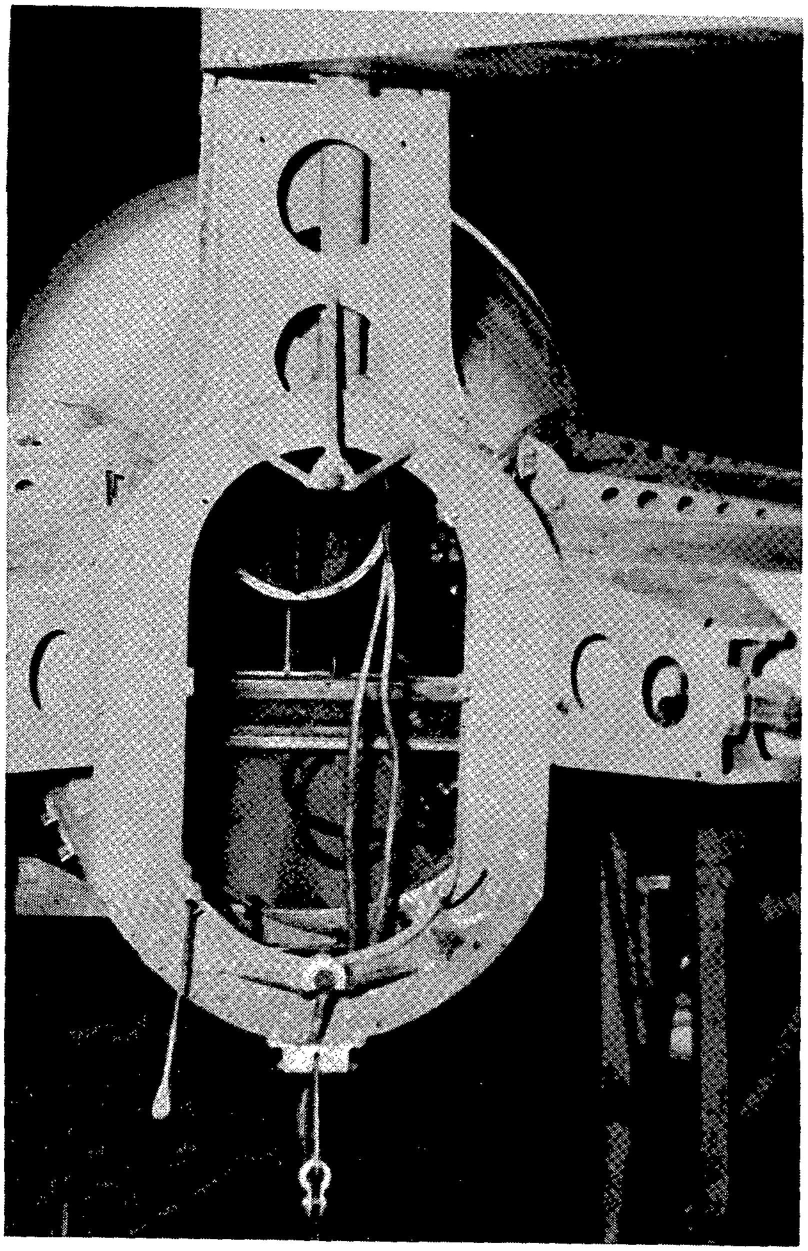
e) Removable panels were installed to provide heating to the windshields by means of a warm air system.

f) The radio electrical station of the airplane was modified to adapt it to the new distribution of the command cabin. The airplane also has the VHF, VOR-ILS, HF and ADF in duplicate, and an intercommunicator for use during flight.

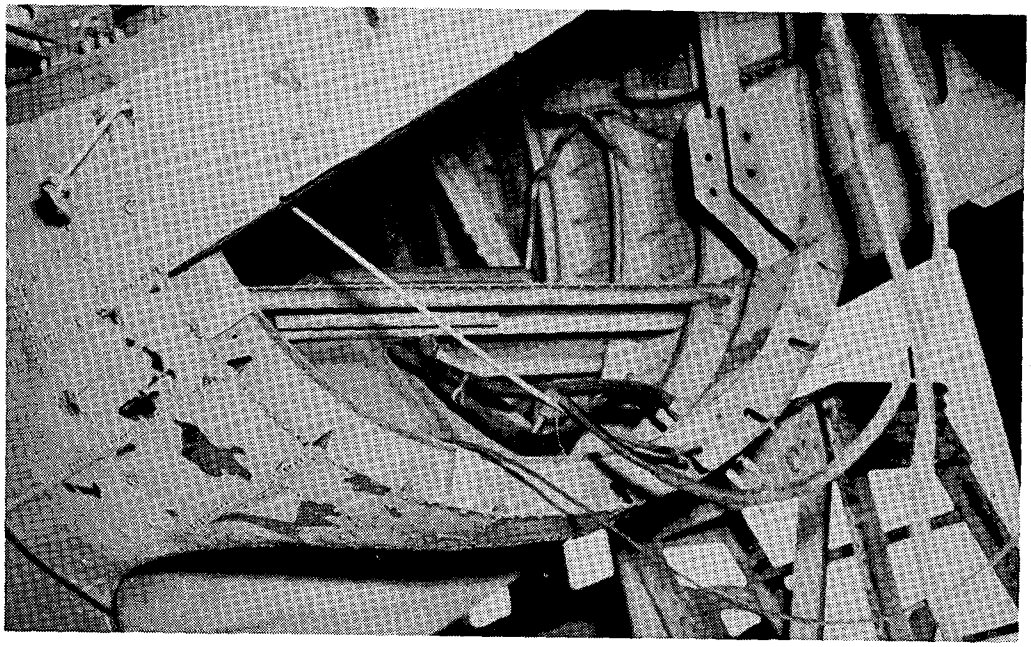
In the described conditions, up to the present time, the airplane has performed 1500 flight hours with several flight across the Drake Strait, including a flight from our Bases to McMurdo through the South Pole.



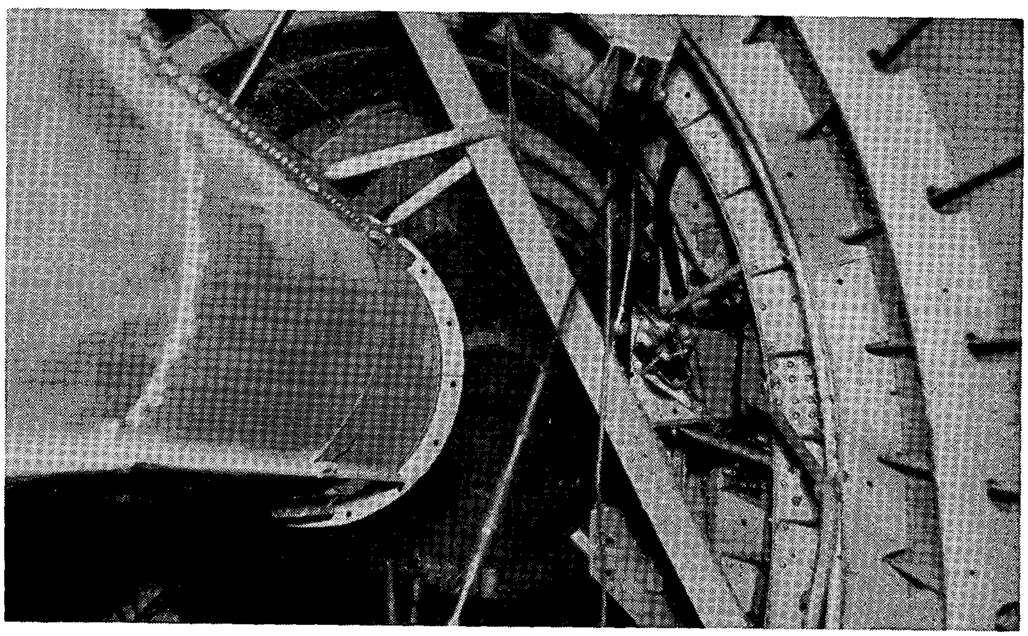
1, View of the fuselage-cone union part. In the superior part, the driven back reactor's air inlet may be seen.



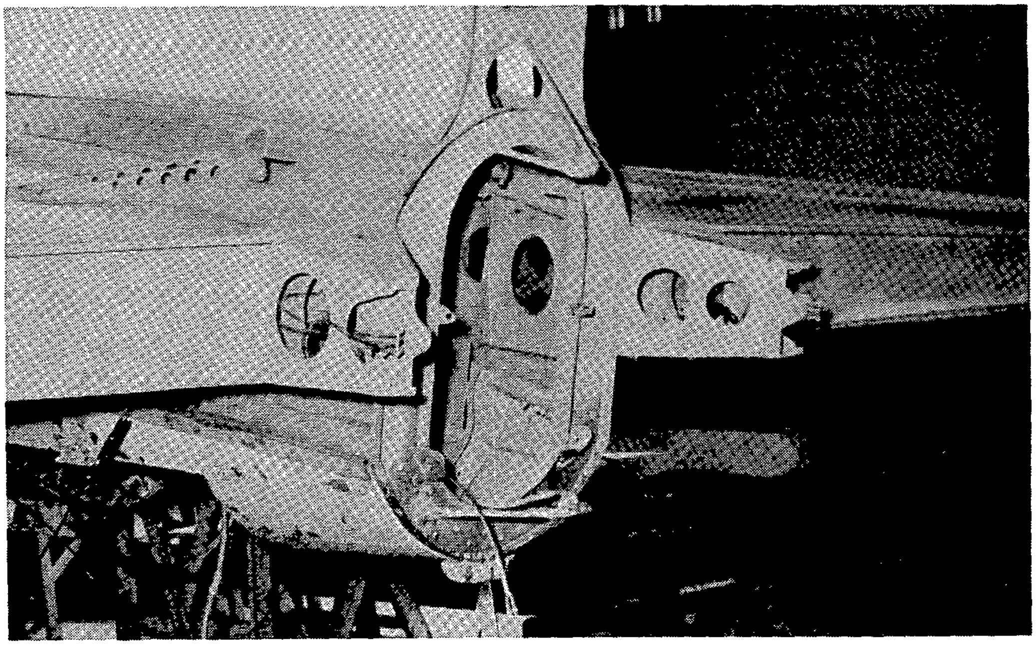
2. Circular crown of the tail cone end. The depth steer limits may be observed.



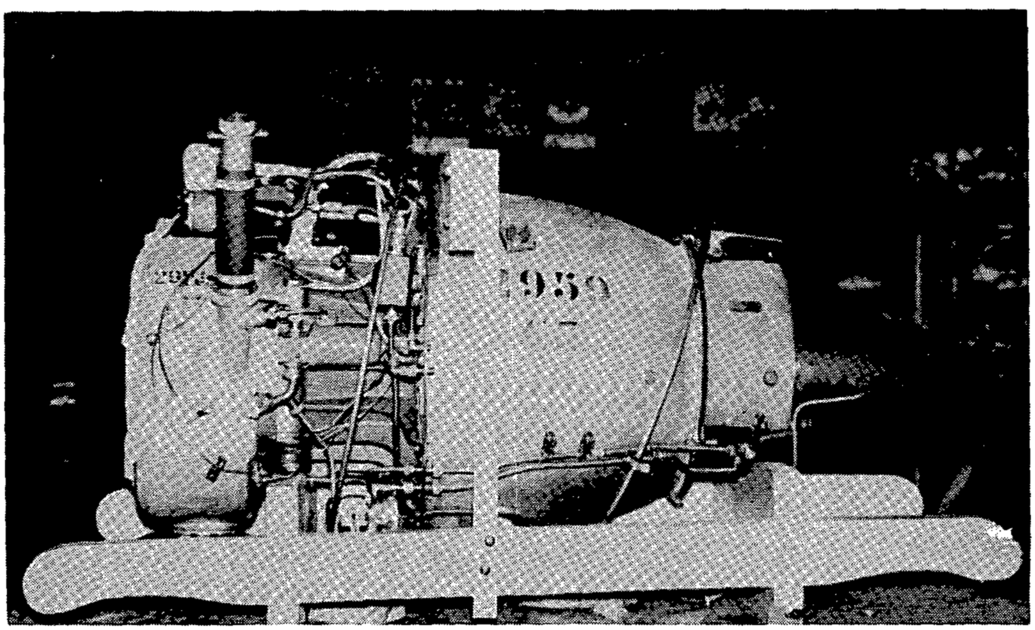
3. Detail of the inferior door of inspection and of the cone reactor mounting.



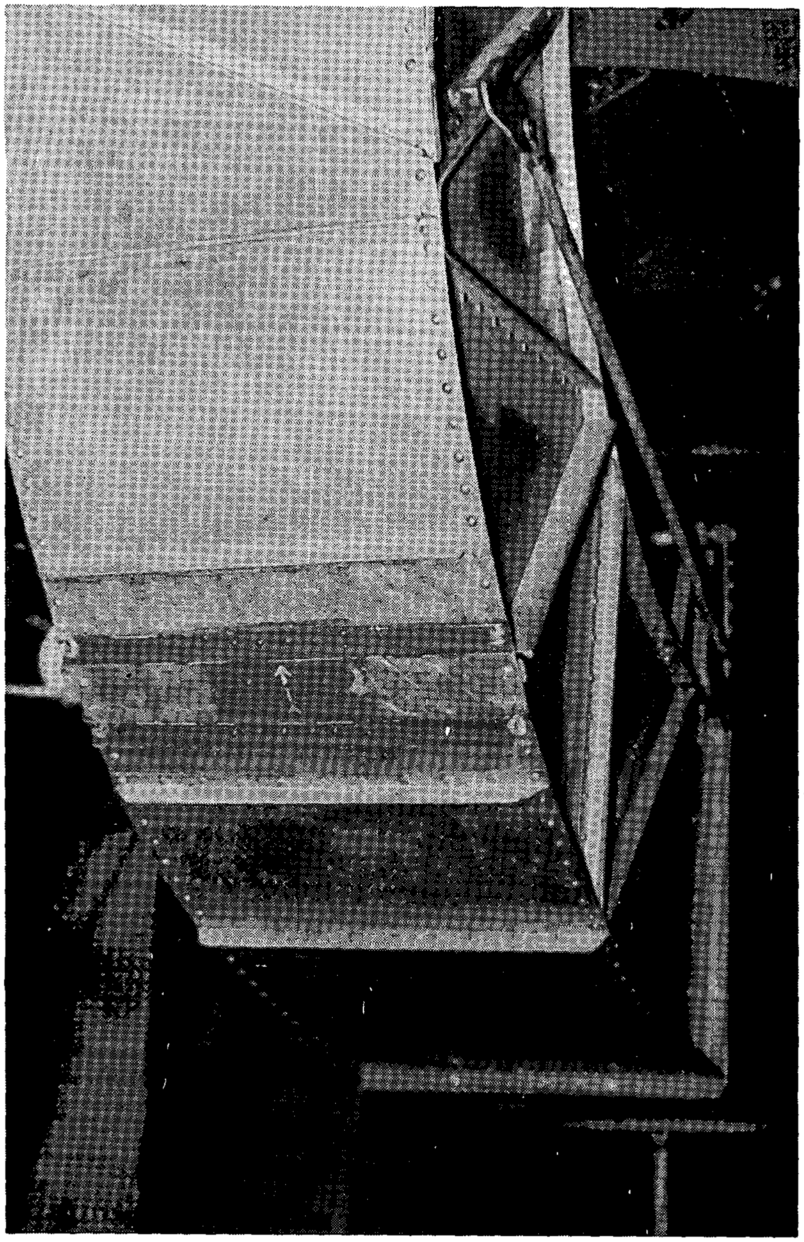
4. Interior view of the tail cone. Details observed;
   1) Command cables pulleys.
   2) End of the reactor's air inlet.
   3) Inferior door of the reactor mounting and inspection.



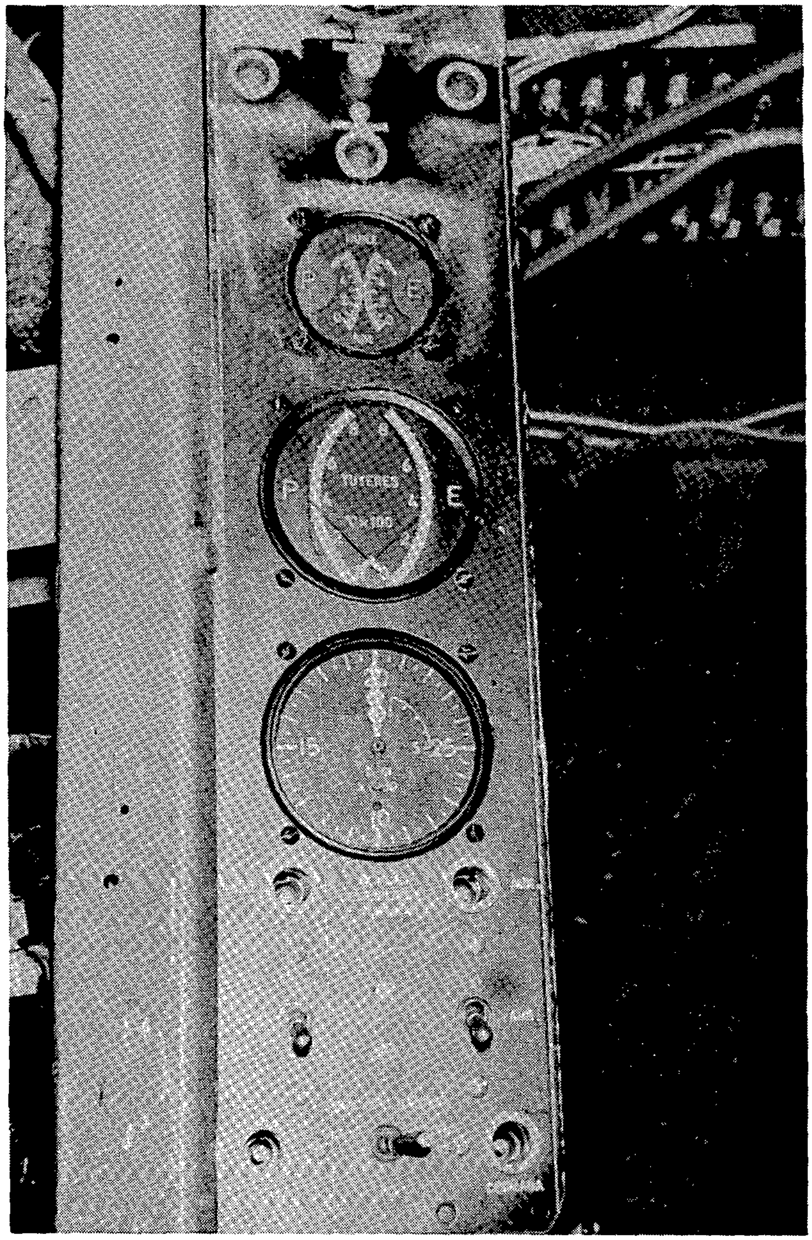
5. Partial view of the modified tail cone. observed;
   1) Circular crown of the tail cone end.
   2) Modified fixed horizontal stabilizers.
   3) Left top back view from the stabilizer to the cone.
   4) Inferior door of the cone (mounting and inspection of the reactor).



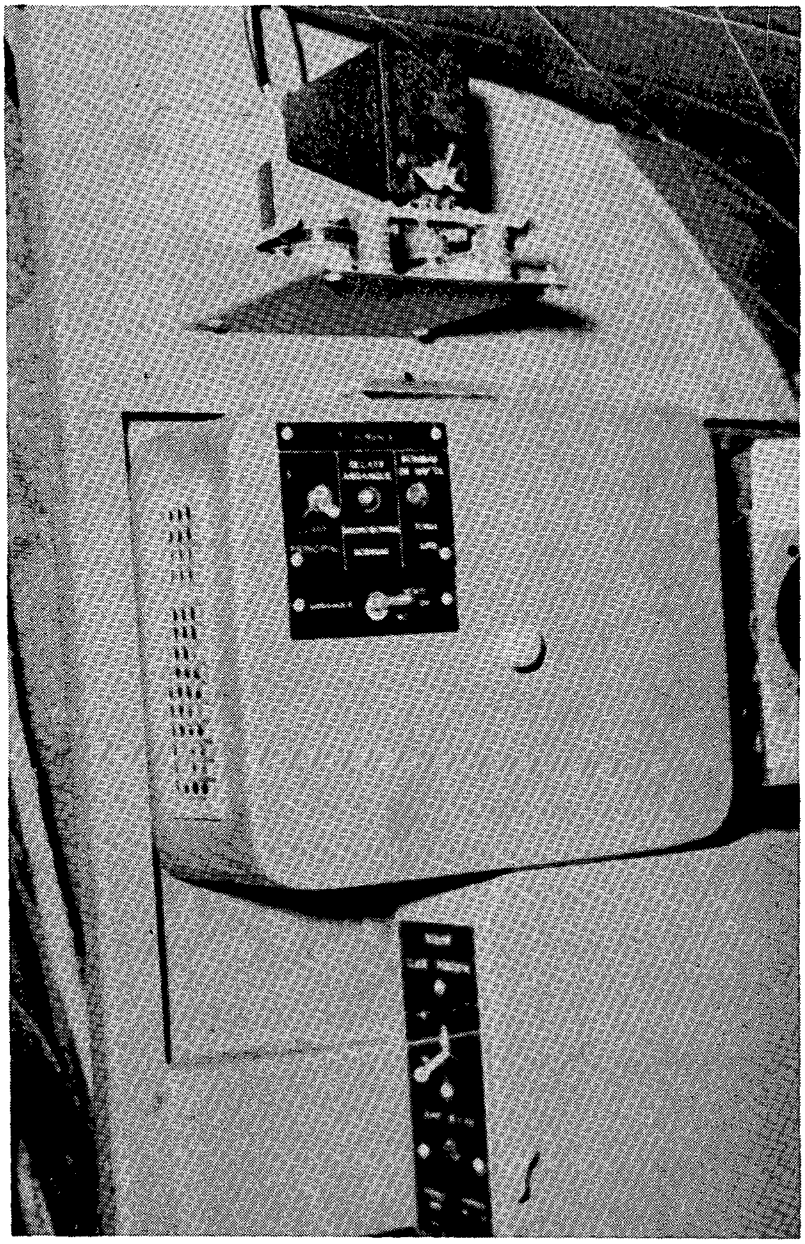
6. Marbore II reactor.



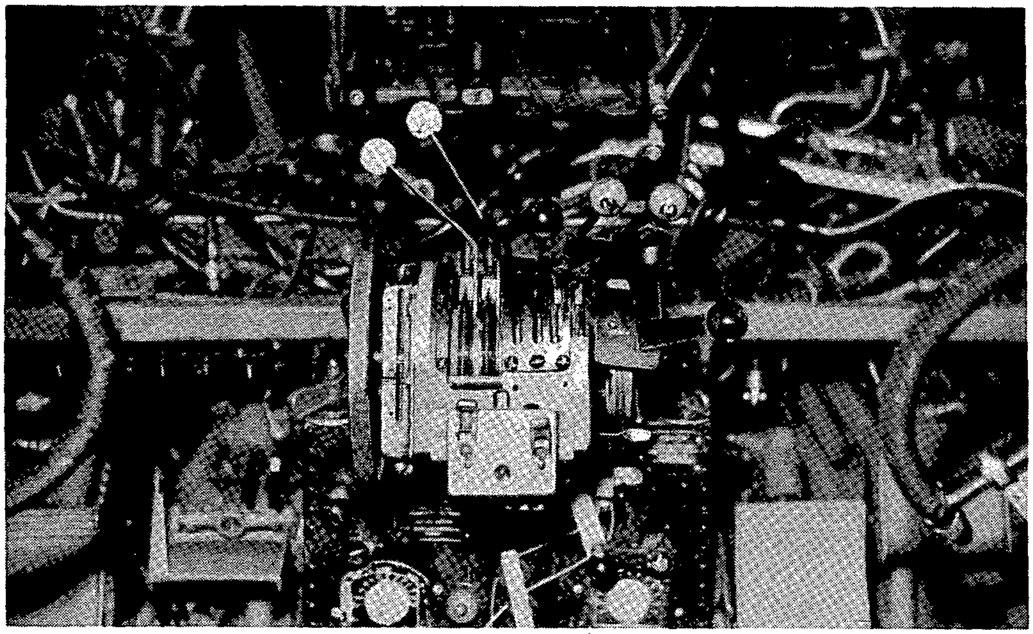
7. View of the air inlet conduct. Details observed :
   1) Bar and mechanism of the drive back door of the air inlet.
   2) Microswich doorstop warning.
   3) Inspection door.



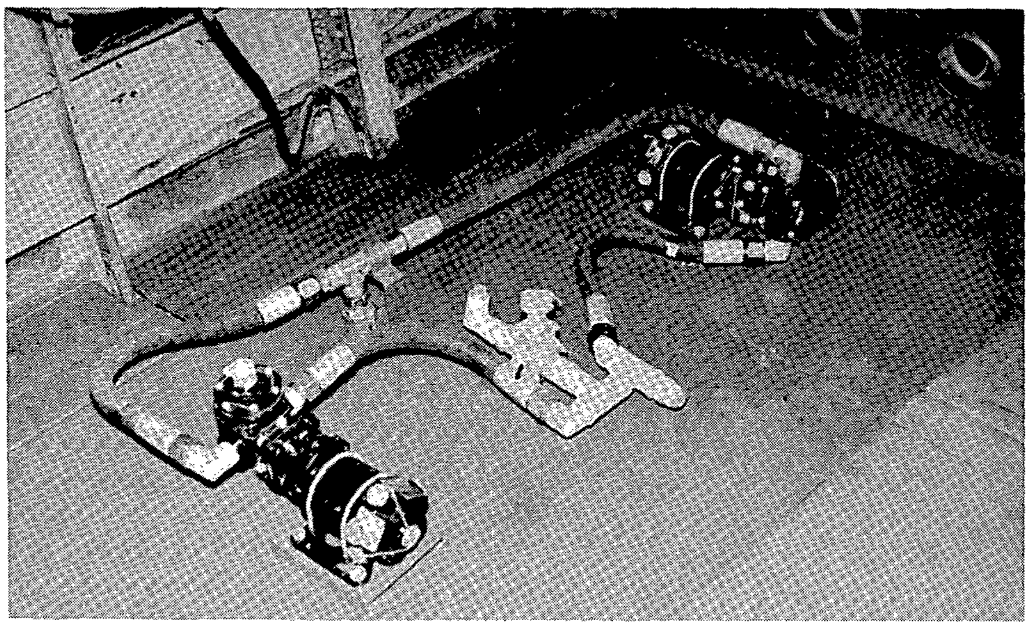
8. Instrument board of the auxiliary reactor. This includes;
   1) Fire detector test key with lights.
   2) Oil pressure gage.
   3) T4 temperature indicator.
   4) RPM indicator.
   5) Fuel pump cocks with warning lights.
   6) Opening and closing control of the drive back air inlet.



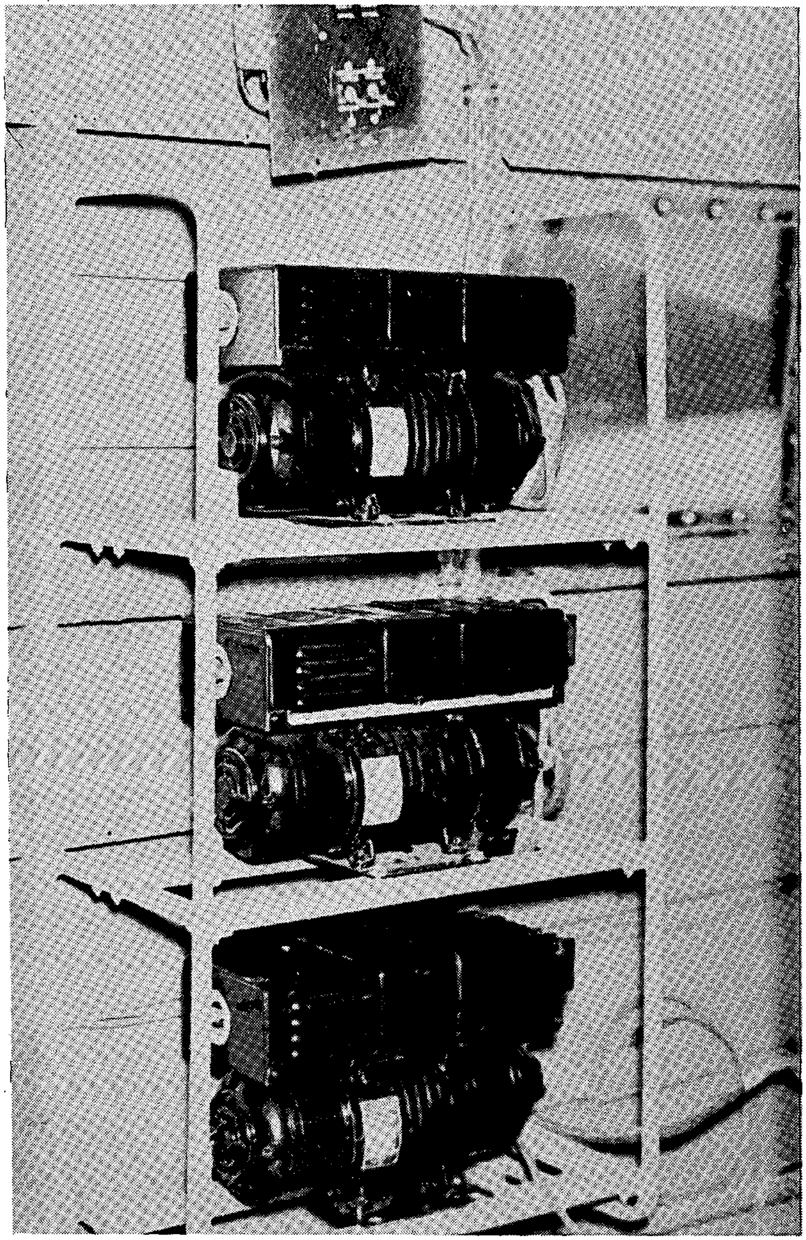
9. Details of;
   1) Top: Fire control box.
   2) Middle: Reactor's starting box.
   3) Bottom: Disconnection thermal circuits' box.



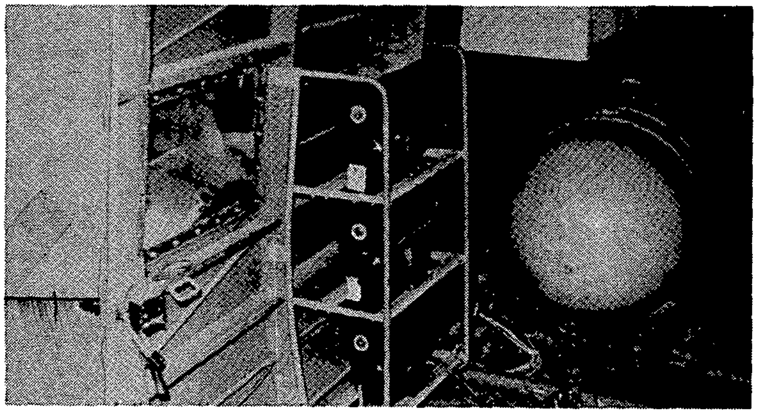
10. Control tower. Details observed;
   1) Control crowbars of the propeller pitch.
   2) Accelerator.
   3) Mixtures control.
   4) Reactor's accelerator.



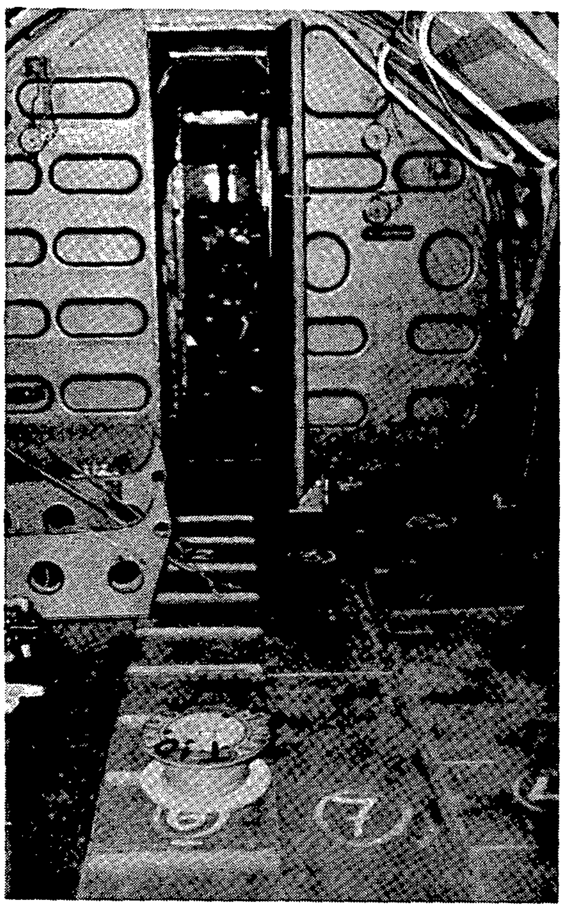
11. JPI Pumps of the reactor's feeding circuit.



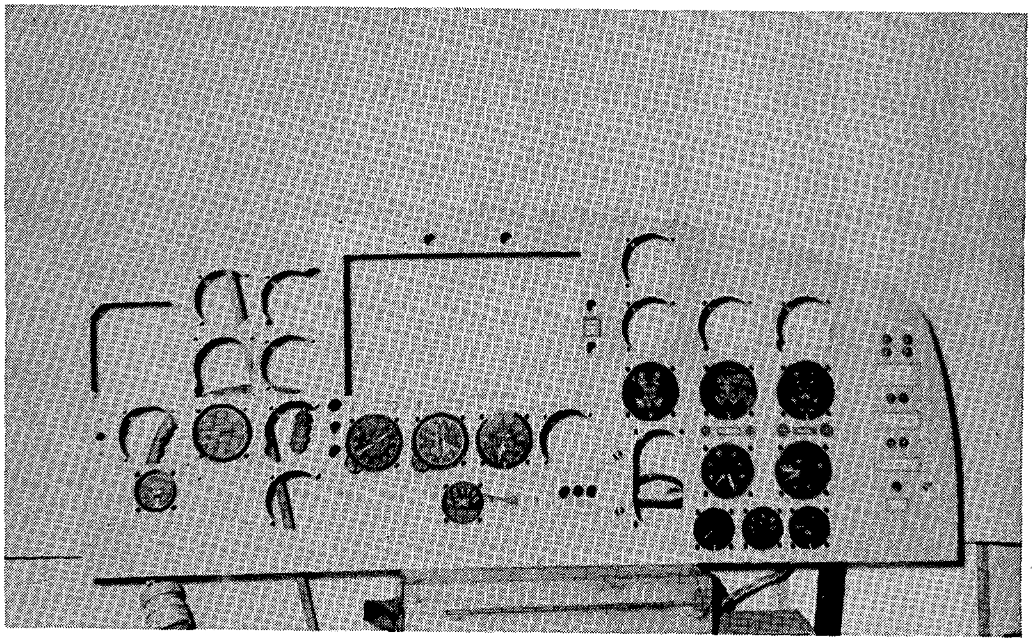
12. Dynamotors mounting and protective thermal keys.



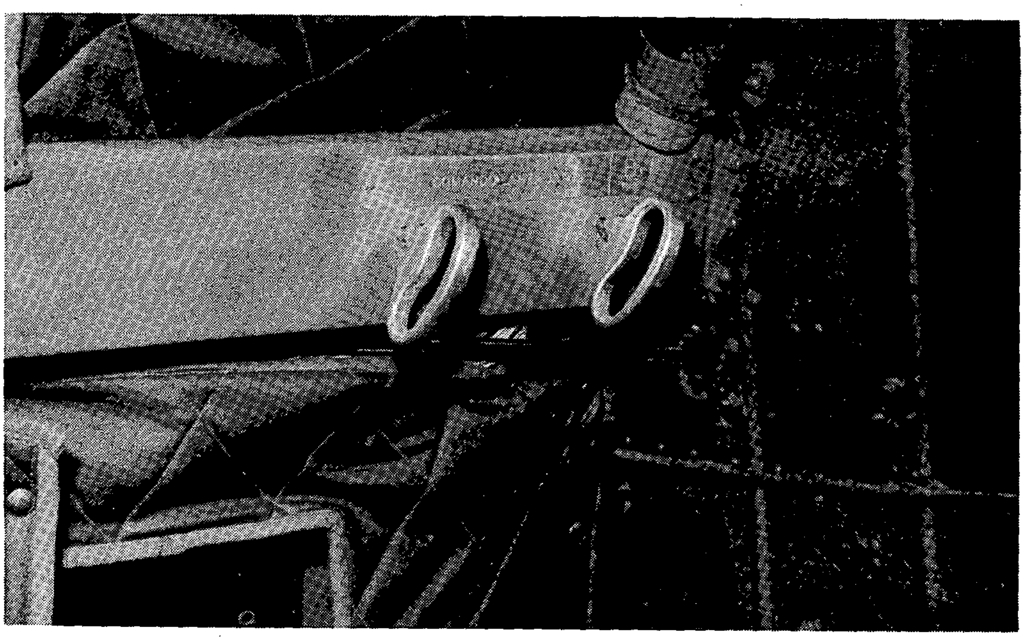
13. Interior view. Details observed;
1) Revertor's panel. 2) 7 mm^3 oxygen tank.



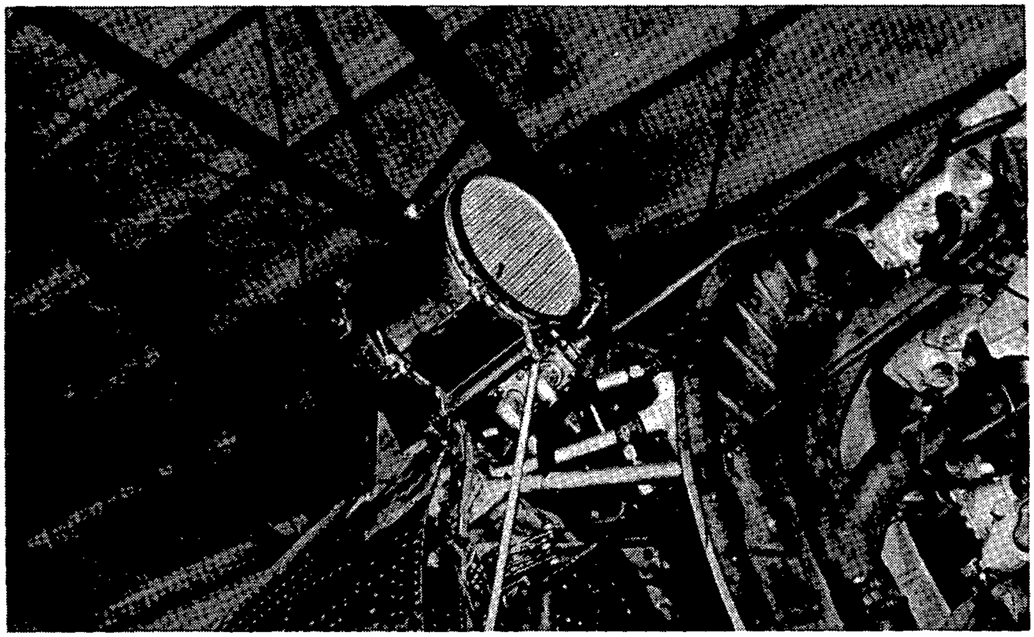
14. Interior view of the fuselage. Details observed;
1) Fuel pumps.
2) Auxiliary tanks'supporting structure.
3) Entrance door to the command cabin.



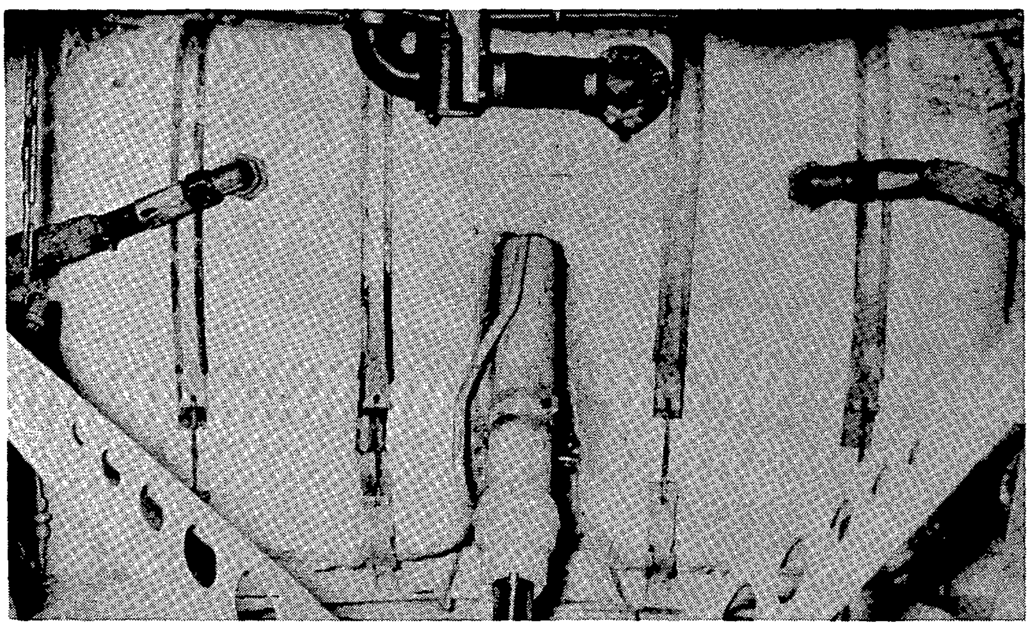
15. Main board of instruments in construction, in the servo mechanism and instrumental section.



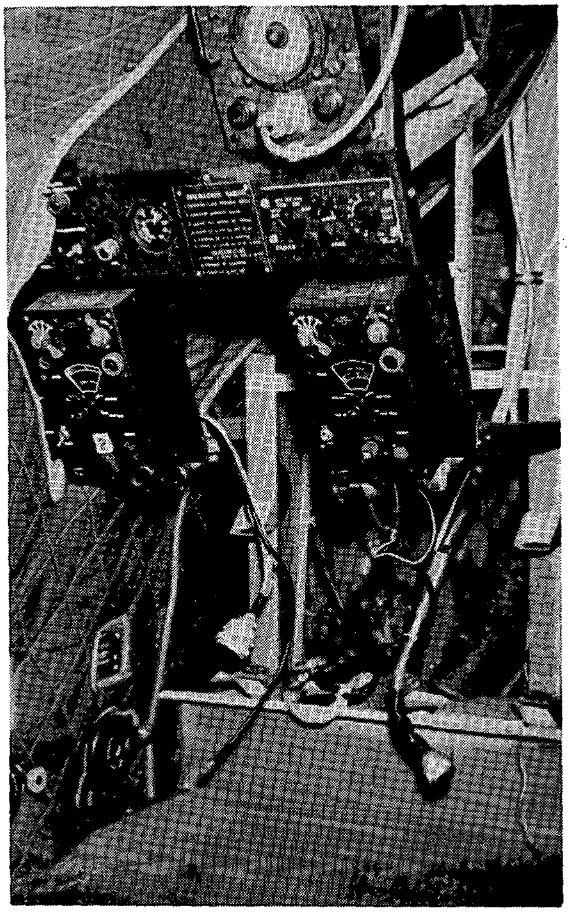
16. Served JATOS capsules dropping control crowbars; each one drops capsules in pairs.



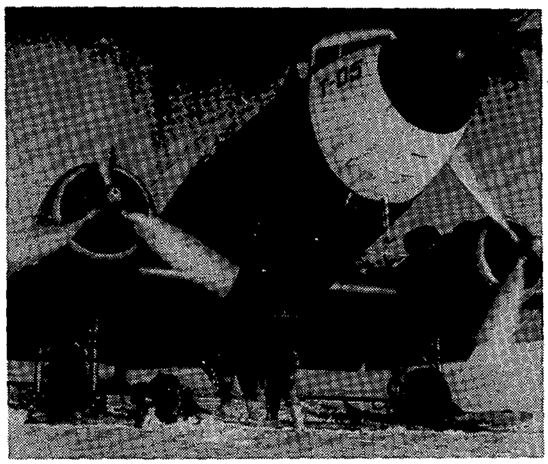
17. Moter oil radiator placed anew at the top of the nacelle.



18. View of the oil tank of one of the nacelles. Details Observed;
    1) Special amianthous lining of the tank.
    2) Train driver.
    3) Rapid oil stop key.



19. Navigator's board in construction. Details observed;
   1) ADF control boxes.
   2) Radio altymeter.
   3) Control box of meteorologycal and navigation radar.



20. The C-47 airplane, license TA-05, landed at "Teniente Matienzo" Air Base.

PORTABLE EQUIPMENT FOR FUEL LOAD TO AIRPLANES

Instituto Antartico Argentino

Summary

This refers to an equipment that was prepared at the "Teniente Matienzo" Air Base. It is mounted on skis so it can be transported to the required place. The equipment includes an special tank made out of rubber and cloth, which has a capacity of 4,200 lts (Type Pillow Tank), and a pumping unit with a capacity up to 100 gal/min.

The importance of this system rests on the existing difficulties in handling ski-equipped airplanes on ground and consecuently the problem to bring them to some fixed place where fuel should be loaded.

* * *

It is an equipment prepared at "Teniente Matienzo" Air Base, mounted on a sled, a fact which allows it to be transported to the place where it is required for the loading. It is composed of a special tank made of rubber and material, of 4,200 liters capacity (Pillow tank type) and a pumping unit with a capacity of up to 100 gallons/minute. The importance of this equipment lies in the difficulties arising from the ground manoeuvres of the airplanes equipped with skis, and therefore, from the problem of getting near to a fixed place in order to load the fuel.

Preparing the Sled.

A common sled is used, without bannisters, with a load capacity sufficient for the type of Pillow tank to use. On the sled, a wooden platform about one inch thick is constructed in order to fit on it the fuel pump system, the filter and the Pillow tank.

The platform must be constructed in such a way as to prevent irregularities on its surface which could produce abrasion through friction or which could pierce the Pillow tank.

Type of Tank Employed.

A Pillow tank type of 1,100 American gallons is used in order to avoid the use of drums, due to the fact that the first ones have proved to be more successful in the speed and simplicity of the fuel supply operations in the airplanes. The normal life time of the Pillow tanks was estimated to be from five to seven years, as long as it is intensively used, since extremely cold temperatures do not affect them as long as they have been constructed in such a way as to be capable of enduring those particular conditions. The Pillow tanks are also capable of bearing considerable volumes of load and only through much effort can they be cut or pierced.

Pumping Engine and Filter Equipment Characteristics.

It is a Heavy Duty Air Cooled Wisconsin engine, AELND model which reaches 9.2 HP. at 3,600 r.p.m. with Stillete exhaust valves, high tension magneto and hand starter. This engine is directly attached to a special fuel pump SILWAN 97-148 model, all in bronze, with an entrance of 5" and an outlet of 4" with a pumping capacity of from 71,000 to 76,000 liters/hour at 2,600 r.p.m. of the engine and with an elevating capacity of from 12 to 15 meters/monometric.

The Warner Lewis type filter, FCS-262-3N1 model is prepared to be used in very cold regions and has a filtering capacity of approximately 381 liters per minute (100 gallons/minute) with pressure gauge, exhaust valves and escape valves.

Starting Types.

The material employed consists of a nylon 1.5" cord with a high tightening strength; The fastener consists of two or three lengthwise straps and a number of side straps, according to the container employed, which are placed on the Pillow tank. The size of each of the straps is slightly greater than that of the empty container and on its ends there are metal handles to facilitate its fastening.

Considering the possibility that the frontal part of the container might be subject to a strong deformation whenever the vehicle dragging the sled makes rough movements, special precaution must be taken of having it well fastened.

Due to the fact that the common cords are not too appropriate, 1" circumference nylon cords are being used. This cord is ran through the handle ends of each of the nylon cords and is attached to the sled itself, in order to set the shole in a single unit.

Once the Pillow tank is full, the following precautions must be taken when moving it:

1) It may be seen that in sharp turns, the tank has a tendency to change shape and to bend outwards as a result of the centrifugal force; in spite of it, the location of the container base on the platform will not change as long as the tank is not excessively full and has been correctly fastened.

2) Whenever the vehicle is set in motion or roughly stopped, the liquid in the container is thrown backwards in the first case and forward in the second case. This impulse is restrained by the container and the typing system.

3) The pumping engine and the filter are attached to the platform by means of set screws.

MARKING OF AIRSTRIPS IN ANTARCTICA

R.F.M. Dalton*

Abstract

Presents a layout and method of marking airstrips which would be practicable for Antarctica and follow closely in line with ICAO standards.

1. Introduction

Standards for air operations have been developed to a high degree of sophistication by ICAO at the international level, and most national civil aviation organisations adapt their procedures to conform with these standards.

In Antarctica it is desirable to set standards which will be compatible with the ICAO standards and will in fact follow them as far as the exigencies of the local conditions will allow.

In the matter of marking airstrips, the impermanent nature of the snow surface presents a local problem. The problem was discussed at the SCAR Symposium on Antarctic Logistics at Boulder in 1962 and the conclusion (No.15) was reached:

"The standardization of airstrip markings in Antarctica is necessary. Methods of marking, using poles with flags, dye marker, fuel drums, vehicle tracks, panels of paulin and others were discussed. The use of drums for markers, which provide a radar and visual target from any angle, was accepted as the best method".

Experience in recent years indicates that it is desirable and practicable to move more closely into line with the more conventional application of ICAO standards in this matter of airstrip marking.

When the utilization of ice and snow as constructional materials, and their permanency and control become established, then the already internationally accepted methods of defining runways and strips may possibly be followed. Only minor changes to meet the unique environment may be necessary.

Meanwhile it is vitally important, from a safety point of view, that some form of standardization be accepted and introduced without delay. When considering any form of standardization, it would be well first to look thoroughly at the already established airfied-marking principles.

* Antarctic Division, Department of Supply, Melbourne, Australia.

Such examination would reveal that the established procedures for the marking of FLARE PATHS would, with the substitution of markers for lights, provide the necessary standardization, leaving only some minor issues such as type of markers, their colours, etc., to be resolved.

The object then, of this paper, is to outline an adaptation of the FLARE PATH and to suggest a type of marker that would be suitable for its definition.

The method described would then be, in general terms, in keeping with the provisions of ICAO Annex 14, and the definition of the strip would be one that is familiar to all in aviation.

2. Characteristics and Location

The strip should be marked as near as possible in accordance with the requirements for a normal flare path by substituting markers for lights. Some slight modification is necessary, such as the definition of the threshold, but this will leave the resultant presentation in conformity with the familiar pattern of a night flare path (see Figure 1).

The strip will then consist of a double line of markers, with additional markers placed on each side of the down-wind end of the lines, to indicate the threshold, and at the up-wind end to denote departure.

The spacing of the two lines of markers must be not less than 150 feet apart, and no obstructions shall exist within 150 feet of each side of the centre line of the strip.

The position of the threshold and departure must be checked to ensure that no obstructions project through the normal approach surface on 1 in 30 measured from the threshold and departure markers.

The markers must be evenly spaced at intervals of not more than 300 feet for the full length of the strip.

As a guide for length of strip to be marked, reference should be made to Appendix 1.

3. Boundary Markers

The cone-type marker (see Figure 2) is considered the most useful as it is an approved marking device, is easy to construct, frangible and stackable for ease of transportation, and conserves storage space when not in use.

All markers, with the exception of those used at the threshold, should be painted an orange colour, and the threshold markers finished in black matt surface.

4. Wind Indicators

A standard wind sock should be available and positioned in the vicinity of the threshold, but clear of the approaches to the strip. Otherwise it could be mounted on a vehicle attending the movement of aircraft.

5. Advance Information of Intended Use

Pilots intending to use airstrips at other Antarctic stations must recognize that at many of these stations there is likely to be no one available who has any knowledge of aviation requirements at all.

Pilots should therefore take all reasonable steps to ensure that the physical strip dimensions applicable to the type of aircraft to be used are made known to the station.

Appendix 1.

The effective length of a strip must be not less than the length specified in the aircraft flight manual or approved performance charts as being necessary for take-off or landing under the conditions pertaining.

As a general guide to length of strips for aircraft operating in normal configuration, the following table is given:

Aircraft up to	4,500 lbs	AUW = 2,500 ft plus 200 ft for each 1,000 ft ASL.
Aircraft up to	6,500 lbs	AUW = 3,500 ft plus 300 ft for each 1,000 ft ASL.
Aircraft up to	12,500 lbs	AUW = 6,500 ft plus 400 ft for each 1,000 ft ASL.
Aircraft up to	40,500 lbs	AUW = 8,500 ft plus 500 ft for each 1,000 ft ASL.
Aircraft up to	250,500 lbs	AUW =10,000 ft plus 500 ft for each 1,000 ft ASL.

(AUW = All-up weight; ASL = above sea level).

The above table is to be used only as a general guide and it assumes that the general area upon which the strip is to be positioned has already been examined and proven for grade, surface and load-carrying suitability.

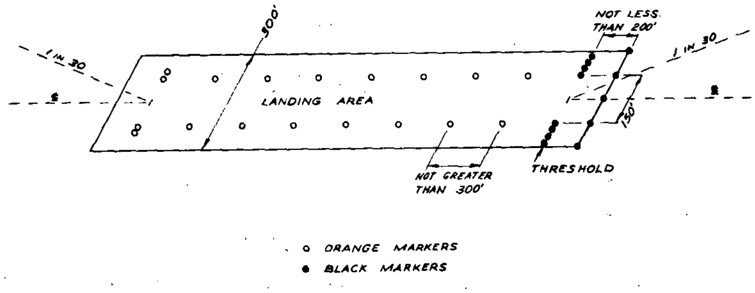


Fig. 1. Standard strip marking.

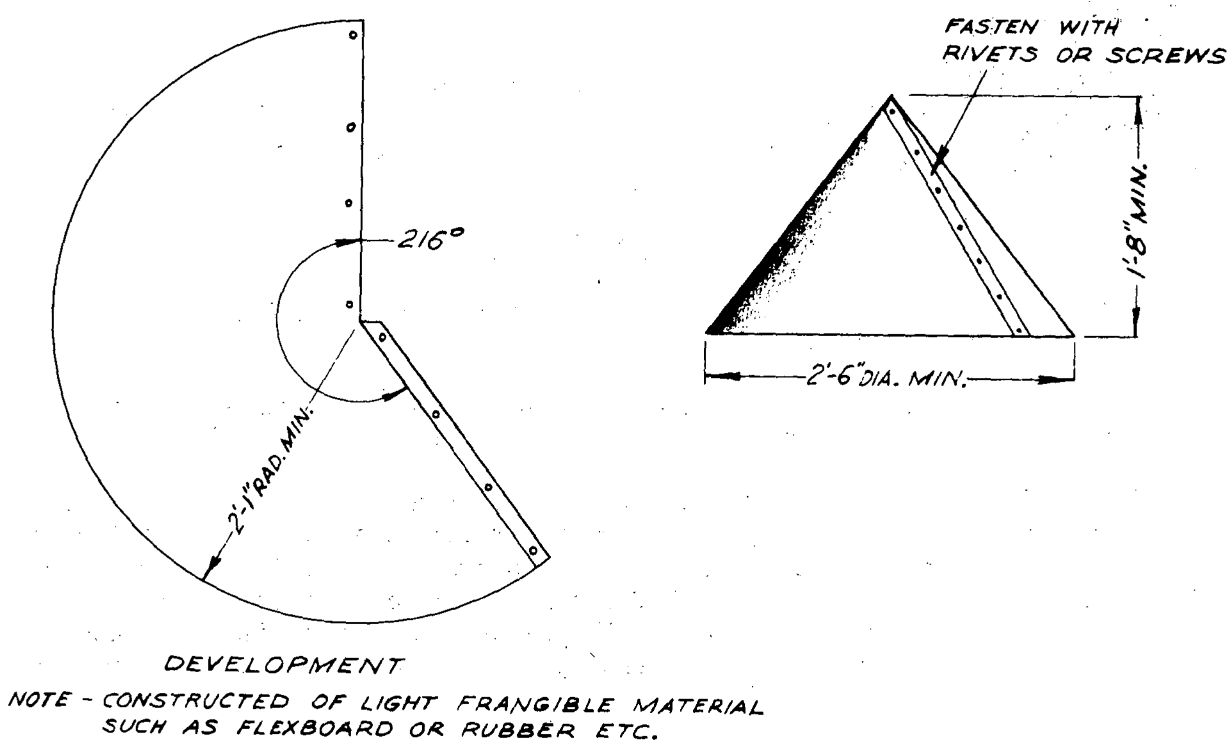


Fig. 2. Cone strip marker.

DUMONT D'URVILLE BASE HELICOPTER WIND-BREAK WALL

Expeditions Polaires Françaises

From 1957, approximately from December 15 to the beginning of March, the French Polar Expeditions had been using a helicopter at the Dumont d'Urville Base during each summer Antarctic campaign. Although meteorological conditions are reasonably favourable during this period of the year, violent storms nevertheless occur during each campaign during which the wind can reach a velocity greater than 200 km/hour (maximum recorded: 227 km/hour). Mooring of the apparatus and fastening the blades do not provide sufficient safety measures to avoid damage, and it is therefore, necessary to provide protection for the helicopter on the ground by a suitable construction.

These windstorms can arise very suddenly (minimum recorded: a few minutes); their bearing is remarkably consistent (wind from SE to SSE sector); protection by means of a wind-break wall was thus sought, providing very fast sheltering, in preference to the building of a hangar, where the necessarily long time for manipulating the doors would have become impossible, and, in addition, would have been more costly.

The studies for this wind-break wall were performed by the Scientific and Technical Study Bureau at Paris, in collaboration with the Technical Bureau of the French Polar Expeditions.

1. Specifications

This wind-break wall is comprised of separate elements, juxtaposed to allow subsequent extensions.

To allow for easier transport and construction, each wind-break element is not very wide, and can be broken down into units of low weight.

These elements can be lowered into a horizontal position by a simple mechanism; in raised position, they form a barrier providing a reduction of wind velocity in the protection area; when lowered in a horizontal position in the bed of the wind they prevent formation of a snow-drift in winter, and keep the helicopter platform free for immediate use at the start of each summer campaign. In certain cases, the lowered position can assist in manoeuvering the helicopter.

2. Aerodynamic Flow Study

Maximum velocity: The fluid weight-flows in front of and behind the wind-break wall must be equal. The lateral vein divergence is estimated to be 1.5

times its original width; the height behind the wind-break can reach 3.5 times the original height; the ratio of the sections is then virtually equal to 5. Under extreme conditions, that is to say, with a wind of 250 km/h, the velocity behind the wind-break will thus not be greater than 50 km/h.

Protection area: If the fluid were perfect, the area of protection would theoretically be infinite. On account of the viscosity of air, there exists a velocity gradiant which tends to limit this protection in length, and, at a certain distance from the wind-break, one encounters a down flow identical to that of the up flow.

The true aerodynamic flow and the protection areas are shown on the attached general diagram. (see also the following photograph where the flow is shown visually by means of a smoke-producer).

3. Description of a Wind-Break Element

Each wind-break element consists of 2 titling side uprights connected by open metallic panels forming deflectors (see diagramatic section in the following figure).

Deflector panels: These panels are "Goliath" panels of the same type as those used at Orly to deflect jet airstreams.

These consist of steel blades with edges parallel to the ground that are inclined at an angle of 80° to the horizontal. These blades are laminated steel plates with a section of 50 x 4, split lengthwise along their centre, opened and assembled by welded joints so as to form a mesh. There is a 70 mm space between plates. Each panel is encircled by a 60 x 6 plate.

Experiments have shown that the optimum angle of inclination of the panels in relation to the ground is 60°.

Each wind-break element consists of 2 identical panels.

Side uprights: Each side upright is made from an UPN bar and two angle-irons welded onto gussets. Each upright forms a rigid triangular hold onto which the deflector panels are bolted; a joint at the base allows tilting. The lower part of these uprights rests on a sole-plate supporting two checks.

Cheeks: At its joint, each upright rests on 2 braced sheet cheeks; these cheeks are welded onto a sole-plate formed by an HN 100. This sole-plate acts as a thrust-block for the side uprights.

Wind-bracing: Angle-irons provide lateral rigidity to the wind-break. They integrate the side uprights to each other, and the cheeks to each other.

Counterpoising: When the wind-break is in a lowered position, a counterweight allows it to be easily raised.

The wind-break being raised, the vertical axis of the jointing obviously passes through the centre of gravity of the "raising-panel" unit (without counterweight). Thus, in this position, the addition of the counterweight provides proper equilibrium.

The wind-break is designed in such a way that when there is no wind, the effort required to raise it or lower it, when applied to the extremity, is less than 40 kg.

Two chains are attached at the end of the side uprights to allow the wind-break to be lowered.

Counterweight: This consists of ten 10 kg cast iron discs.

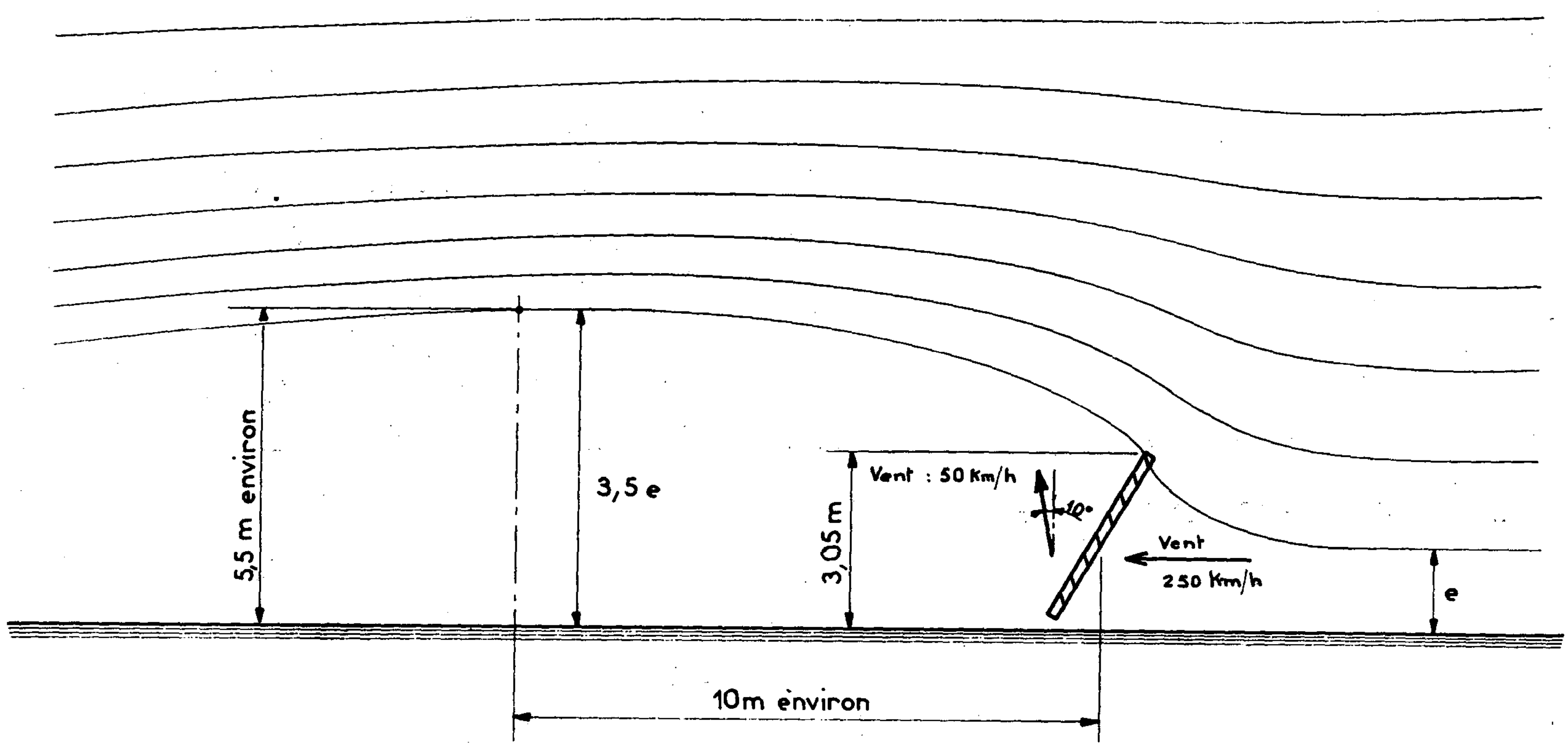
Handling: The weight of a complete wind-break mounted with counterweight and "Goliath" deflector panels is about 550 kg.

The weight of any one separate part is less than 80 kg.

The shape of the parts allows easy stacking for shipping.

The wind-break wall was constructed at the Dumont d'Urville Base during the 1965/1966 summer campaign. Since that date, it has been systematically used during each campaign.

Before being put in service, damage had occurred on several occasions to the helicopters (buckling of blades, damage to rotor-head). Since being put in service no damage of this kind has been noted.

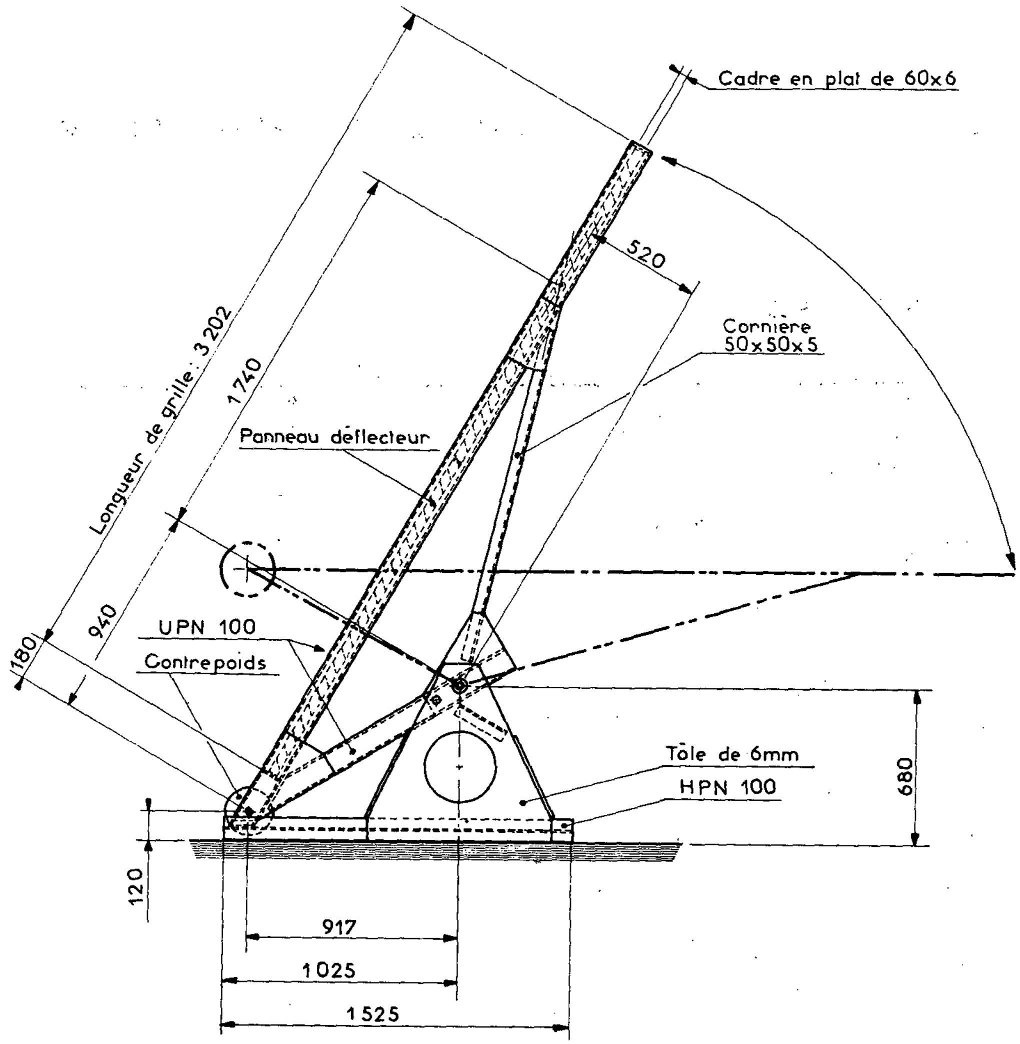


NOTA : Effort sur panneau : 700 kg / m²

PARE-VENT POUR HELICOPTERE

Ecoulement théorique

Expéditions Polaires Françaises



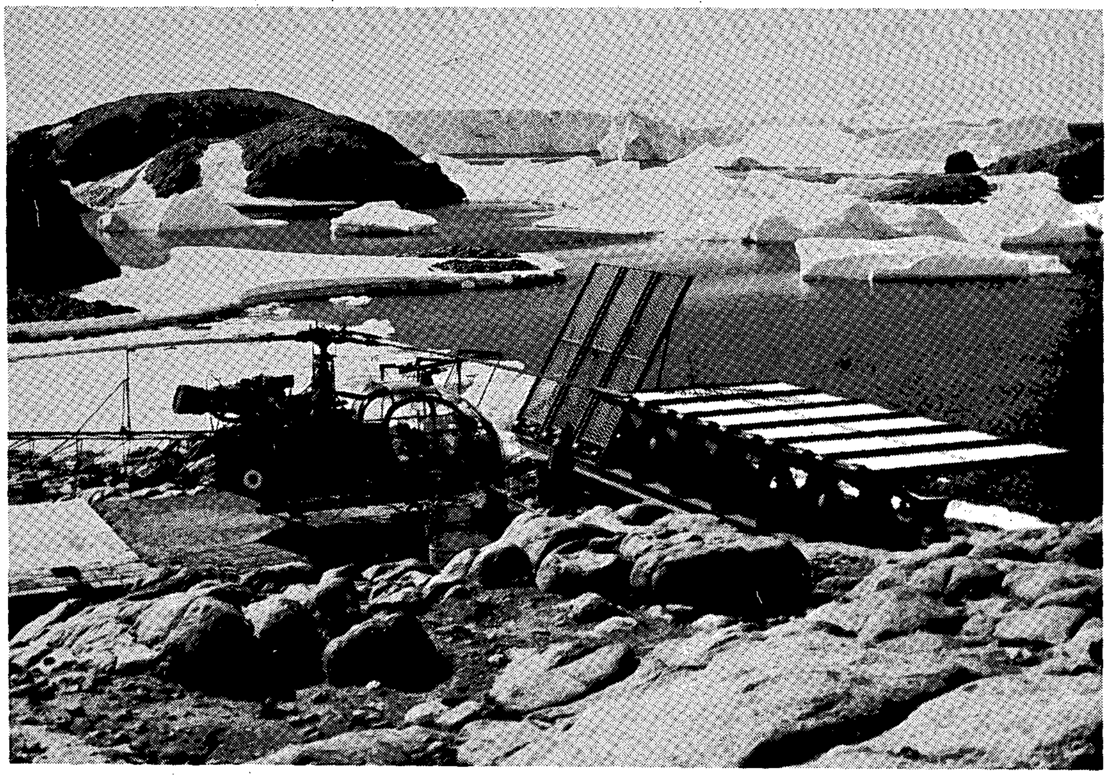
PARE-VENT POUR HELICOPTERE

Coupe schematique

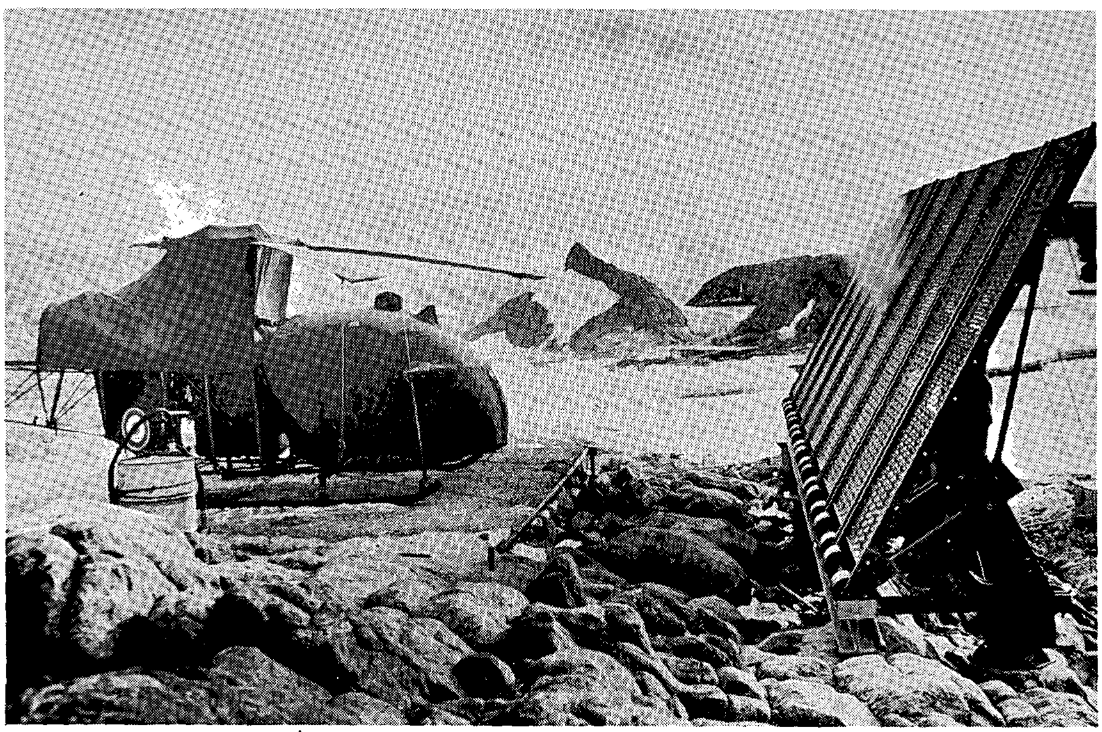
1965

NOTA : – Les goussets sont en tôle de 6 mm
– Contrepoids : 10 anneaux Ø 210 – poids total 100 kg

Expéditions Polaires Françaises



General view: 3 elements in lowered position; 9 elements in raised position.



Air flow is shown visually by means of a smoke producer.

AVIATION SUPPORT FOR THE U.S. ANTARCTIC RESEARCH PROGRAM

A. J. Toth*

Summary

This paper will provide basic, general information (with photographs) of the airfields, aircraft, and air-navigation aids used in Antarctica by the United States, along with a brief description of the methods employed by aviation organizations supporting the U.S. science program. While it is not intended to be a historical review of U.S. aviation, a comparison will be presented between the period prior to and that after the introduction of the LC-130 Hercules aircraft.

This paper will be limited to the antarctic area; air operations between New Zealand and the United States will not be described.

Introduction

This paper has been prepared for presentation at the Antarctic Treaty Meeting on Logistics, June 3-8, 1968.

In this paper basic and general information is presented of recent air operations in Antarctica as employed in support of the U.S. Antarctic Research Program. The information supplements Martin D. Greenwell's paper presented to the SCAR Logistics Symposium of August 1962.

Summary of Recent Air Operations

Antarctic air operating principles and cold weather flying techniques have remained much the same over the years. Flying in Antarctica is still a hazardous occupation and pilots, aircrewman, maintenance and cargo handling personnel must be thoroughly trained and experienced. The threat of an accident coupled with survival while awaiting rescue under the most demanding of conditions is ever present and requires continuous attention to preparation and readiness for all eventualities. A satisfactory shelter to protect maintenance personnel still has not been developed. See photos 1-5.

The U.S. continues to participate with or provide support to Antarctic Treaty nations engaged in air activities. See photos 6-8.

In November 1966 the first all jet powered aircraft to operate in Antarctica landed at Williams Field, McMurdo Station, after a five hour flight from New Zealand. The evaluation flight demonstrated that the C-141 could operate

* U.S. Naval Support Force, Antarctica.

in the antarctic and in DEEP FREEZE 69 two C-141 Starlifter aircraft will carry 250,000 pounds of cargo from New Zealand to McMurdo Station in 5-6 flights. This "routine" operation is a far cry from the 12 to 15 hour, New Zealand to McMurdo flights by the C-47/C-117 carrying no cargo or passengers. The Dakota/Skytrain aircraft were phased out of the program in February 1968. See photos 9-11.

Following the delivery of the Hercules LC-130F to Air Development Squadron SIX in 1960, notable program changes have taken place. In DEEP FREEZE 62 a total of 37 aircraft consisting of 11 different type aircraft flew in the Antarctic. This past year 20 aircraft, of 6 types, operated in the McMurdo area, and six of the twenty, flew only over a two month period; the RNZAF AND U.S. Military Airlift Command (MAC) Hercules flew nine flights between New Zealand and McMurdo and only one of the three C-117S flew 86 hours before being dismantled and prepared for shipment aboard ship to the U.S.

The Hercules has performed emergency evacuation flights to McMurdo and Byrd Stations during the austral winter under conditions of darkness and this capability is now-utilized each year on a scheduled basis during the months of June and August to transport science personnel who cannot conduct their studies during the austral summer.

After much experimentation it has been found that the best lighting for the night landing area is a combination of high-intensity strobe lights leading up to the threshold of the skiway, then electric powered lights for the first 1000 feet on either side followed by gasoline burning lanterns hung on steel rods every 500 feet alternating each side of the skiway. The lantern is of the type commonly used by outdoorsmen and campers and has been found to be capable of withstanding winds up to 60-70 knots. They also were used for lighting the taxiways and cargo handling area. The lanterns were visible for 15 miles.

For a number of years a considerable investment was made in constructing an ice runway on the permanent ice shelf for wheeled aircraft arriving from New Zealand and for the C-124 Globemaster aircraft to conduct para-drop flights to resupply the inland stations. Now, the Hercules operating on the skiway delivers all cargo inland including petroleum products delivered in bulk form rather than in the cumbersome 56 gallon drum airdrop configuration. Three thousand to thirty five hundred gallons of fuel may be delivered each flight. See photos 12-18. The easily constructed annual ice runway is available to the first part of January and is satisfactory for wheeled aircraft to about 80 inches in thickness. Outer Williams Field ice runway (on smooth permanent ice) is available during the latter part of the summer although it is about 17 miles from McMurdo Station. See chart 1.

The Hercules is capable of landing on an unprepared snow surface delivering cargo, men, scientific supplies, helicopters and construction equipment to remote field parties. This one aircraft has become more responsive to the needs of the investigators than a combination of 5 or more types have been in the past. And the long haul, slow moving traverse parties to deliver cargo or to conduct investigations may soon be discontinued particularly if further evaluation of airborne data gathering instruments is favorable. Geologists and other investigators now are delivered to remote sites, resupplied during the season and have helicopter support; the Hercules LC-130F now delivers the UH-1D helicopter directly to the field from Christchurch, New Zealand via a McMurdo Station fuel stop. See photos 19-23. Not only has a flexible, responsive support system been developed but for two years in a row, DF-67 and 68, there were no AIRDEVRON SIX aircraft accidents or fatalities. One U.S. Army helicopter was lost, with no fatalities, when storm conditions were sudenly encountered while approaching for a landing at base camp in Marie Byrd Land. DF-68 was the first year that was completely accident free although there were a number of incidents that could have worsened and resulted in tragedy. A fifth Hercules, designated LC-130R, will be flown to Antarctica during DF-69 following its delivery to the air squadron in November 1968.

New Aircraft

Commencing in DF-69 the C-141 Starlifter will provide cargo delivery support from Christchurch, New Zealand to McMurdo Station. It is an all-jet plane expressly designed for high-speed cargo handling and transport. It is powered by four Pratt and Whitney TF-33-5-7 turbo-fan engines, each with a 21,000 pound thrust rating. It has a maximum cruising speed of 550 miles per hour. The wing span measures 160 feet. It has a range of 4,000 miles with a 50,000 pound payload and for short distances is able to carry 90,000 pounds. Gross weight is 316,000 pounds.

Fixed Base Facilities

A. McMurdo Station (Williams Field) Latitude 77-53 S/ Longitude 166-48 E (Ross Island) Photo 24.

1. Landing facilities

   a. Prevailing wind skiway - 07/25 GRID (10,000' X 300')

   b. Crosswind Skiway - 18/36 GRID (7,000' X 250') Photo 25

   c. Prevailing ice runway - 07/25 GRID (10,000' X 300')

   d. Crosswind ice runway - 17/35 GRID (8,000' X 250') (Outer Williams Field)

   e. Field elevation - Sea level

2. Available NavAids/Approach Aids

a. Skiways - Precision Radar Approach (PAR)
- Surveillance Radar Approach (ASR)
- TACAN (*)
- LF/UHF DF Homer (**)

b. Annual Ice runway - Surveillance Radar Approach (ASR) 25 GRID only.
- Precision Radar Approach (PAR) 07 GRID only.
- TACAN (*)

c. Outer Williams - Surveillance Radar (ASR)
- Precision Radar (PAR)
- TACAN (*)

3. Helicopter operating base located McMurdo Station on Ross Island. See photo 26.

4. Skiways and ice runways marked with standardized markers.

B. Byrd Station Latitude 80-01 S/ Longitude 119-32 W Photo 27

1. Landing facilities

a. Prevailing wind skiway - 08/26 GRID (14,000' X 300')

b. Crosswind skiway - 01/19 GRID (7,000' X 250') Not constructed each year.

c. Field elevation - 5095 feet.

2. Available NavAids/Approach Aids

a. Precision Radar

b. Surveillance Radar

c. TACAN (*)

d. UHF ADF (**)

3. Skiways marked.

C. Pole Station 90-00 S Photo 28

1. Landing facilities

a. Prevailing wind skiway - 012/20 GRID (10,000' X 200')

b. Crosswind skiway - None

c. Field elevation - 9186 feet

2. Available NavAids/Approach Aids

a. Precision Radar

b. Surveillance Radar

c. TACAN (*)

d. UHF ADF (**)

3. Skiway marked.

D. Hallett Station Latitude 72-19 S/ Longitude 170-13 E Photo 29

1. Landing facilities

a. Prevailing wind skiway - 034/214 GRID (6000' X 200') (Can be used by wheeled aircraft for emergency only).

b. Crosswind skiway - None

c. Field elevation - Sea level

2. Available NavAids/Approach Aids

a. LF/ADF (**) - (VER required at minimums, when out of "Procedure turn" on final approach)

3. Skiway marked.

4. Becomes unusable about mid-November each year.

E. Plateau Station Latitude 79-148 S/ Longitude 40-3C E - Photo 30

1. Landing facilities

a. Prevailing wind skiway - 02/20 GRID (14,000' X 200')

b. Crosswind skiway - None

2. Available NavAids/Approach Aids

a. UHF Homer

3. Station will be deactivated in January 1969.

Statistics

U.S. Navy Air Development Squadron SIX

		DF-65	DF-66	DF-67	DF-68
LC-130F	Flight Hours	4574.9	4825.0	4091.4	4355.0
	Total PAX carried	2025	1845	2525	3831
	Total Cargo (incl Pax wt.)	5312.0	5247.2	4098.9	4457.5
C-121J	Flight Hours	1040.8	678.3	1129.5	1514.8
	Total Pax carried	1750	1437	2549	2485
	Total Cargo (incl Pax wt.)	405	385.9	494.3	6650.0
LC-47/117D	Flight Hours	1211.7	762.5	491.3	(1)269.4
	Total Pax carried	(2) N.S.	(2)N.S.	(2)N.S.	419
	Total Cargo (incl Pax wt.)	182	(2)N.S.	1966	16.8
LH-34D	Flight Hours	1119.7	1230.4	960.0	908.4
	Total Pax carried	5473	5936	2987	1550
	Total Cargo	867	702.3	478.8	91.4
TOTALS	Flight time	7947.1	7496.2	6672.2	7047.6
	Pax	9248	9218	8061	8285
	Tonnage	5457.4	6335.4	5091.6	5215.7

Bulk POL delivered DEEP FREEZE 68 - 666,380 gallons.

(1) Only 85.5 hours flown in Antarctica. No passengers carried in Antarctica.

(2) Not Significant. In DF-65 major work was airborne magnetometery recording: DF-66 three aircraft flew U.S. to Antarctica and policy established not to carry passengers due to previous accident/fatility rate. Open field landings on unprepared surfaces were discontinued.

	DF-65 Hours	DF-66 Hours	DF-67 Hours	DF-68 Hours
U.S. Army UH-1B/1D	659	536	403	372
U.S. Air Force (MAC) N.Z. to McMurdo Station C-130E/C-124	622	261	268	105
Royal New Zealand Air Force "Operation Ice Cube" C-130H	--	45	44	45

(*) TACAN - (Tactical Air Navigation) A ground transmitting station that provides distance and azimuth to aircraft with receiving equipment.

(**) LF/UHF/ADF - Low Frequency/Ultra High Frequency/Automatic Direction Finding equipment.

Navigation and Communication

UHF, VHF and HF frequencies are employed for tower and station radio communications. Photo 31 pictures a TACAN/Radar/Communication (Tower) complex on the snow surface at Pole Station and is typical of such antarctic installations. Photo 32 is a portable landing aid system that was evaluated and proved to be unsatisfactory due to an inability of pilots to transition easily from instrument flying in the cockpit to visual control on the mirror display.

Two units evaluated last year and will be further tested in DF-69 are homing devices used by the Hercules to easily locate field and remote location parties. One unit is a Low Frequency portable radio that has been useful up to 60-80 miles; the second unit is a radar beacon set that located the DF-68 Polar Plateau Traverse party in excess of 100 miles distance. The radar beacon set weighs only 3.5 pounds requires very little maintenance, and is powered by a 28 volt D.C. source. The unit appears to be very practical for field party ad and station location use as well as for emergency or survival situations.

Photo 1.

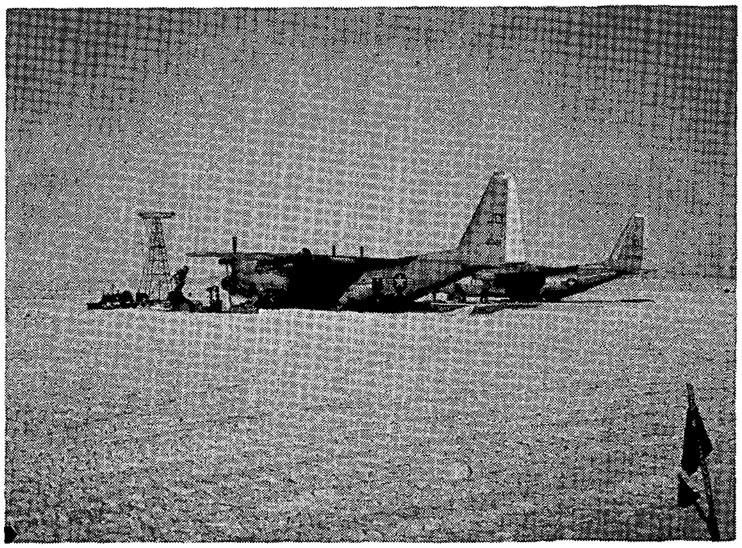


Photo 2.

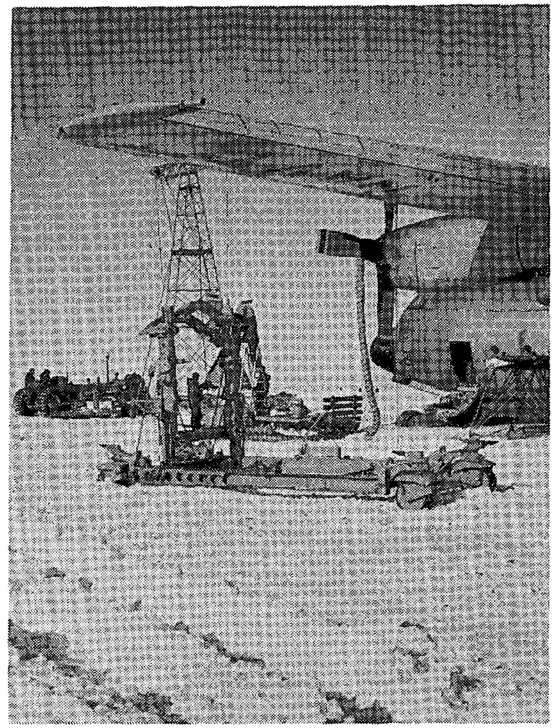
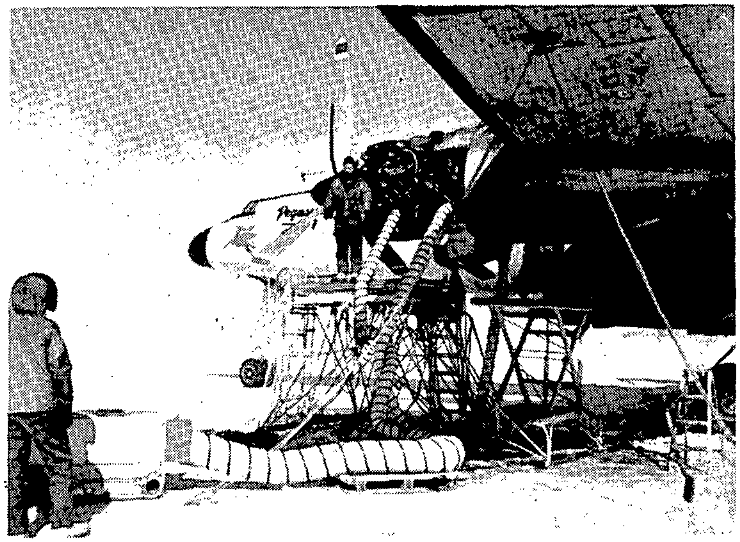


Photo 3.



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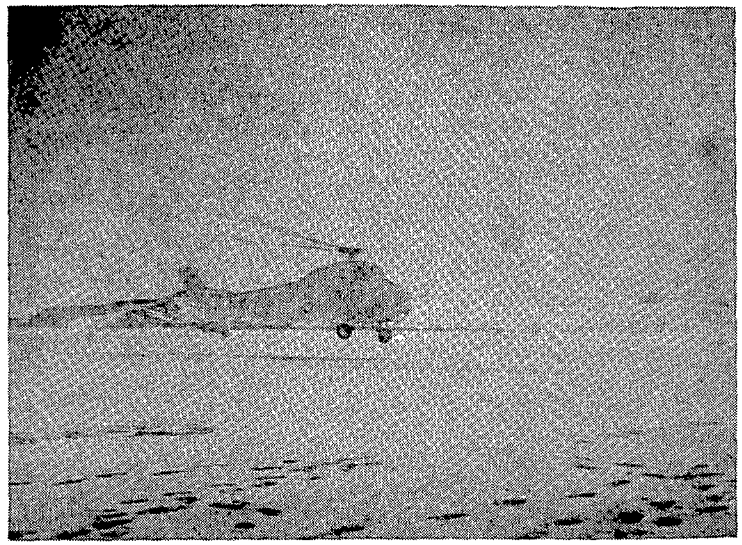


Photo 5.

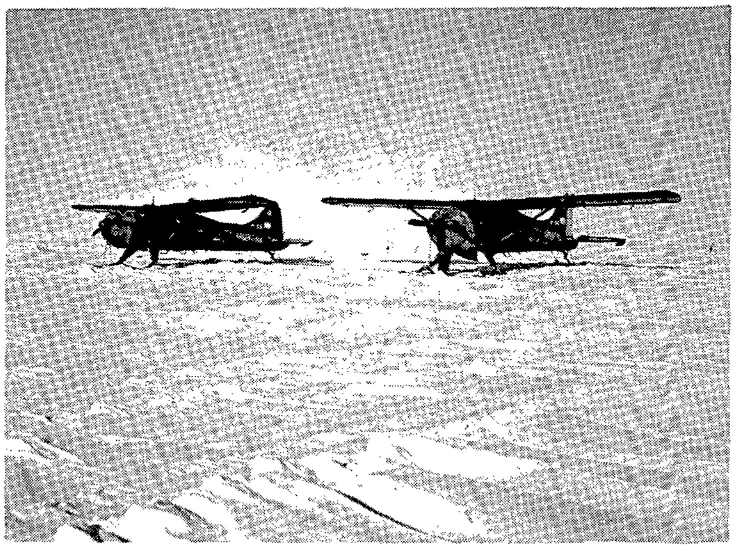
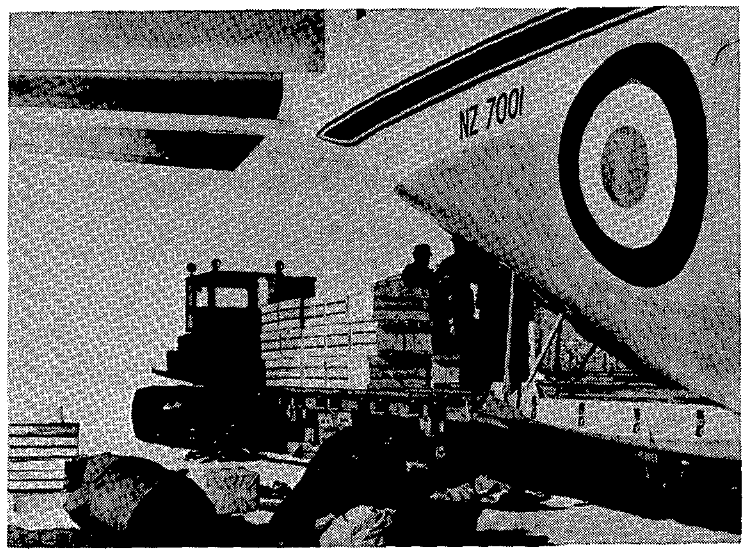


Photo 6



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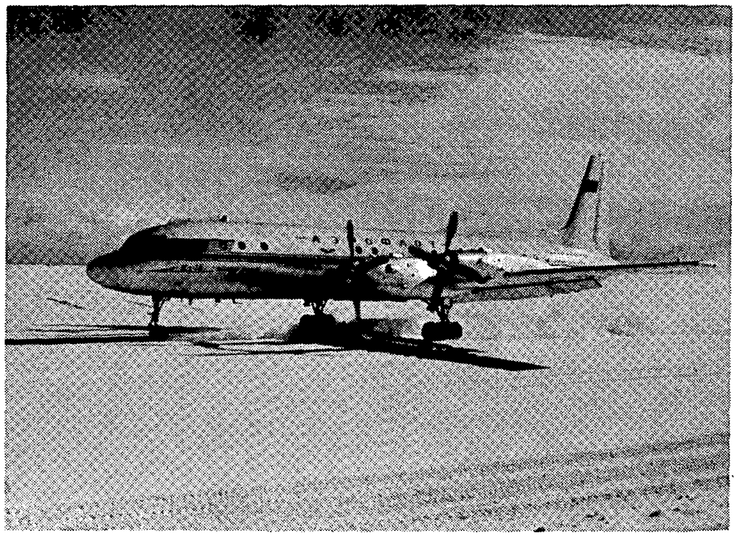


Photo 8.

Photo 9.

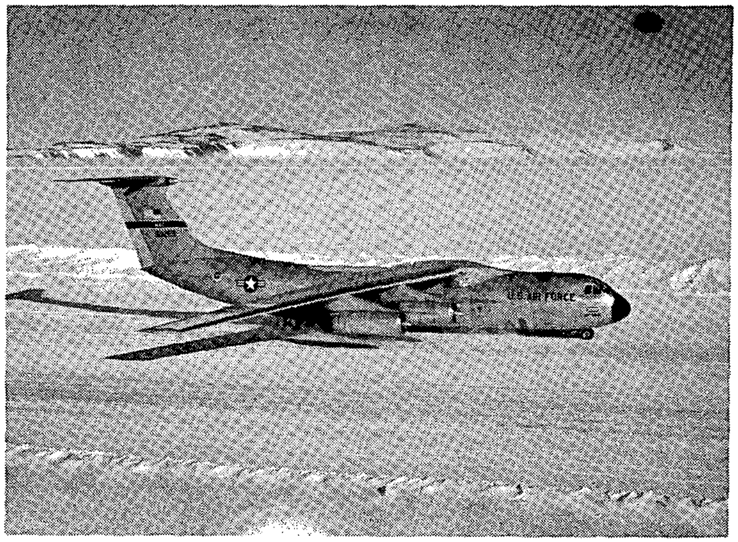


Photo 10.

Photo 11.

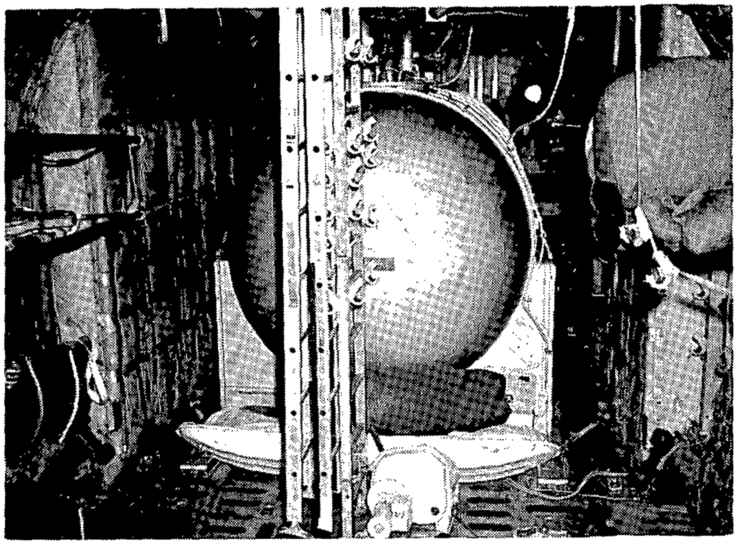


Photo 12.

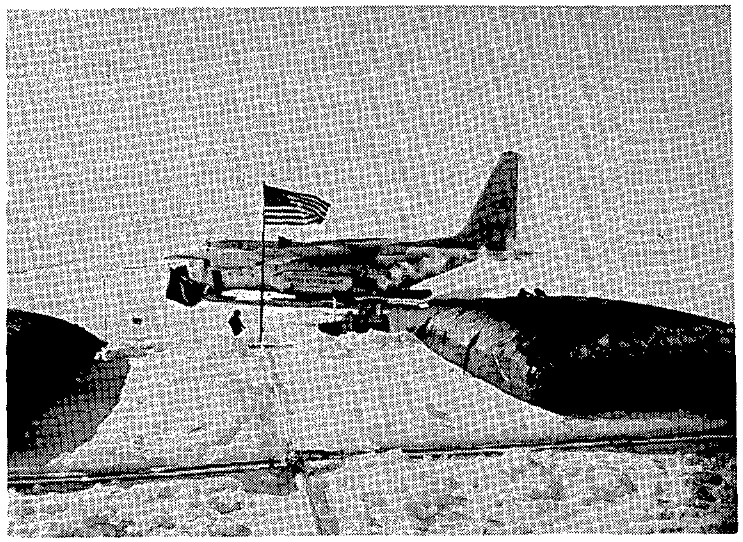


Photo 13.

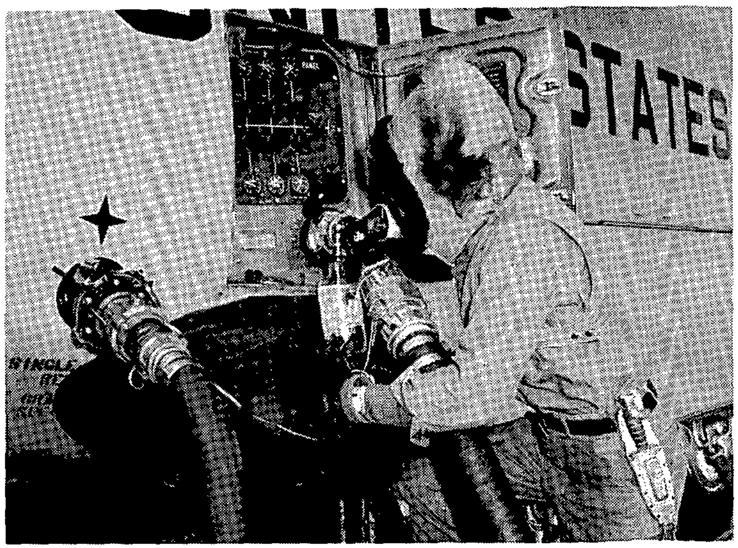
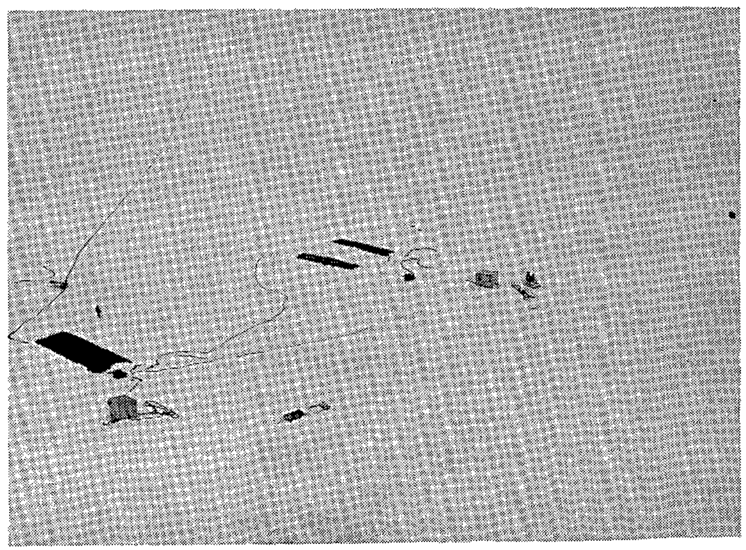


Photo 14.



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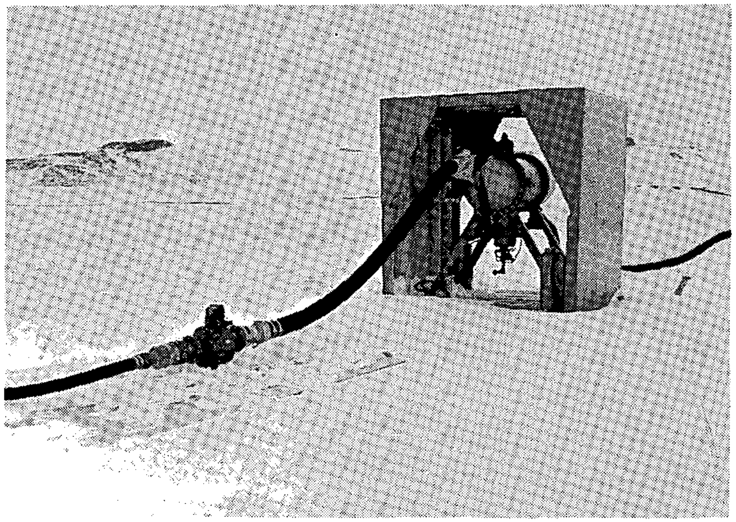

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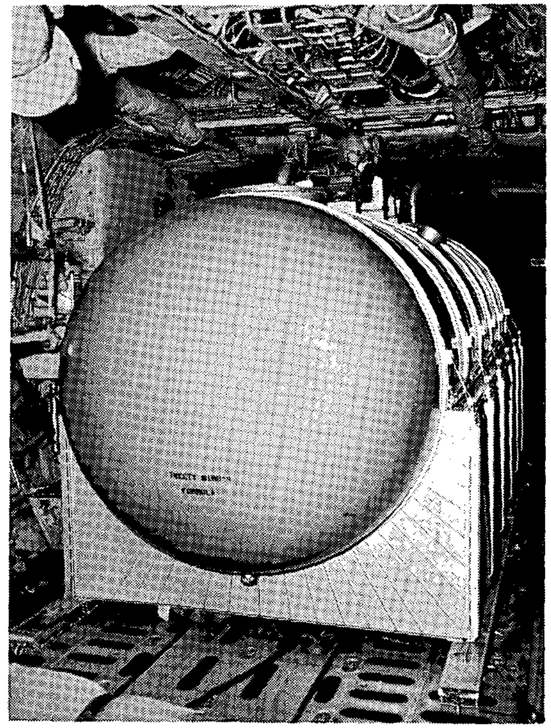


Photo 17.

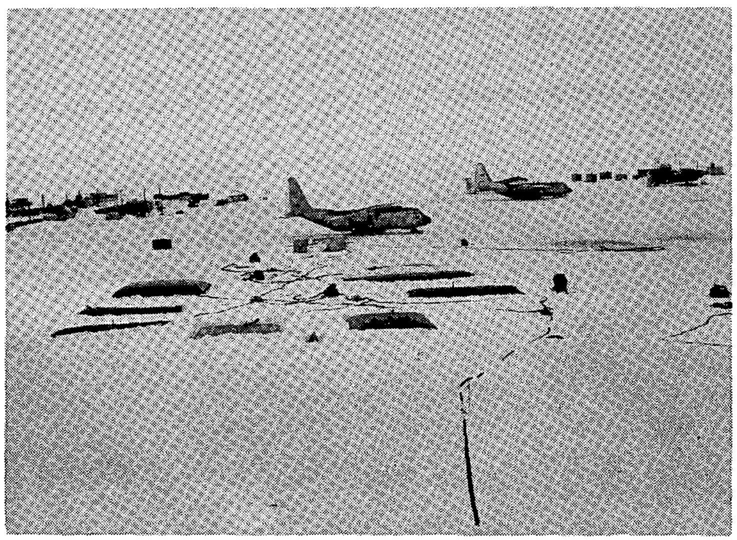
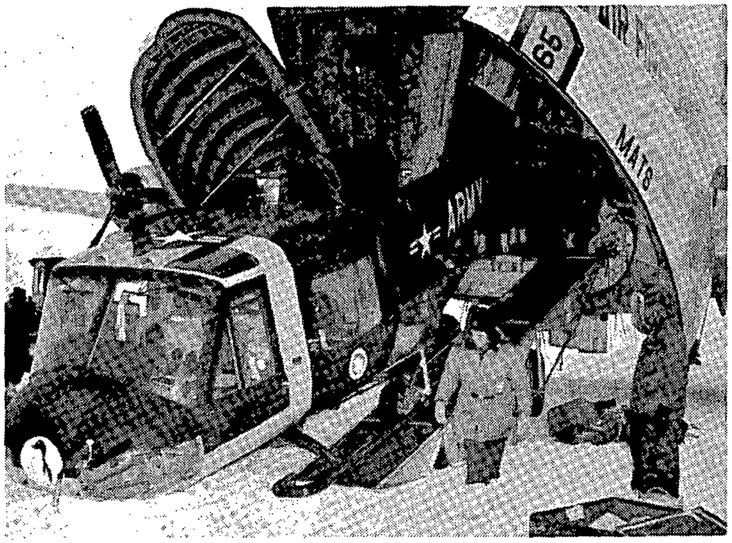


Photo 18.



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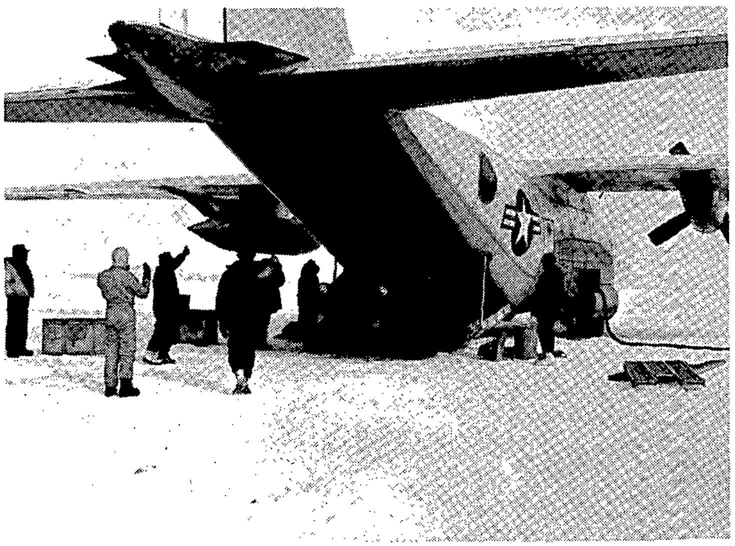

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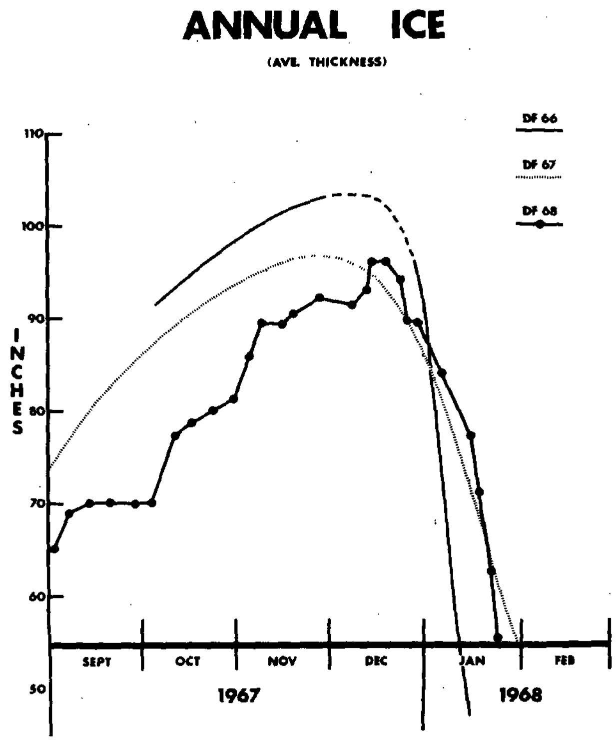


Chart 1.

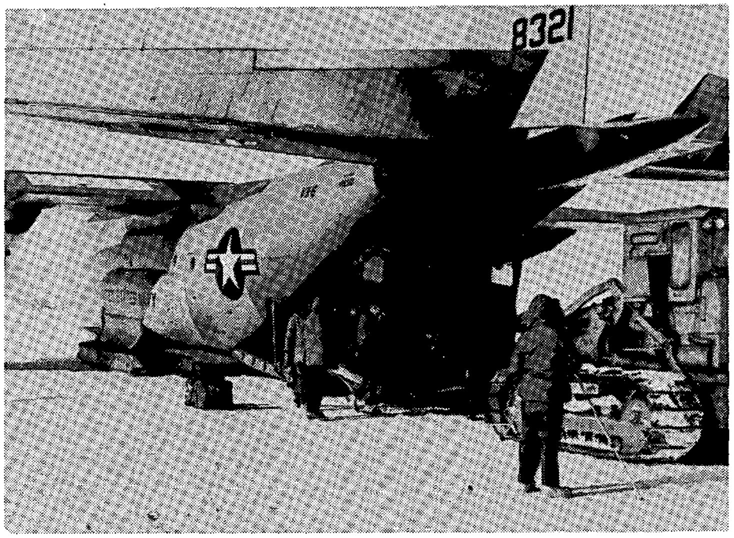


Photo 21.

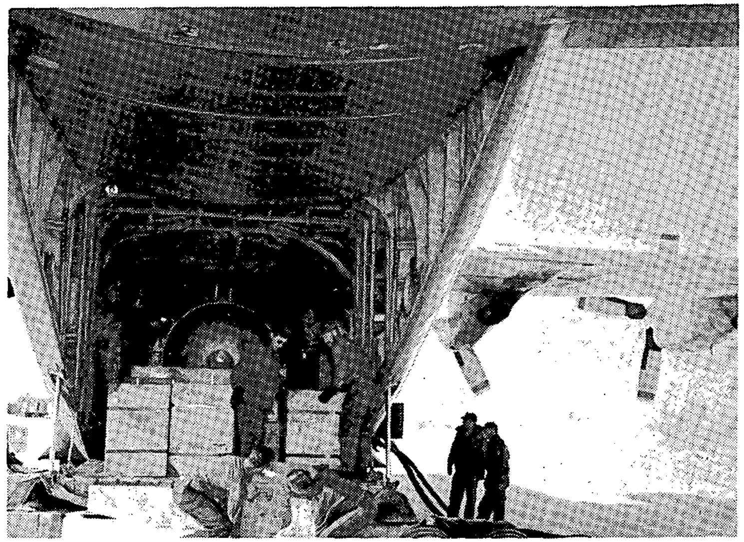
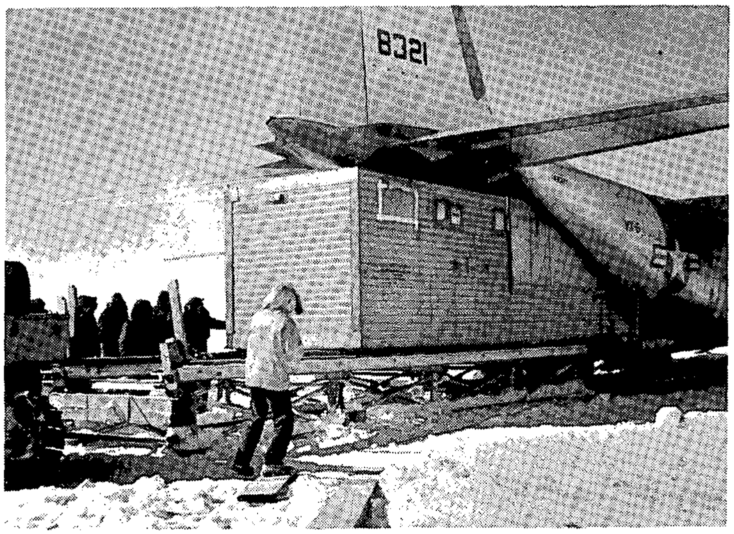


Photo 22.



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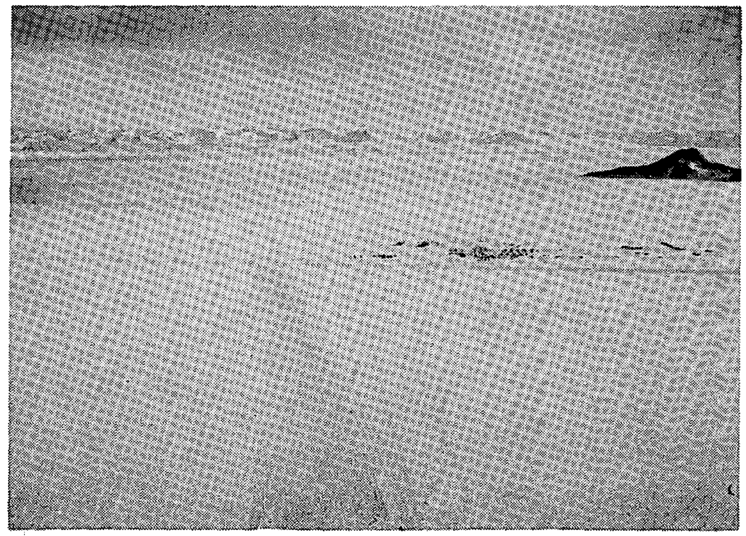
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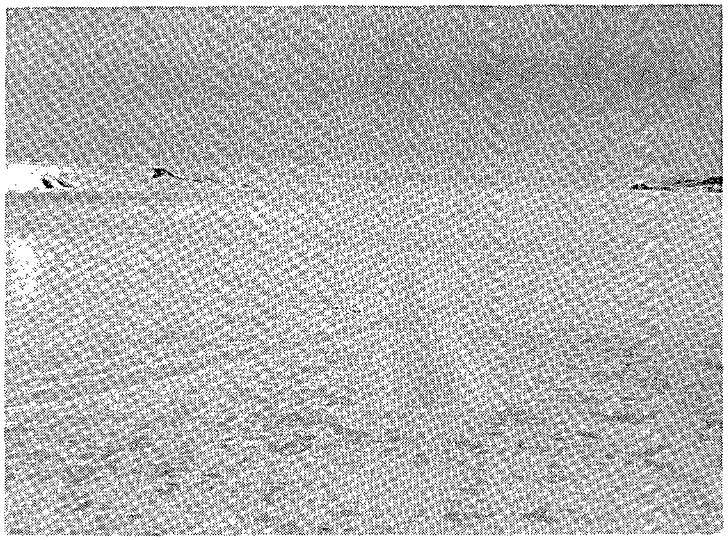

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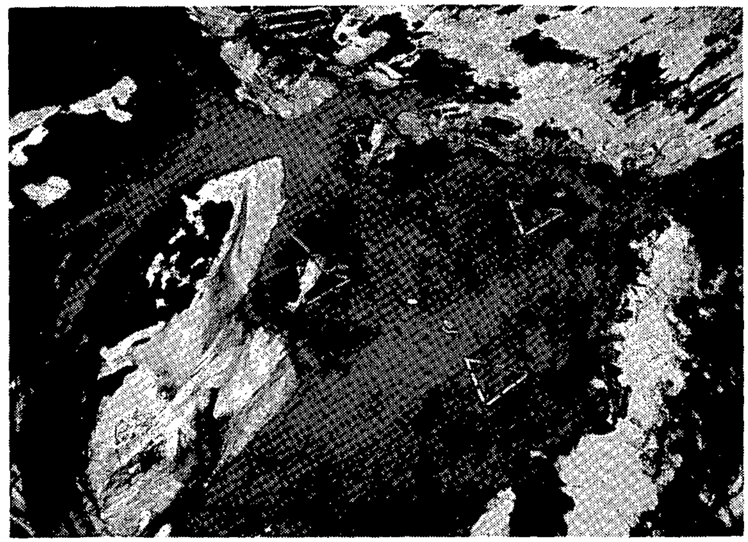


Photo 26.

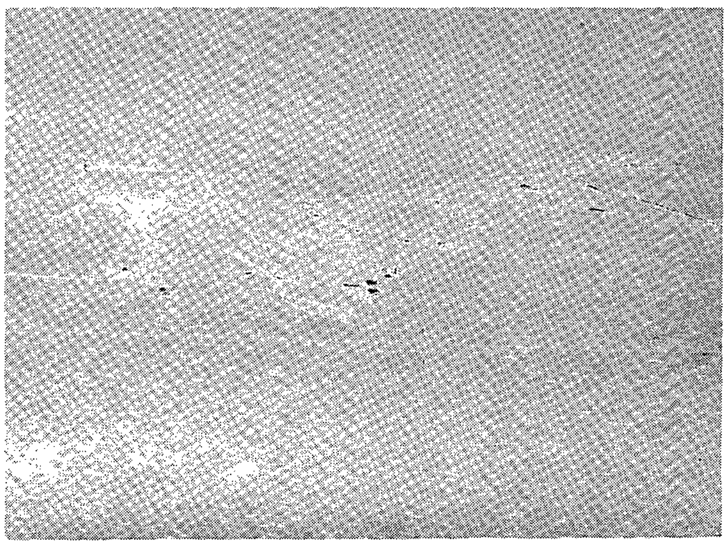


Photo 27

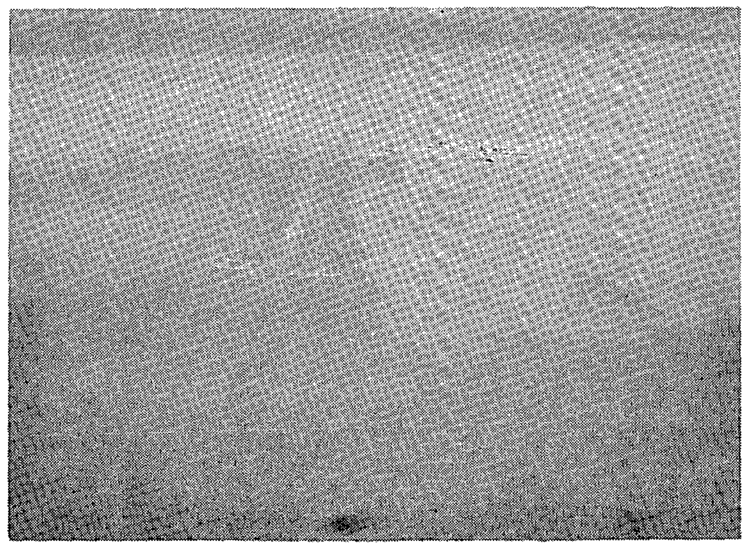


Photo 28

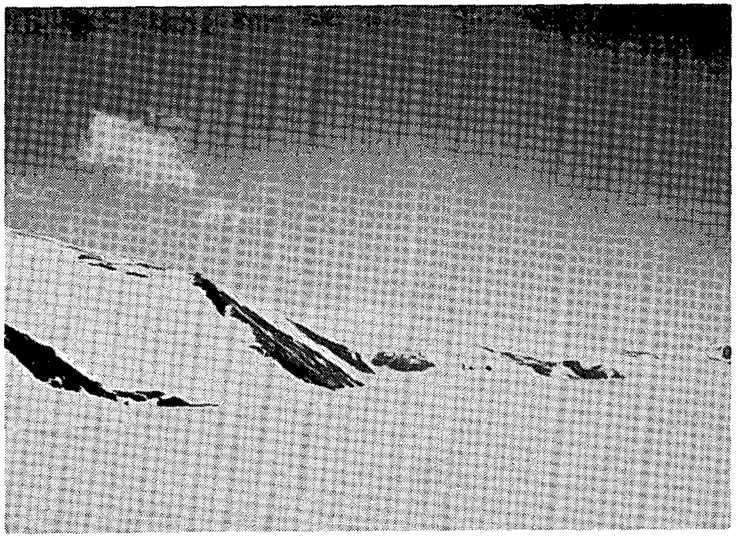


Photo 29

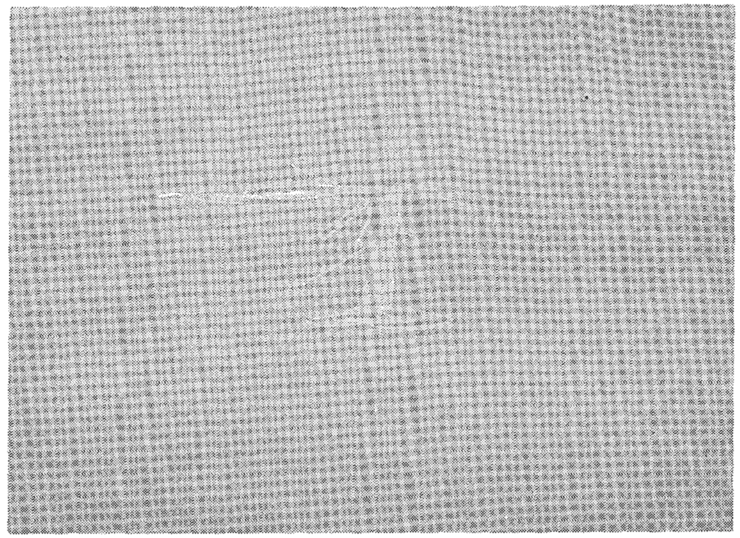


Photo 30

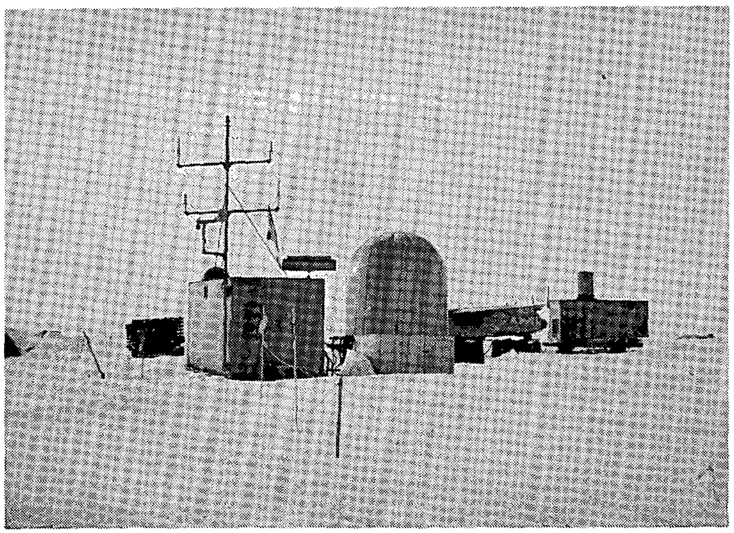


Photo 31

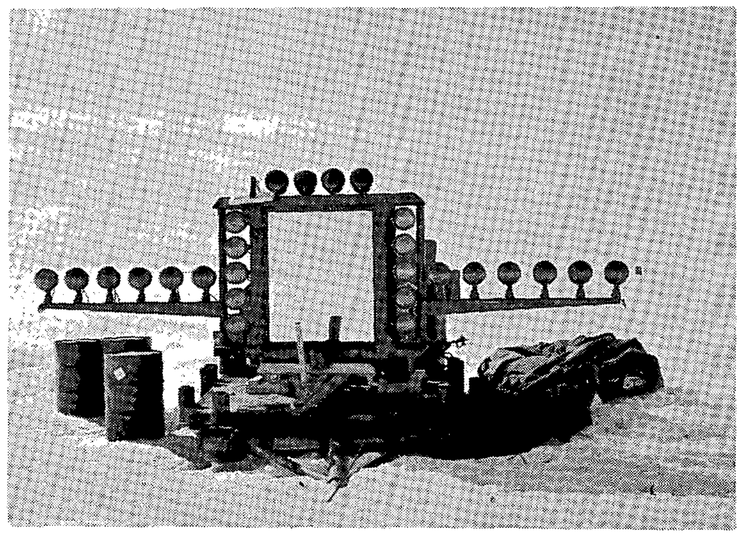


Photo 32

4. SEA TRANSPORT

EMPLOYMENT OF SMALL PLASTIC CRAFT IN ICE AREAS

Enrique Jorge Pierruo

Abstract

This paper deals with the use of plastic surface craft for the accomplishment of tasks in the Naval Stations ORCADAS and PETREL their performance and navigational conditions in 9/10 ice areas, are specially when working in the laying of nets and long lines, and when supporting Scuba divers in marine biology tasks.

1. General Considerations

The model of small craft employed in the Argentine Navy Stations in Antarctica up to 1966 was that of the classic type, built in wood, and with a capacity for 4 persons and a load of 150 kg.

This type of craft was subject to the following shortcomings:

1. Having been designed as the smallest type of craft consistent with the needs of a station, it turned out to be too heavy to set afloat, which made it necessary to count upon with no less than 4 persons for such a task, with the logical inconveniences to the stations, where personnel is generally very limited.

2. The problem posed in 1., became more complicated because of the special conditions in Antarctic waters, where, when a boat is in operation, another must be in readiness to give support.

3. Continuous knocks against the ice in navigation and the bumps over the rocks on landing, made the structure to damage rapidly. This caused that, through the open boards of the lower works, water sipped in and soaked the caulking. Once on land and under certain meteorological conditions very common in the area, the water sucked by the caulking of the boat froze and made the boards of the hull to crack open completely, destroying the sealing material and causing leaks which made it impossible to use the boat with any degree of safety and efficiency.

4. Means and personnel available in the Argentine Antarctic Stations do not permit a thorough overhauling of sailing craft. Therefore, such craft had to be sent to Buenos Aires for general repairs.

The above reasons led to the idea of building boats wholly made of plastic materials and which should meet the following requirements:

1. Be sufficiently light and possessing such elements as would permit to set them afloat and to land them with the effort of only one man or at most two men.

2. Be so sturdy as to undergo the continuous knocks against the ice, and the bumps and draggings over rocks and boulders without suffering serious damage.

3. Have a bow which would help their grounding in beaches of very low gradient.

4. Be unsinkable.

5. That the plastic material with they were built did not vary its strength qualities under low temperature conditions.

6. Be seaworthy to navigate in choppy seas.

7. Be capable of quick and simple repairs in the area.

With these specifications and the experience gained by the Antarctic Division of the Argentine Navy Hydrographic Office with small boats operating in ice areas, the Bureau of Ships (Dirección General del Material) of the Argentine Navy, planned, designed and ordered the construction of plastic boats in accordance with the attached drawing.

II. General Description

The general features of plastic boats, made specially to operate in the Antarctic area, can be summarized as follows:

1. Measurements

a	Length	3.60 m
b)	Beam	1.70 m
c)	Depth	0.60 m
d)	Weight, empty	180 kg
e)	Maximum speed with a 10 HP motor	8 knots
f)	Load capacity with motor included	4 persons and 150 kg

2. Type of construction

They were made of reinforced polyester, laminated by contact over a mold, in four layers, until the thickness indicated in the attached drawing (5 mm thickness in the bottom and benches and 4 mm in the sides) were obtained.

They have a middle reinforcement in the bottom, and two side ones for landings on the beach.

They are unsinkable, buoyant spaces being filled with telgopor H, unalterable in contact with hydrocarbons. They are shaped in shch a way to make them seaworthy for operation in choppy seas.

III. Construction

1. Materials

A polyester resin of the nautical type was used as construction material. Glass fibers were of the Mat type and Rowing intertwine (30 strands).

The Gol-Coat, which remained exposed, was prepared with nautical resin and pigmented orange color.

2. Lamination sequence

a) Gol-Coat with surface film

b) A 450 gr/m^2 Mat coat

c) 30-strand Rowing intertwine

d) Another Mat-coat, and so on until the thickness desired is obtained in each one of them.

This lamination sequence of construction, known as "contact sequence" (that is, the application of the different materials over an adequate mold where the buoyant spaces were filled with telgopor H), was carried out with the best materials and skilled workmanship, in accordance with the attached drawing which is prepared for construction in plastic materials.

Inasmuch as these boats were designed for service in an area of very severe characteristics, they were reinforced, especially their bottom, and the connections of bulkheads, benches and other flat surfaces to the hull. Special care was also taken with the anchoring of additional parts, such as locked ringbolts, motor frame, outboard motor, tholeboards, etc.

Furthermore and because they would be exposed to being dragged over rough surface--rocks, coarse sands, boulders, etc., the bottom was provided with three 40 x 30 mm laths made of hard wood and attached to the hull of the boats by bronze bolts, 6 mm in diameter, in order to be able to change them whenever necessary.

3. Laboratory tests

Two test tubes, of adequate shape and size, were obtained for the tests which were to be carried out in the experimental laboratory of the Argentine Navy, for which purpose the following breakage tension, compression and flexure values had been established as minimum limits:

a) Breakage tension 1.500 kg/cm^2

b) Compression 800 kg/cm^2

c) Flexure 1.300 kg/cm^2

Because the material used had to be resistant to low temperatures, these resistance tests were carried out at temperatures below 0° C(32° F)

IV. Results Obtained in Laboratory Tests Determination of Mechanical Characteristics

Pull and Hardness Test

Material : Plastic

Initial diameter : (mm) 4.3 x 14.4

Initial area : (mm^2) 61.9

Breakage load : (kg) 1,232

Results

Tensile strength : (kg/mm^2) 20

Flexure Test

Material : Plastic

Results :

$$So = 26.35 \times 5.3 = 139.65 \text{ mm}^2$$

Equivalent diameter $\emptyset e$ = 13.32 mm

Clearance between supports L = 100 mm

Maximum load p max. = 125 kg

Static resistance to flexure = 21.1 kg/mm^2

Maximum deflection f = 857 mm

Compression Test

Material : Plastic

Results :

Initial thickness e = 5.2 mm

Initial section So = 315.3 mm^2

Loads (kg)	Thicknesses (with loads, mm)	Thicknesses (without loads, mm)	Deformations (permanent, mm)
1,500	5.1	5.2	0
3,000	5	5.2	0
5,000	4.7	5.2	0
7,000	4.55	5.15	0.05
8,000	4.4	5	0.2
10,000	3.7	4.5	0.7

Compression resistance for a 3,000-kg load 9.53 kg/mm^2

V. Additional Parts

1. A galvanized steel ringbolt, 13 mm in diameter, in the motor frame to rig the breastfast.

2. Two galvanized steel ringbolts, 13 mm in diameter, in the upper and lower parts of the bow for fastening ropes, and to hoist the boat, respectively.

3. An aluminum fender all along the uppèr part of the gunwale, inner brim.

4. A hemp fender all along the upper part of the gunwale, outer brim.

5. A pair of tholepins, in galvanized steel (oarlocks).

6. A pair of pine oars, approximate length 2.20 m, edges of the blades with copper plate fenders.

7. Two gratings, in painted cedar wood, placed on the floor, one aft and the other astern.

VI. Operation

The boats described were operated **simultaneously** at Orcadas Naval Station (Laurie Island, South Orkney Group); Petrel Air Naval Station (Dundee Island), and Groussac Naval Shelter (Petermann Island). In this last place, use was in marine biology work and in an intensive manner during 70 days, in which different navigational conditions were met from open sea to 10/10 ice.

The three places named are different as regards the geologic structure of their coasts, which permitted to gain experience under different conditions. Thus, the landing of the boat at Groussac was made over rock; at Orcadas over large glacial marine boulder; and Petrel over coarse sand. This permitted to enlarge the scope of the observations and tests in a more complete manner. Furthermore, the plastic boats were always used jointly with the wooden ones of the same design and with similar motors (YUMPA, 10 HP) striving to subject them to the most severe use and under the most unfavorable glaciologic conditions in the water surrounding the stations and the shelter.

The whole of Uruguay and Scotia Bays at Laurie Island (South Orkneys) were navigated, and several times Punta Geddes, 10 miles away, was reached; also the Petrel roads and the Active strait in almost all its length, all of Petermann island, Penola strait and French passage.

Glaciological conditions varied alternately from 1/10 to 9/10 and water temperature ranged between -1.1° C (30° F) and +1.2° C (34.20° F), being that of the air between -16° C(3.20° F) and +9° C(48.20° F). It was necessary to constantly open the way pushing the ice with the bow of the boat or pushing it aside with the boathook and the oars.

The smaller chunks of ice escaped control and passed below the hull scraping the wooden battens with their sharp borders. This was possible because of the type of construction (truncated bow). Knocks of the bow and both sides against the floes were many, and many times very violent, to the extent that the motors suffered the breakage of the propeller blades and pins on numerous occasions. This on account of the ice that passed under the hull.

The wooden boat, after two or three departures, with ice conditions 4/10, commenced to leak through the hull boards, while the plastic one, in spite of the heavy use to which it was subjected, never sprung leaks in her hull. The heavy use referred to was due to the fact that in a very short time the plastic boat proved to be more reliable for navigation in ice areas.

The worst sea under which the boat was operated (condition 3), with four men on board, left no doubt as to its seaworthiness. Navigating in a head sea, it breaks the waves considerably shipping a sea in small quantities becuase of its special features. This problem was solved each time slowing down the speed to 1/4 the total power of the motor.

Veering conditions to either sede are excellent, veering being done almost over a point with the helm hard to one side.

It light weight permitted on several occasions, on account of the pressure of the ice, to hoist it on to the floes, some of which had a height of 0.80 to 0.90 cm above the surface. This task only demanded the effort of 2 men.

In the special case of the use of this boat with the marine biology group which included Scuba divers, many times it turned out to be very convenient to accompany men who were to dive in waters covered by ice. As divers change direction abruptly seeking areas having bioligical species or alga fields, it is necessary to follow them by rowing with a light boat, of little draft and great maneuverability. This last condition is obtained through the special design of the raised bow which, at a single stroke of an oar, follows the changing position of the bubbles of the diver's air equipment. It was likewise possible to closely follow the immersion, even in cases where the sea was covered with brash.

In one opportunity, working at Naval Shelter Groussac (Petermann Island), water temperature being -0.8° C(30.40° F), one of the divers, submerged in 40 m found himself without air on account of some failure in the diaphragm of the valve, and also because the auxiliary tank, much to his desperation, was empty.

The ascent was brusque and upon reaching the surface, he found that a thick cover of ice did not let him find a way out. On the surface the men that operated the plastic boat and the wooden one, ignorant of what was going on, tried to find the bubbles lost to view by a thick cover of ice brash. All of a sudden, the diver's head showed up some 50 meters away and through his desperate efforts to disengage himself of his mask in order to breathe freely, it could be seen the seriousness of the situation, especially serious in those latitudes. Both boats, with their motors at full speed, helped along with oars and boat-hooks, and rushing violently against large and small floes, tried to open a way in the direction of the man in distress. The maneuverability and special conditions of the plastic boat permitted it to reach the diver in a few seconds and save him from a very risky situation. The wooden boat instead lagged considerably behind.

Experiences carried out in the work areas with the plastic boat were many: knocks against ice and rocks, collisions and scrapings with bergs, floes and debris of very varied size and shape. This notwithstanding, in no case the plastic hull suffered changes that might impair its safety. Quite on the contrary, the wooden boats of the same type became seriously or completely damaged.

The shape of the boat is recommended for the type of tasks to which it was put to, but the lack of a prow and a luff keel do not make it very recommendable for navigation in areas of small debris inasmuch as this passes through below the bottom of the boat and end up by damaging the propeller blades of the motor. On being taken ashore, the plastic boat, slides more easily over any type of surface: rock, boulders, ice, snow etc.

VII. Advantages and Disadvantages

1. Advantages

   a) Very sturdy be comparison with those of the same design but built of wood.

   b) Great maneuverability

   c) Relative low weight in relation with its transportation capacity.

   d) Easy to make it slide over any type of surface (ice, snow, rocks, etc.)

   e) Easy to wash and to rid it of greases, etc. after operations in which all kinds of substances and materials are transported.

   f) Quick to repair in the event of possible damages to its hull.

   g) Does not require servicing.

h) The shape of its bow greatly facilitates its grounding ashore, even in such beaches having a very low gradient.

i) Absolutely unsinkable.

2. Disadvantages

a) The lack of a bow permits small ice debris to pass below the hull, damaging the propeller blades of the outboard motor.

b) When the inside part of the boat gets wet by the spray, the area not protected by the wooden grids becomes very slippery, which, under certain conditions, may cause serious falls inside the boat.

VIII. General Conclusions

Experiences carried out with plastic boats and with boats made of wood were very many, and under all the different conditions that can be met in such a particular area as Antarctica is.

The plastic boat proved to be in all situations very superior to the wooden one. The material of which the former is built was not affected in the least neither by the knocks against the ice and rocks nor by the low temperatures.

The only traces that remained of the hard work carried out were the marks left by the scraping of the ice against the upper work of the boat.

The speed attained using the same type of motor, was very much higher than that obtained with the wooden boat; it was also proved that the maneuverability of the plastic boat was clearly higher to that of the other boat.

Hoisting and lowering operations, as well as heaving that boat ashore were accomplished with one man or two, while in some areas four or five men were necessary to heave ashore the wooden boat.

IX. Outlook for Future Design

In view of the experience gained along 70 days of intensive use of the plastic boat, it can be averred that, eliminating in the new design two fundamental factors that acted negatively, the result would be an ideal prototype within its general characteristics.

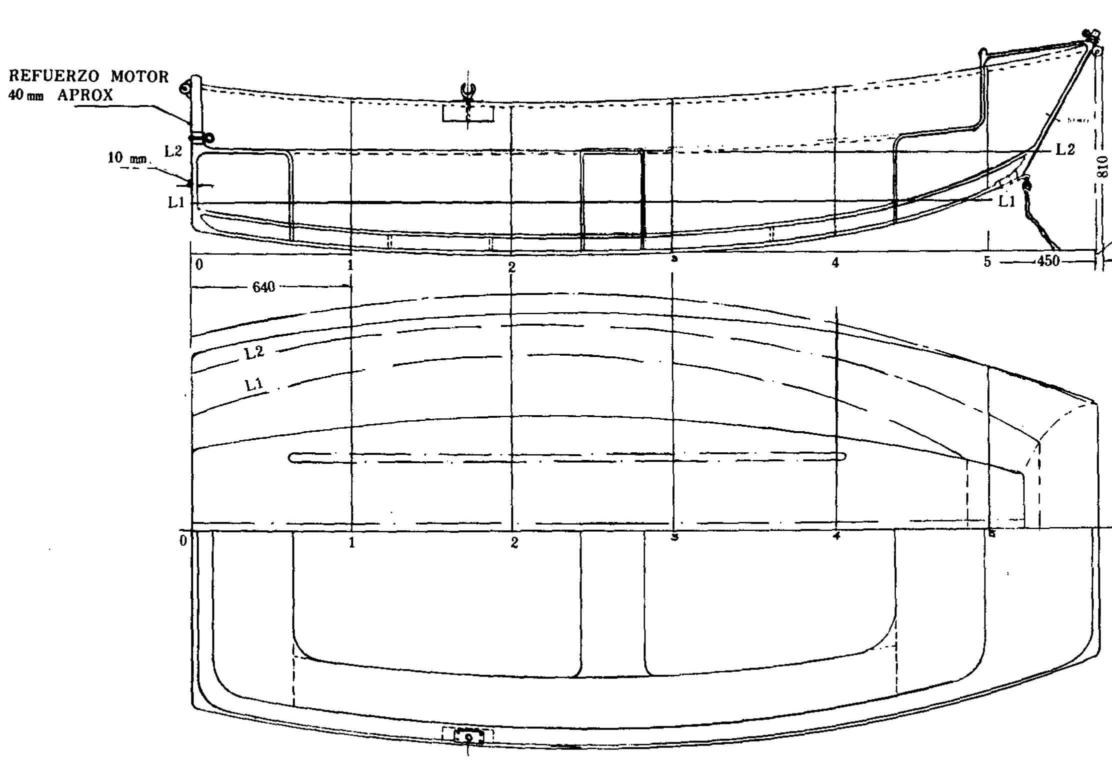
Those factors were:

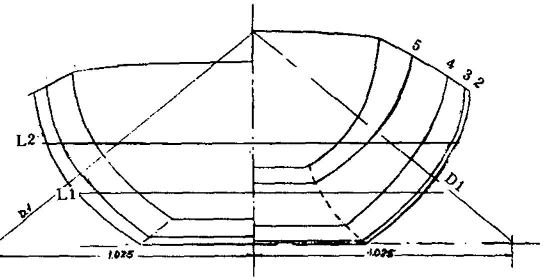
1. The slipperiness of the benches and gunwale which turned very

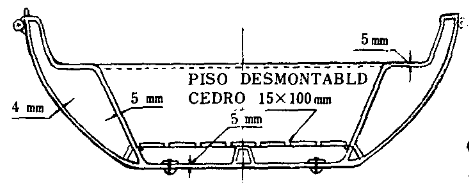
dangerous the operations that the personnel had to carry out, and causing some serious falls inside the boat and even out into the water. It is considered that this problem could be solved easily by applying some safe antiskid product to the above mentioned surfaces.

2. Ice debris which passing below the hull of the boat, reached the propeller blades of the outboard motor, and damaged them (the propeller blades). This situation came about because of the truncated bow of the boat and, therefore, it did not open the water as it is done by a boat of conventional design.

It would be the case of changing the type of bow while keeping the condition of easy grounding in beaches of very low gradient.







SECCION MAESTRE A
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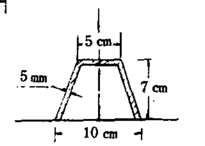


REFUERZO del FONDO

CARACTERISTICAS

ESLORA	3.60 m
MANGA	1.70 〃
PUNTAL	0.60 〃

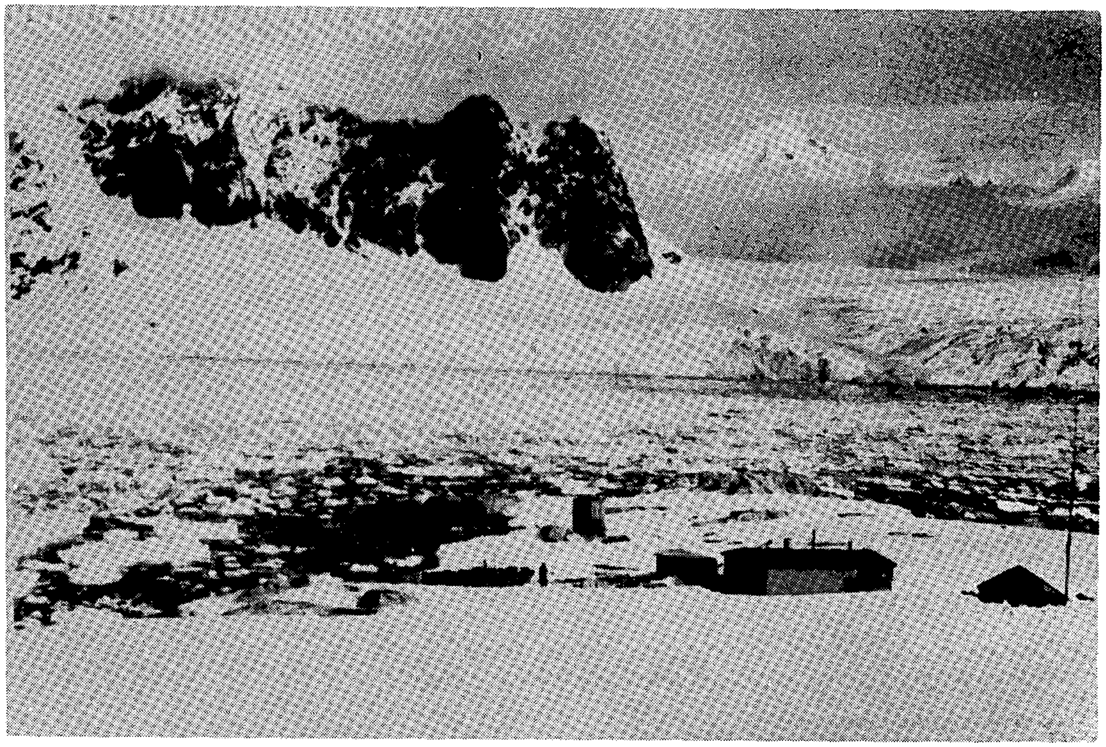


Photo 1. Normal working area of plastic boats.

Photo 2. Plastic and wood boats side by side in marine biology working area.

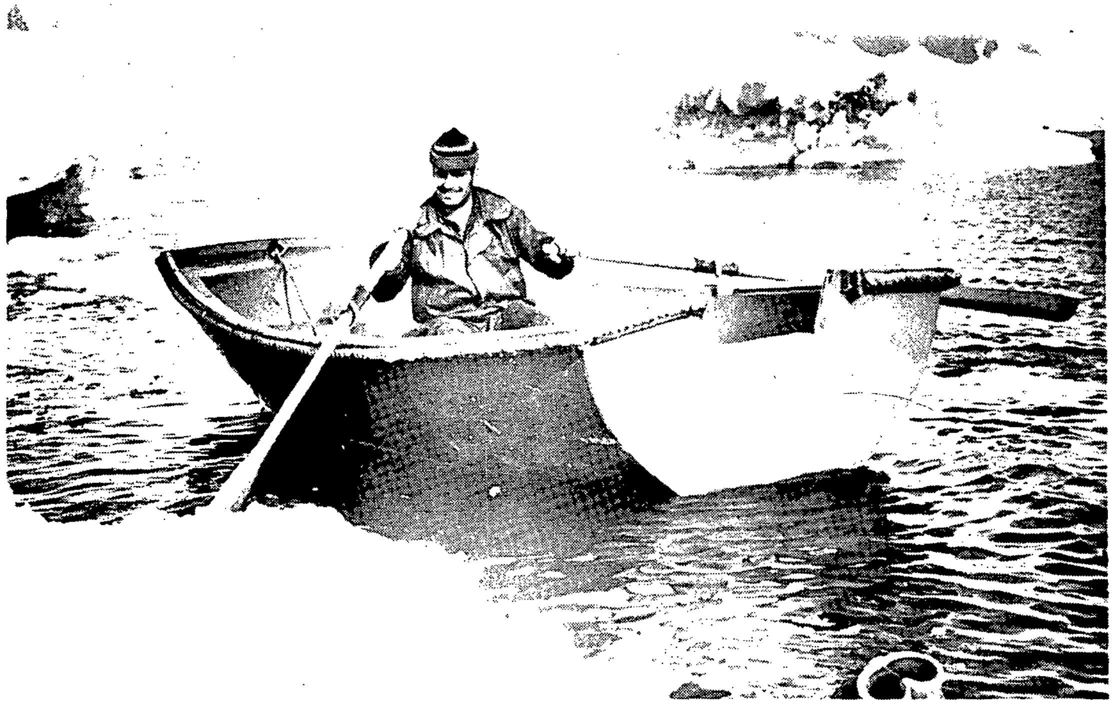


Photo 3. Plastic boat in working area supporting frogmen.

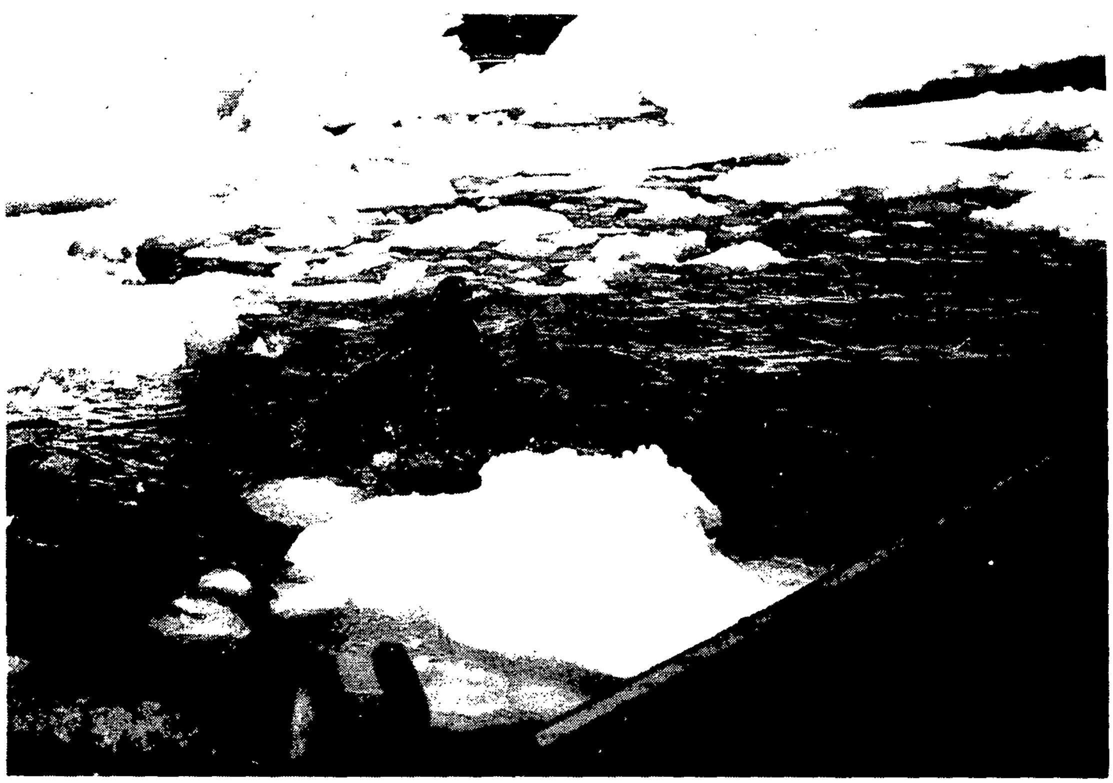


Photo 4.

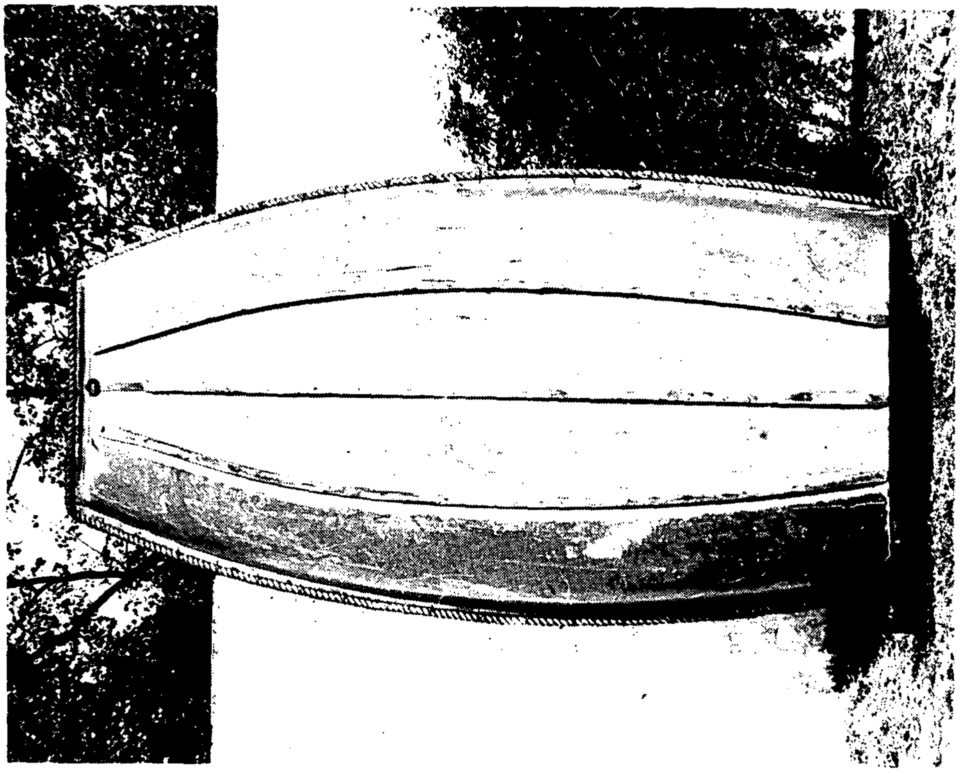
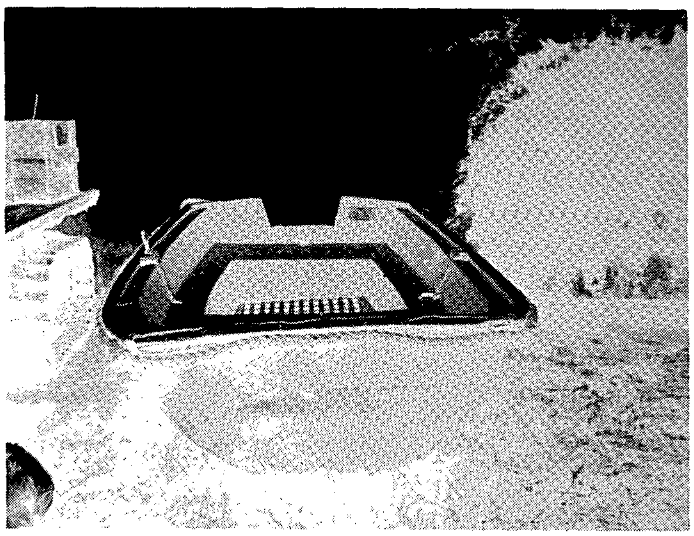
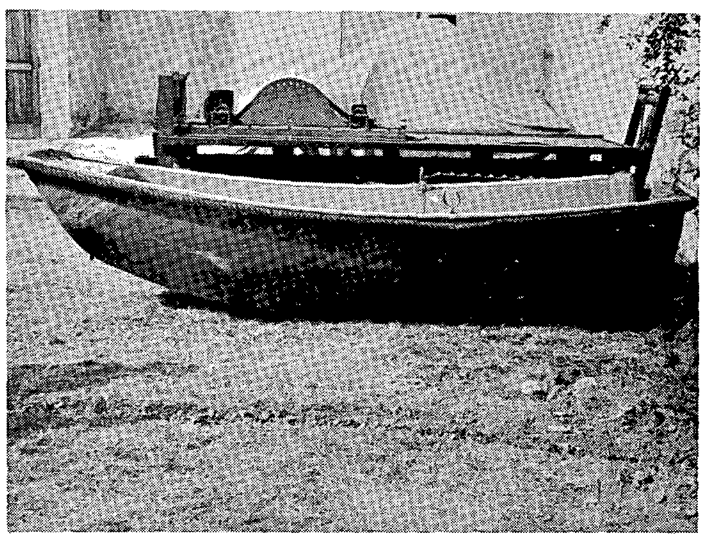
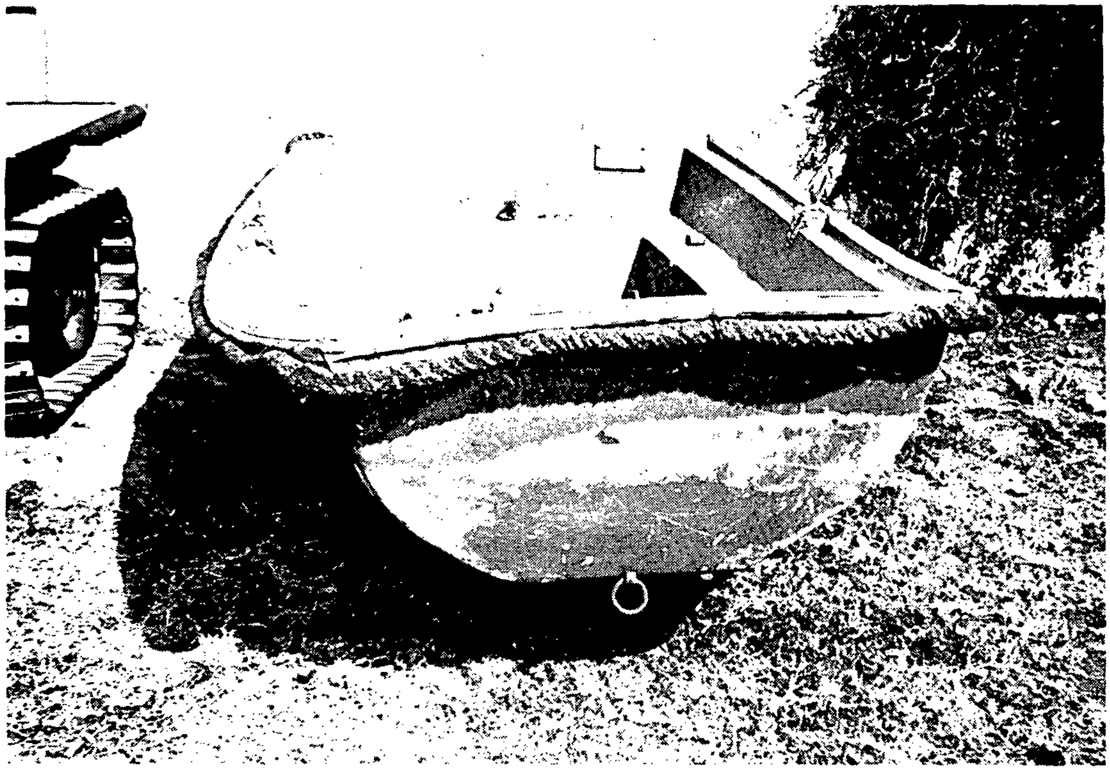


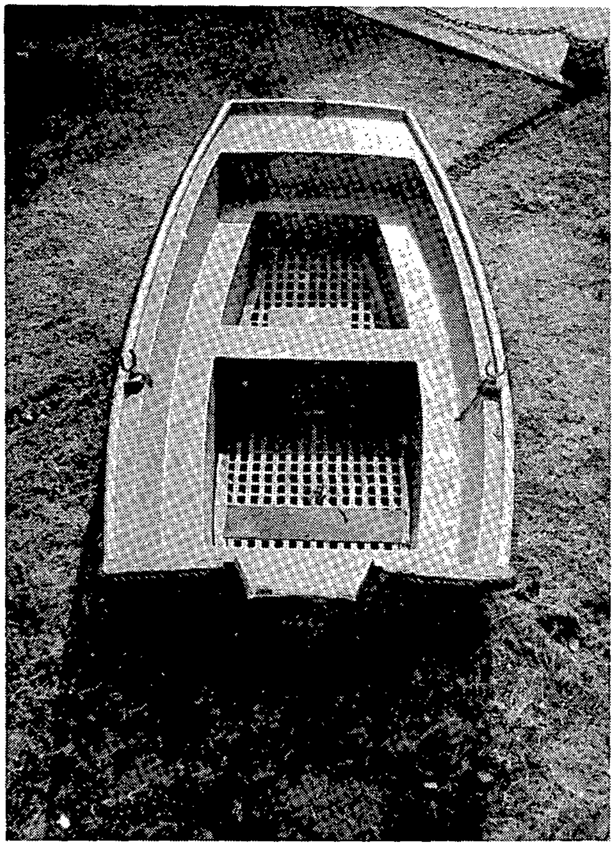
Photo 5. Boat of plastic and wood laying trammel net.





Photos 6 and 7. Plastic boat after 70 days of work in ice.





Photos 8 and 9.
Plastic boat after 70 days of work in ice.

MOORING BOLLARDS FOR SHIPS IN 100 KNOT WINDS

G.D.P. Smith * and A.J. Gamble **

Abstract

Rapid shelving of the coastal rock allows vessels to lie close in shore in deep-water roadsteads. The rapid onset of extremely high velocity winds, however, requires the provision of very secure mooring points to protect vessels from being driven onto lee shores or foul ground. Mooring bollards, designed to hold 2000-ton vessels at winds of 100 knots have been installed at some Australian National Antarctic Research Expeditions (ANARE) stations. Being sited on monolithic rocky terrain, an effective means of attachment had to be developed. This paper describes the design of those bollards and techniques employed for their installation.

1. Failure of Inadequate Mooring Points

The re-supply and relief of Australian Antarctic stations is effected solely by ship, 2000-ton polar class cargo vessels being chartered for the purpose.

During the discharge of cargo, ships lie off-shore and the cargo is ferried to the station by amphibious vehicles (DUKWs). At Macquarie Island and at Davis, the vessels ride at anchor in open roadsteads some distance from shore. At Mawson and Repstat, however, deep water allows the vessels to anchor much closer. At Mawson, vessels lie about 300 feet offshore within a small land-locked harbour, and are moored to the surrounding shoreline by bow and stern lines spread around the harbour.

Until recently, the ships' hawsers were made fast to very rudimentary mooring points which usually consisted of two-inch solid steel pins in holes drilled in the rock, or holdfasts made from steel rails captive behind rows of steel rods grouted into holes drilled in the rock.

Twice in recent years hawsers parted during hurricane winds at Mawson. Hawsers failed sequentially around the up-wind series of mooring points, these failures causing progressively heavier stresses to be imposed on the remaining hawsers. These stresses caused failure at the point where bights passed round the small-diameter rails or pins which constituted the mooring points. Some pins were dislodged from the rock by the strain, and some holdfasts snapped at the centres, In one case, the ship was driven against the shore of the harbour, fortunately without damage. (See Figure 1).

* Antarctic Division, Department of Supply, Melbourne, Australia.
** Department of Works, Australia.

2. Design Requirements

It was obvious that adequate mooring points were essential if ships were to ride out in safety the violent winds encountered at Mawson and other ANARE stations. Any acceptable design would need to meet the following requirements:

(a) a large-diameter bollard to prevent severance or abrasion of thick hawsers;

(b) each bollard to anochor two 7" diameter nylon hawsers, each having a breaking load of 46 tons;

(c) fixings, to anchor bollards to monolithic rock;

(d) the point of attachment of ropes to be at such a height above surrounding rock as to prevent abrasion;

(e) fast and easy mooring and slipping of hawsers;

(f) materials and components to be conveniently transported to the site and erected in position, using manual labour only.

3. Design Details

The Department of Works, in collaboration with the Antarctic Division, producted the designs.

The design incorporated a concrete and steel structure, with a large-diameter cylinder to accommodate the hawser bights. Shear stresses were opposed by steel dowels set in holes in the rock. Design details are illustrated in Figure 2. This design could be easily installed with available resources (Figure 3).

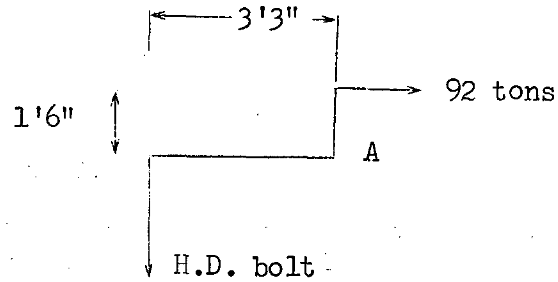
4. Design Calculations

The basic design of bollards consists of two parts:

(a) bending in the unit;

(b) shear between unit and bed.

(a) Bending.



Force in HD bolts ($M_A = 0$)

$$= \frac{92 \times 2240 \times 18}{3.25 \times 12} = 95{,}000 \text{ lbs.}$$

From this figure the number of HD bolts can be computed taking the strength of rock and diameter of bolts into consideration.

(b) Shear. The shear force of 92 tons is resisted by steel dowels grouted into holes drilled into the rock. A shear value of 1500 lb/in^2 ultimate strength was used in the design of shear members.

5. Construction of Mooring Bollards

The steel components were prefabricated in Australia, and sufficient were procured to provide five bollards at Mawson and six at Repstat.

At Mawson, a large rock on the foreshore provides an additional natural bollard.

In February 1967 the Mawson bollards were installed. Plywood templates were set out for positioning the holes for rock-anchor bolts and shear pins. The steel components were set up and levelled, the cylinder being tack-welded on site to the RSJs and shear pins. The latter were grouted into their holes by molten sulphur, the surface of the sulphur then being screened from the concrete by a layer of bitumen. The rock-anchor bolts were tensioned to 300 ft/lbs. Formwork was positioned and concrete poured. This concrete was mixed, placed and finished as described by Smith [1]. Hot air tents and snow slurry were used for setting and curing the concrete, which was made using high alumina cement.

An inflated rubber pontoon was employed to ferry the bollard components, materials and equipment to their various locations around Mawson harbour. Fresh water being in short supply at the time, and the harbour foreshores being clear of snow, pontoon loads of ice and névé were deposited at some of the outlying locations. This was melted in steel drums surrounded by burning brown coal briquettes which provided efficient and easily transportable heating (Figure 3).

6. Utilization of Bollards

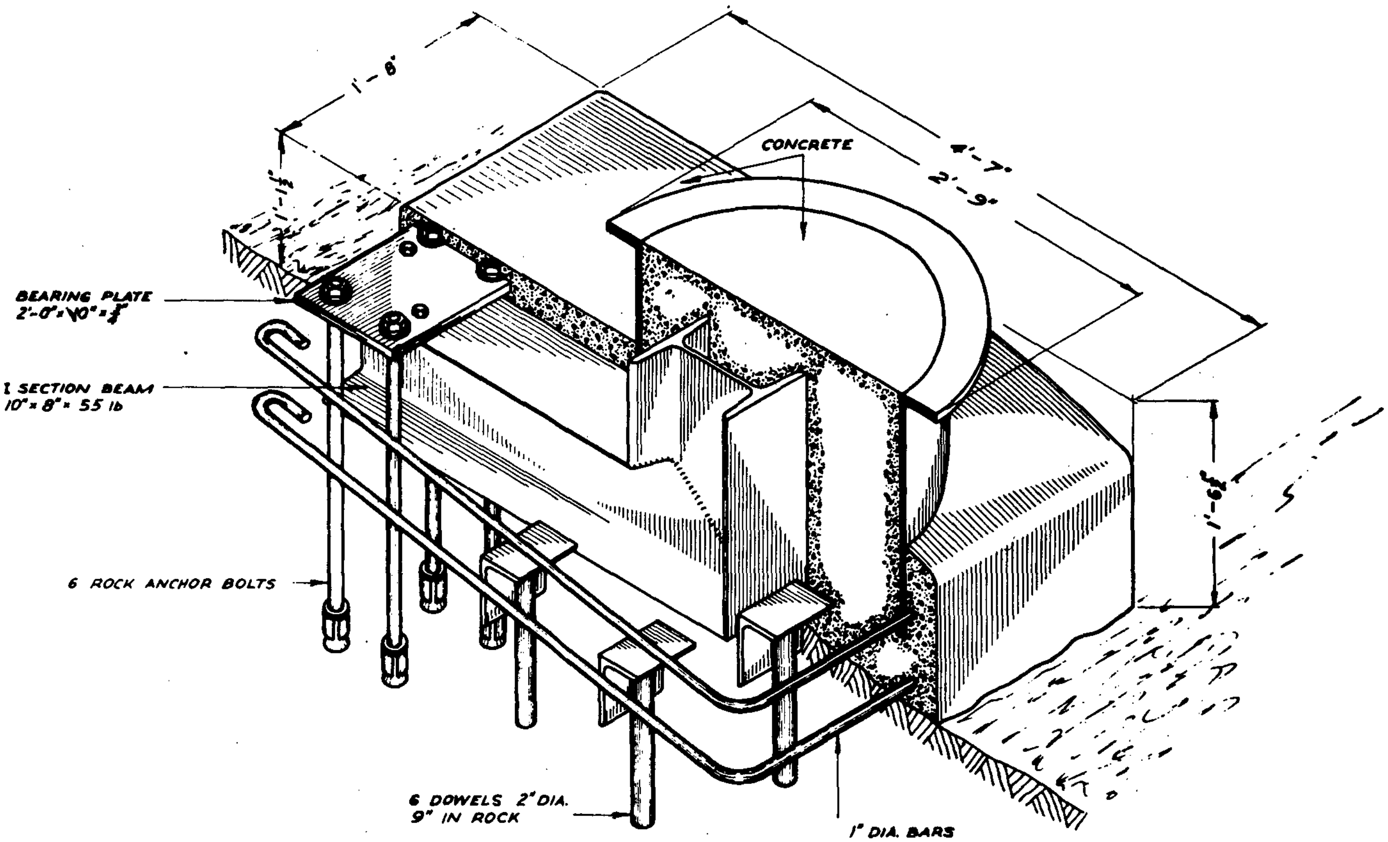
The m.v. "Nella Dan" was tethered in Mawson harbour to the new bollards during the relief of the station in February 1968 (Figures 4, 5 and 6). The bollards have yet to be installed at Repstat.

Reference

(1) Smith, G.D.P. Experience in Concreting in Antarctica. Antarctic Division, Department of Supply, Commonwealth of Australia, presented to Antarctic Treaty Meeting, Tokyo, 1968.

ANARE photo 17013B

Fig. 1. m.v. "Nella Dan" with bow grounded on windward shore of Mawson harbour after moorings failed during violent winds. Engines were operated throughout the gale in order to maintain this position and avoid grounding on a lee shore.

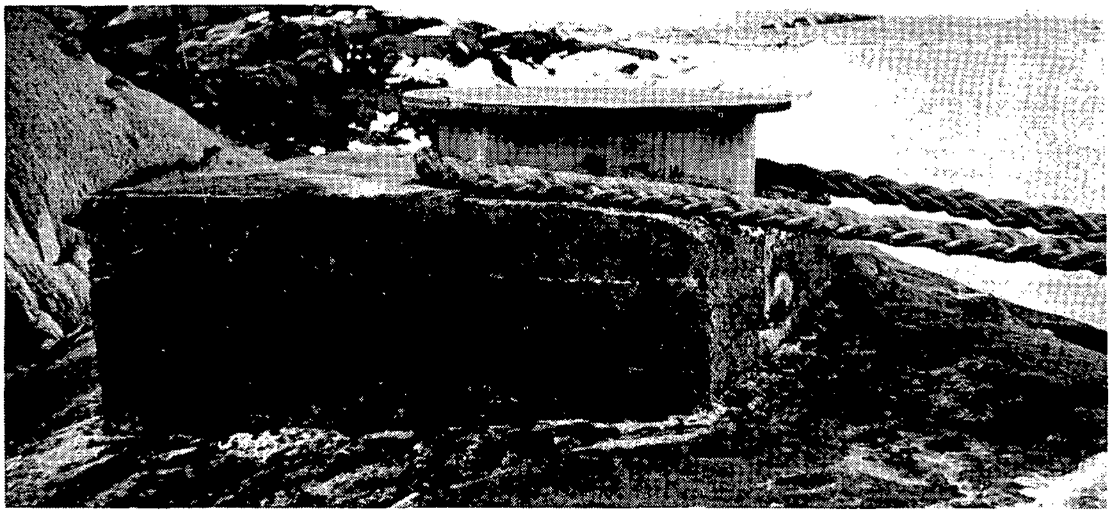


ANARE Drawing 2/68/03

Fig. 2. Design of mooring bollards.

ANARE photo 17876A

Fig. 3. Pouring concrete for a bollard at Mawson. Note mixing water being heated by brown coal briquette fire in drums at left, pontoon for transport, drummed aggregate, and sulphur-melting furnace.



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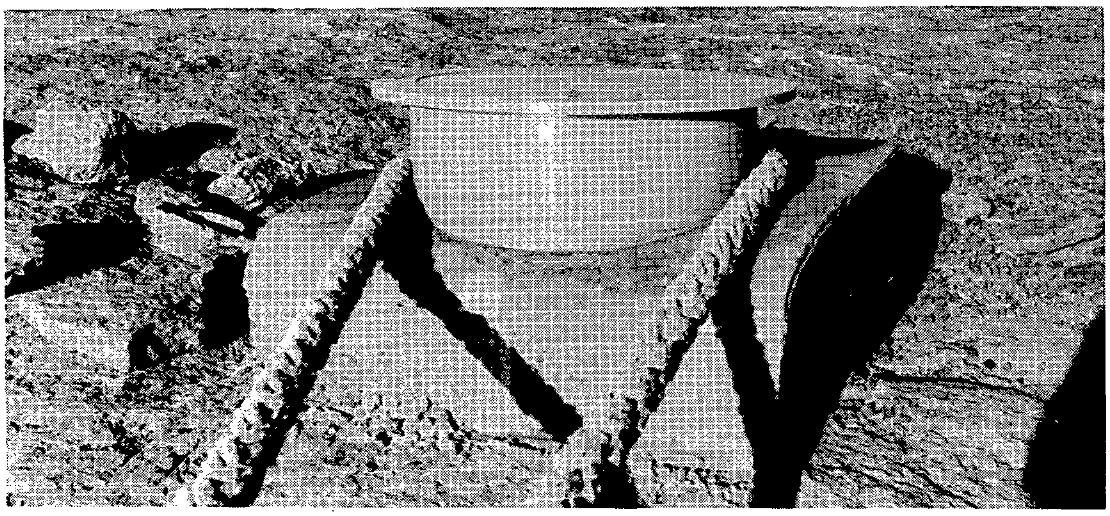

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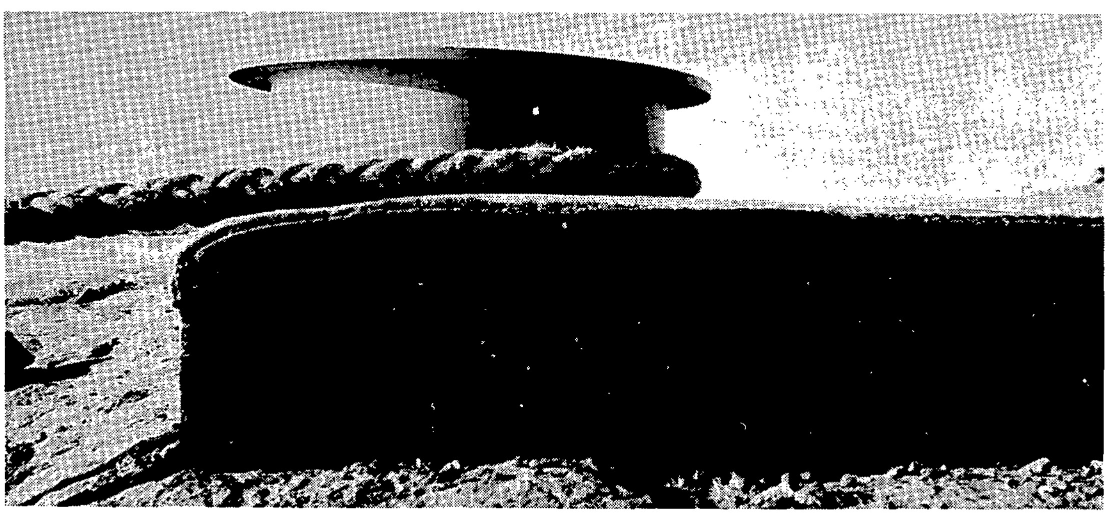
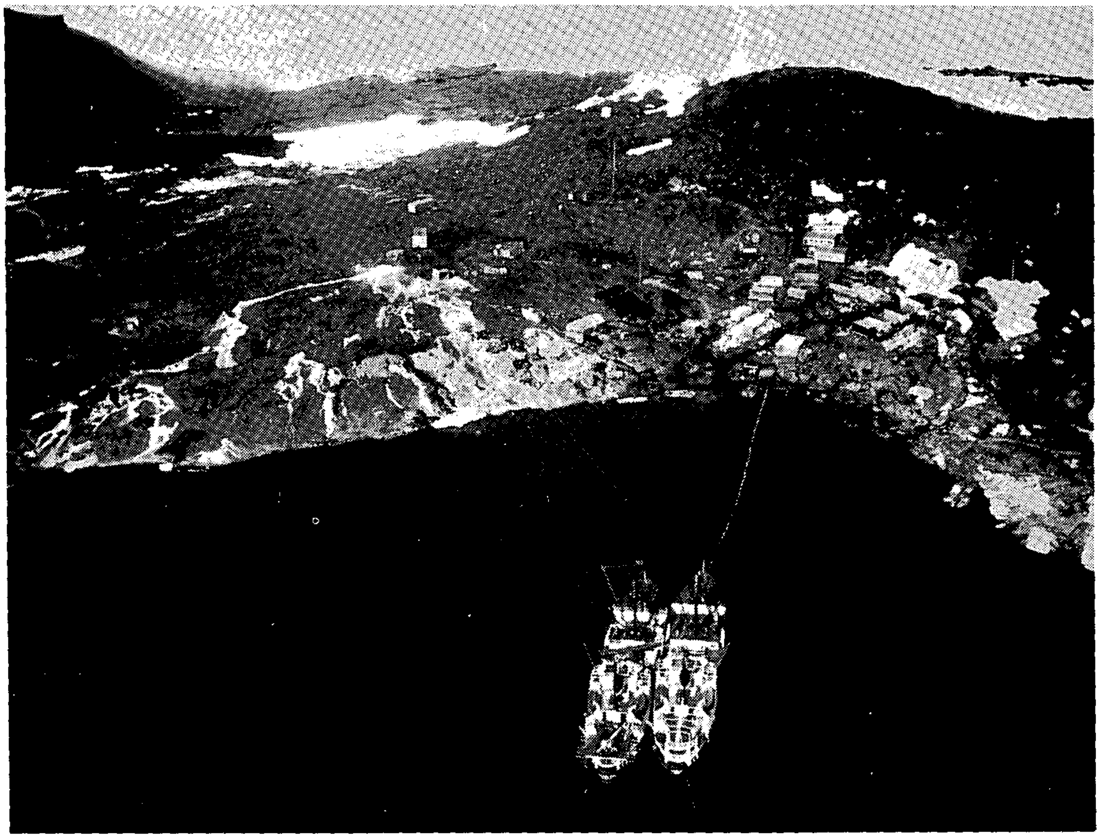


ANARE photo 18007

Figs. 4, 5 and 6. Ship's hawsers attached to completed mooring bollards.



ANARE photo 10117

Fig. 7. Ships moored in Mawson harbour.

ICEBREAKER OPERATIONS IN ANTARCTIC WATERS

D.F. Styles *

Abstract

The limitations of operating icebreakers as escorts to other ships are briefly discussed, and the possibility of combining the functions of an icebreaker and an expedition ship in a signle vessel is suggested as a project for a future design study.

1. Introduction

Ships engaged in Antarctic operations have to enter sea ice so frequently that it is not at all surprising that they sometimes need the help of icebreakers, either to be able to complete an essential part of a programme in time, or to ensure that they can be extricated from the ice before the end of the short season.

The season is normally confined to midsummer and late summer when the sea ice is most easily penetrated by ships, and when there is least danger of excessive ice accumulation on the top hamper during storms. The programmes most commonly mounted are the voyages to relieve stations, coastal survey work and oceanography.

Some of the stations are difficult of access from the sea even in midsummer, because the pack ice has not been dispersed; and in a few cases fast ice is still present when the annual relief ship is due. Survey work is being extended into the areas where ice conditions are more difficult, as programmes of mapping and general surveys in such disciplines as geology, geophysics and biology are gradually being filled in the more accessible coastal areas of Antarctica. Oceanographers, too, are extending their surveys by ship further south into ice-filled waters where there is so much valuable work to be done.

The use of icebreakers as backing for these programmes is likely to continue for a long time until satisfactory alternatives to ship transport are fully available. It is therefore suggested that it would be a useful exercise to study the manner in which icebreakers are used in this environment and to consider whether a new approach is desirable and possible.

This paper is based on limited experience in the area from 44° E to 160° E between 1954 and 1968, but it is hoped that it will stimulate discussion from those with more intensive experience in other parts of this large and varied scene of operations in both hemispheres.

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2. The Main Purposes for Which Icebreakers Are Used

Icebreakers at present in use are quite specialised tools which were originally designed to open sea lanes in fast ice and keep them open for the passage of unreinforced ships: and this is their primary value in which lies the economic justification for their existence. It is of immense importance in places where there is heavy traffic, such as the Baltic Sea and the St. Lawrence Seaway, and of course their capability can meet the limited fast ice requirement in Antarctica if the icebreaker has sufficient power and structural strength.

An icebreaker can offer a lane in pack ice too, but only whilst the pack is motionless. If there is a wind or current or tidal race, the lane will be modified and may be obstructed immediately behind the icebreaker if indeed the icebreaker can work in such conditions.

The final value of an icebreaker is for the emergency operation of extricating a ship which has come under pressure in pack ice and, having lost motion, or finding the ice rafted by the pressure and too heavy, cannot get going again.

3. Pack Ice Conditions in Antarctic

The large section of Eastern Antarctica where Australia is active almost everywhere, offers a convex coast to the open sea in latitudes 65° to 70° S, so that pack ice is not generally confined but tends to move out towards the open sea. There are almost no large islands or deep embayments to form enclosed seas such as are found in high northern latitudes, but on the other hand there are no warm currents such as the Gulf Stream to melt the ice at these latitudes. Massive icebergs, many of them eight or ten miles square and 1,000 feet thick, coming from the continental ice cap, are common. Consequently temperatures are low, even in summer; sea water temperatures are usually -1.5° to $+ 3^{\circ}$ C, and air temperatures range from -40° C to $+9^{\circ}$ C with a mean of -10° C. Strong winds and storms are prevalent even in summer and increase in frequency, duration and intensity with reduced hours of daylight.

The prevailing surface winds cross the Antarctic coast from the southeast under the influence of the Coriolis effect, and converge with the westward setting current. Katabatic winds at right angles to the coastline extend up to twelve miles out to sea and help break out the sea ice leaving pools of land-water in some areas. The winds carry a considerable amount of drift from the plateau to supplement the rather meagre precipitation of snow.

Under the influence of these three forces of prevailing winds, katabatic winds and current, the pack ice is concentrated in belts, frequently under pressure, which reach their greatest extent about September and their least in January to March. In September they may extend several hundred miles out to sea and in summer their dispersal and erosion sometimes leaves sections of the coastal ice cliffs open to the swell until new sea ice forms about March.

It is continually varying condition of the pack ice which presents the main difficulty for ships. Not only wind, currents and tides, but also snow cover and sea water temperatures affect the properties of the pack. Late in the summer season, when the ice has been exposed to relatively warm sea water erosion and ocean swells for a long time, the pack will break easily but, if it is covered with much snow, a ship forcing its way through it will encounter a mixture of snow and broken honeycombed pack of a porridge-like consistency which produces so much friction at the water line that the ship loses momentum and cannot continue. When the pack has been under even moderate wind pressure for some days it will have hummocked or rafted, and even though the sea ice in this area does not freeze to a depth of more than six feet in one season, rafting often produces floes fifteen feet thick. Cloud cover also adds to the difficulties of ships working pack by reducing daytime temperatures and visibility and by hampering aerial reconnaissance; but in providing a mirror to reflect ice and open water it sometimes helps ice navigation.

These are the conditions which ships must cope with when they venture into sea ice, and no matter how easy the passage may be when they enter there is some likelihood that conditions will change whilst they are still working the ice or before they return to the open sea. They may be caught by such a change or they may simply find the ice conditions beyond the capacity of the ship. If this occurs early enough in the season there is some prospect in most cases that the ship will be released or that the ice will be penetrated before the end of the season. However, if the ship is delayed too long, some programmes will be prejudiced or some parties working in Antarctica may not be relieved. If an icebreaker is available in the vicinity, it will be economical to use it so that the trapped ship may be released as soon as possible to proceed about its business before the short season ends.

4. Working Ships in Pack Ice

Provision of a sea lane as mentioned above will allow ships to reach their objectives without working the ice and in fact this is the technique usually employed when the pack ice is motionless and an icebreaker is available, such as frequently happens on the run to McMurdo, which is visited by several ships each year.

However, in other circumstances, ships have the greatest difficulty in following an icebreaker even in only moderately close pack because, in order to move through it, an icebreaker has to twist and turn and heel.

The mechanics of moving through the pack involve manoeuvres which have the effect of transferring floes and pieces of floes from ahead of the orthodox icebreaker along past its sides to the stern, where they move into the wake (thre is nowhere else for the floes to go unless they are cast under or over the surrounding ice, e.g., the Canadian-developed "Alexander Prow"). Naturally, the larger floes block the way for the following ship so that she is always being stopped.

When this happens there is a very laborious manoeuvre by the icebreaker to free her. The icebreaker at first tries to use the wash of her powerful propellers to "blow" away the ice which is blocking the following ship. This only succeeds sometimes. Often the icebreaker must painfully turn around in tight pack and cut a path dangerously close to one of the vulnerable sides of the stranded ship and then enlarge it to give her room to move again into the wake of the icebreaker. This operation has to be repeated with monotonous frequency.

The solution to this common operational problem is to have the trailing ship follow the icebreaker so closely that there is no room for the floes to come into the space between the two ships and they are passed instead into the wake of the second ship. But it is very difficult for the two ships to maintain such very close formation because they are of such different shape, size and power and are driven independently, and also because the icebreaker has to twist, turn, roll and accelerate in order not to be stopped herself by massive floes ahead. The acceleration of the icebreaker tends to wash the following ship farther astern.

One ingenious improvement devised is the provision of a notch in the stern of the icebreaker to take the stem of the following ship so that they can be coupled as closely as possible. Most ice-strengthened ships, however, are designed to have a raked stem so the solution will only work if the notch is built to suit the particular stem it is to accept; if it is not there is likely to be some damage to the bulwarks of the escorted vessel or to the stern of the icebreaker.

In short, this solution has very limited application. The total ship traffic in Antarctica is extremely small by comparison with that in the northern hemisphere and the ice conditions are frequently almost beyond the capacities of the ships employed. It must be remembered, however, that the scientific programmes which they support are of very considerable importance, no matter how difficult it may be to calculate the tangible values in actual money terms. This is not to suggest that there should be an icebreaker available in case of need for every cargo or passenger vessel entering the ice but some better intermediate solution of combining the functions may be attractive.

5. Modified Icebreaker

As mentioned in the introduction, Australian experience has been rather specialised. It is therefore with some diffidence suggested that a solution might lie in modifying the design of an icebreaker to enable it to carry out other functions rather than to modify a cargo ship to work in ice.

This is suggested as a design study rather than as a firm proposal that such a design should be undertaken. The "Ob", built in 1953, already stands part-way between an expedition ship and an icebreaker, and has been extremely successful. "Fuji" is a more modern and, it seems, a very successful vessel also in this half-way class.

The ship contemplated would be basically an icebreaker designed for working heavy pack ice of the type common in Antarctic waters. It would have sufficient power to water line friction ratio to drive it through pack (not under pressure) up to perhaps fifteen feet thick. The hull would need to be shaped (as most ice ships are now) so that floes under pressure would be driven under the ship, and strong enough to withstand the initial pressures; but there need be only the normal precautions against being best for the winter, because of the fact that the convex shape of most of the Antarctic coast and the direction of the winds in most places tend to release a ship trapped in ice, if it is not too late in the season. The hull would average, say, eight feet deeper about the water line than the orthodox icebreaker, in order to provide the necessary cargo space. Passenger accommodation would not be so great as to increase the top hamper too much, for that would expose the ship to the dangers of ice loading.

It is not the purpose of this paper to do more than indicate the intention. The actual design of such a ship would of course need the detailed study which can only be given by shipbuilders, but it would be helpful to discuss the intention in principle at this meeting and, in particular, to have the comments of those operating icebreakers in Antarctic waters in recent years.

SEA AND AIR TRANSPORTATION TO THE SYOWA STATION

Toshiharu Honda *

1. Summary

This paper describes the air transport method employed by the Japanese Antarctic Expedition Team because of unfavorable and peculiar ice conditions near the base, which make it impossible to connect ocean transport directly with ground transport by snow-car.

2. Important Factors Affecting Transport Operation

Topographically, Japan's "Syowa Station" is situated deep in the recess of Lutzow-Holm Bay, on the west side of which the Riiser-Larsen Peninsula jets out to sea. Thus, in early summer, very close pack ice solidly cover the sea up to several miles**off the outer edge of fast ice, completely blocking the passage of a vessel. Fast ice is mostly perennial, so a navigating vessel must keep close to jostling icebergs to avoid perennial ice as best it can.

In the area near the Station, puddles begin to form usually in early summer---a condition which would make it necessary to confine the operating area even for a small, light snow-car to within a short distance from the shoreline, posing difficulties to land transportation to the base.

Another important consideration is the weather: December through January is the best season of the year in this area with fine weather prevailing and, for this reason, it is the time most favorable for transport operation. At the same time, it is imperative to accelerate construction work at the base to the greatest possible extent during this brief period. In view of this, ship-to-base air transport was the obly reasonable answer to the situation.

Japan's current Antarctic transport operation was devised to lift most of the cargoes by air over a distance of about 40 miles, engaging the icebreaker "Fuji" and 2 helicopters (S-61A) carried on board the ship.

Since "Fuji" is the only vessel in active service in Japan's Antarctic operation, it was designed to be capable of performing multipurpose duties.

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* Maritime Staff Office, Maritime Self Defence Force, Tokyo, Japan.

** Nautical miles are used throughout the present report.

3. Outline of Transportation

The weather tends to be fine in December through January at the Station and its vicinity. To make the most of the best seaason, "Fuji" leaves Japan toward the end of November, arriving in the Antarctic in early January to moor alongside the outer edge of fast ice and, after building an ice-heliport, to commence cargo transportation.

Generally, emergency goods and precision instruments are carried inside the cabin of a helocopter all the way from the ship to the base, while the rest of the cargo is first unloaded on the ice for later sling-transportation.

Ice conditions permitting, the ship will attempt to force its passages through ice to take the closest possible position to the base so as to shorten a haulage distance.

By the middle of January, close pack ice therefore stuck to the outer edge of fast ice will have drifted away and fast ice adjoining icebergs will have become brittle enough to permit the vessel's further entry. (For the past 3 years, "Fuji" was able to reach the neighborhood of the Syowa Station by mid-January at the latest.)

The vessel's close access to the base will facilitate efficient to-and-fro shuttling of a helicopter, affording an appreciable saving in time. Substantial part of transportation will then have been completed by the latter half of January.

4. Vessel and Aircraft Engaged

(1) Vessel

Being the only vessel assigned to Japan's Antarctic observation activities, the icebreaker "Fuji" is given combined duties of ice-breaking, transportation and observation (Figure 1).

(i) Principal dimensions of "Fuji"

Standard displacement: 7760^{t}

Machinery: Diesel electric propulsion

Number of shafts: 2

Shaft horsepower: 12,000 SHP

Speed in open water: 16.5 ^{kt}

Maximum endurance: 15^{kt} - 15,000 mile

Crew: approx 230 men (including about 40 observation team-members)

Cargo: approx. 400^{t} (Volume of the ship's cargo-hold: 1892.8^{m^3})

(ii) Icebreaking capacity of "Fuji"

The fast ice coverage in this area extends as far as to about 50 miles long, 70% of which is hard and solid with an average thickness of about 1.8 m. Such ice condition requires the icebreaker's charging. Usually, it takes about 8 days to break through fast ice. Daily progress averages about 6 miles, with speed averaging at about 0.3 kt. At the time of charging, with the ice thickness 1.8 m, snow-depth 20 cm, water temperature (-) 1.5°C, atmospheric temperature (+)1.1°C and engine use of 6/10 (2200A), the vessel's advance will be about 60 m.

When faced with perennial ice with thickness above 2 m with condiderable snowfall on top of it, the vessel progresses by widening the front ice opening through repeated chargings. Although attempts have been made to use explosives in icebreaking, so far no notable results have been obtained. Nevertheless, the subject is still being further studied.

(iii) Cargo packaging

In view of the fact that transportation is mainly carried out by helicopter, the sizes of cargo packages are limited to:

Large package: $61^{cm} \times 63^{cm} \times 63^{cm} = 0.24^{m^3}$

Medium package: $77^{cm} \times 36^{cm} \times 36^{cm} = 0.10^{m^3}$

Small package: $55^{cm} \times 38^{cm} \times 28^{cm} = 0.06^{m^3}$

(2) Aircraft

"Fuji" is equipped with a BELL47-G2A helicopter for the purpose of scouting of ice condition and two S-61A helicopters for transportation of cargoes. Capabilities and principal dimensions of the latter are described in the attachment.

5. Air Transport

(1) Preservation and mooring of helicopters

To prevent any occurrance of damages during the voyages from and to Japan, long-effective preservation are applied to the airframes which, after being removed of the main rotors and pylons, are moored and tied down inside the hanger. Mooring has been improved to suit the conditions on "Fuji" and generally conforms to the U.S. Navy system (Figures 2 and 3).

After passing through the storm-zone, "depresservation" is carried out to restore the helicopters to flight-ready conditions, to be subjected to "preservation" again when the ship arrives at the outer edge of fast ice on the way to Japan.

(2) Transportation method

In the case of the S-61A helicopter, operation may be roughly divided into 1) cabin-transportation and 2) sling-transportation. However, a major portion of cargo is transported by means of the latter; Cargoes first unloaded on the ice from the ship lying alongside the fast ice, are then carried by the helicopter on the sling over to the base. Or, cargoes are loaded inside the helicopter which takes off from the wooden landing mat (Figure 4). Cargoes are packaged to sizes suitable for air transport. In loading cargoes in to the cabin, work is made easier and speedier by the balancemarking clearly indicated on the floor of helicopter.

Bulk fuel is transported either by slinging of drums or by means of a removable fuel tank temporarily set up inside the cabin. The tank can hold 2 kl of fuel, which will be transferred directly from the mother ship's fuel tank through a pipe. Then, at the Syowa Station, fuel is pumped into rubber-and-metal tanks by a suction pump (Figures 5 and 6).

When the distance is relatively short, sling-transportation is by far the most efficient way of conveyance in terms of time-saving. Nylon or wire nets and wire-ropes are used to sling cargoes according to the size and weight of each package. From considerations of flight-safety, the helicopter, while being engaged in sling-transportation, never takes off directly from the deck of the ship.

Since a helicopter with a sling can serve for a large crane, it is used in installation of a generator, fuel tanks, etc., subject to the following conditions:

Helicopter's gross weight: less than 18,000 lb (standard atmosphere on the surface of the sea)

Wind velocity: less than 15 kt (no gust)

Visibility: more than 5 miles

Range: within 3 miles

(3) Air-transport standards and actual performance records

(i) Standards

a) Cabin-transportation standards

Range (mile)	Cargo weight (ton)	En-route time/ helicopter	Cargo weight/heli-copter/day (ton)
Near the base		35^{min}	20 flights 45.2
20		55^{min}	15 flights 31.5
40	1.8	$1^{hr}\ 20^{min}$	10 flights 21.0
60		$1^{hr}\ 42^{min}$	8 flights 14.8

b) Sling-transportation (bulk fuel drums)

Range (mile)	Cargo weight (ton)	En-route time/ helicopter	Cargo weight/heli-copter/day (ton)
Near the base		7^{min}	56 flights (560 drums) 103.2
20		30^{min}	24 flights (240 drums) 44.16
40	1.8	54^{min}	14 flights (136 drums) 25.0
60		$1^{hr}\ 18^{min}$	9 flights (90 drums) 16.56

Note: Helicopter flight time

Near the base, while the ship is on the berth: $8^{hrs/day}$

Others: $14^{hrs/day}$

(ii) Actual performance records

The table shows the actual air transport records of the S-61A helicopter during its service periods from 1965 to the present year.

Year	Type of Transport	Number of flight	Cargo weight (ton)	Passenger (men)	Average cargo weight/ flight (ton)	Flight hour	Transport range (mile)
'65 - '66	Cabin	127	237.2	268	2.05		38
	Sling	52	94.8	12	1.84		
	Bulk fuel	43	64.6	41	1.57		
	Total	222	398.6	311	1.91	281.4	
'66 - '67	Cabin	97	173.6	62	1.85		Short range (partly 47 miles)
	Sling	166	191.6		1.14		
	Bulk fuel	53	82.0		1.54		
	Total	316	447.2	62	1.43	93.3	
'67 - '68	Cabin	44	65.1	43	1.58		Short range (partly 45 miles)
	Sling	149	204.7		1.37		
	Bulk fuel	84	125.4		1.49		
	Total	277	395.2	43	1.44	86.9	

(4) Safe cargo-sling transportation

(i) Cargo-sling equipment of S-61A helicopter

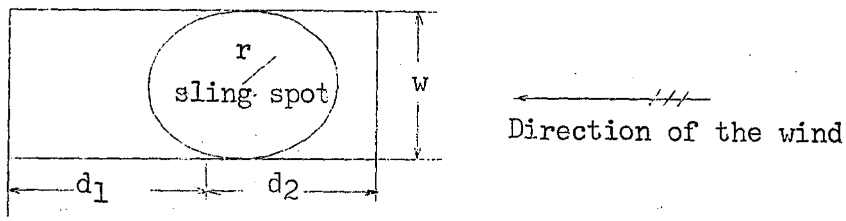
a) This equipment consists of a beam assembly, cable assembly, hook, hook mounting, mechanical release equipment, electrical release equipment and hook wind-up equipment.

Hook can be released mechanically, electrically or automatically. Mechanical release can be performed by operating either the manual lever or the emergency release pedal in the cockpit. The cargo-sling master switch has three shifts: "SLING - SAFE - AUTO". To release the hook electrically, the master switch is set to "AUTO". This will automatically operate the touch-down switch, contained in the hook, to release the hook when the cargo contacts the ground and the load on the hook's arm is reduced to less than 100 $\pm$ 10 lb.

(b) Addtional equipment

To aid the pilot and crew in keeping watch over cargoes on the sling, rear-view mirrors are attached on both sides of the lower front of the cockpit for the pilot as well as to the insides of sponsons for the crew's view.

(ii) Sling runway standards



Dimensions: Sling spot radius: r= 15 m

Sling runway width: w= 30 m

Length of runway

case \ length	d_1 (m)	d_2 (m)
Sling up	200	500
Sling down	500	100

The sling spot may be set up at any appropriate place alongside the ship to suit loading conditions, with due consideration to the aforementioned clearance required.

(iii) Cargoes

The following are some examples of cargo which are <u>inappropriate</u> for sling-transportation:

a) Precision instruments for observation

b) Explosives

c) High-pressure gas

d) Light-weight bulk cargo

e) Cargo with a length of more than 5 m (in the case of long-range flight)

f) Irregularly-shaped cargo

(iv) Safety in sling-transport operation

a) Ground crew

1) In order to prevent electric shock on the ground crew from the electric charge of the helicopter, prior to slinging down of the cargo, static electricity is discharged from the sling-hook, using an earth-rod. Isolated gloves and boots are also used.

2) For protection of the head against ice chips and other scatters caused by the down-wash of the helicopter, the ground crew use specially-made hats goggles.

b) Helicopter

1) Air speed standards during sling flight. While the pilot is responsible for choosing the optimum air speed, taking into consideration the shape of cargoes and sling conditions, standards are as follows:

Shape of cargo	Example	Indicator air-speed (kt)
Bulk light-weight cargo	Fuel tank, panel & long package	30 - 40
Medium-size heavy cargo	Classification left to the pilot's judgment	60 - 70
Small-size heavy cargo	Heavy metal products, concrete blocks & drums	70 - 100

2) It is required to keep the cargo-sling master-switch set at "SAFE" at all times to prevent any accidental dropping of a cargo during a flight which may be caused by a sudden gust of wind or inadvertence on the part of the pilot.

3) In the event of a shackle being used at the upper end of the sling, for the purpose of preventing any damages to cargoes or any possible danger arising out of sparks, upon the cargo's contact with the ground, the helicopter must be moved to such a place as not to let the shackle fall directly on top of the cargo; only then should the hook be released.

c) Command of operation

Flight Commander is able to take command of the operation from the bridge of "Fuji" through radio-contacts with the helicopter and the charging officer on the ground, while ground-air communications can be coordinated through either visual signals or the flight commander.

6. Conclusion

Fortunately, the Syowa Station normally enjoys very favorable weather conditions with many fine days to accomodate flight operation. In so far as Japan's Antarctic transport operation remains at the present level, although there seems to be some room for improvement of flight conditions probably by strengthening the helicopter's anti-icing equipment to do a particular type of duty under certain weather conditions,an S-61A helicopter with the present capabilities and equipment will suffice.

However, complete dependence on helicopter transportation inevitably limits the size of cargo and may well mean inadequacies to keep up with the rapidly-progressing modernization of the equipment and facilities at the Syowa Station. It is the most costly means of conveyance, too.

As it is known from our past experience that in some years, ice conditions improve enough to permit the ship's progress to the base's vicinity by late summer, study is now being made as to the possibilities of pipeline transfer of fuel and increased snow-car transport on the ice, with a view to thus effectively complementing the shortcomings of helicopter transport.

Nevertheless, a well-organized "ship-to-base" air transport system properly geared to the topographical features of the base no doubt offers an advantage of greater maneuverability, which assumes an added significance in an operation which must cope with the very changeable Antarctic meteorology.

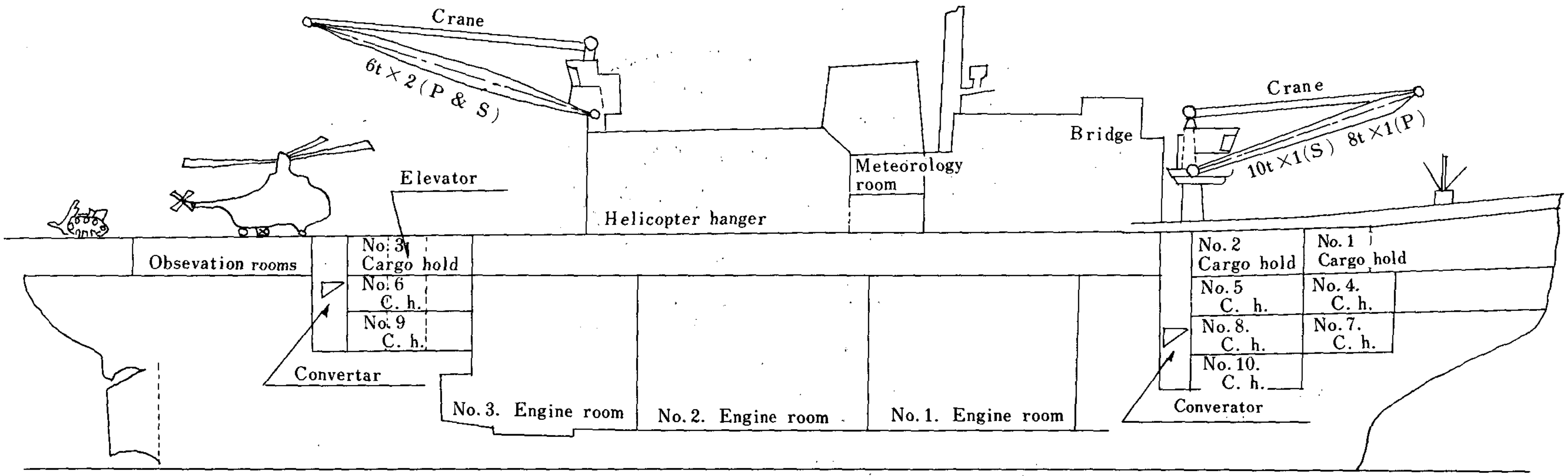

Crane
6t × 2 (P & S)
Crane
10t × 1 (S) 8t × 1 (P)
Bridge
Meteorology room
Elevator
Helicopter hanger
Obsevation rooms
No. 3 Cargo hold
No. 6 C. h.
No. 9 C. h.
Convertar
No. 2 Cargo hold
No. 1 Cargo hold
No. 5 C. h.
No. 4. C. h.
No. 8. C. h.
No. 7. C. h.
No. 10. C. h.
Converator
No. 3. Engine room
No. 2. Engine room
No. 1. Engine room

Fig. 1.

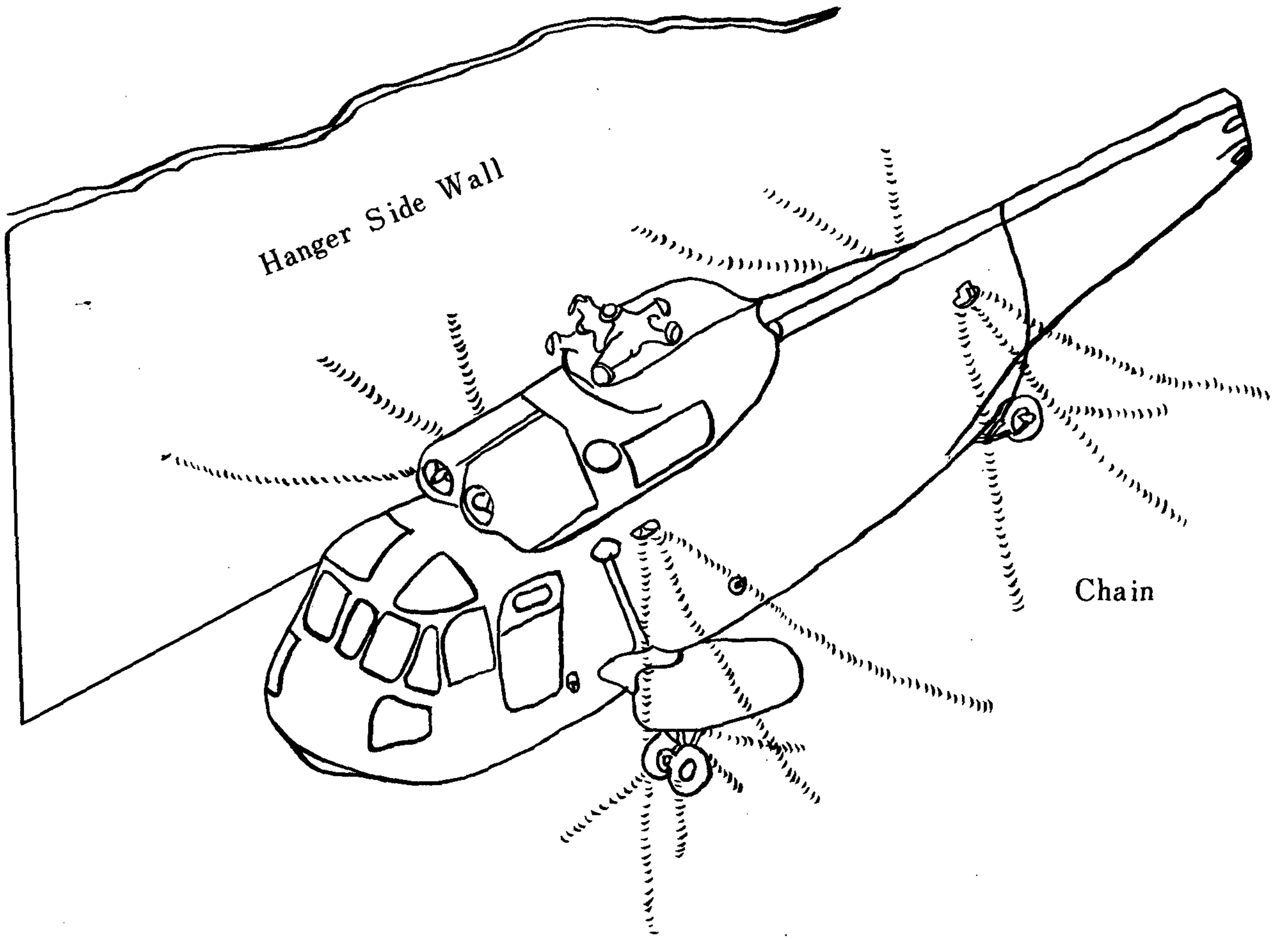


Fig. 2. Mooring diagram.

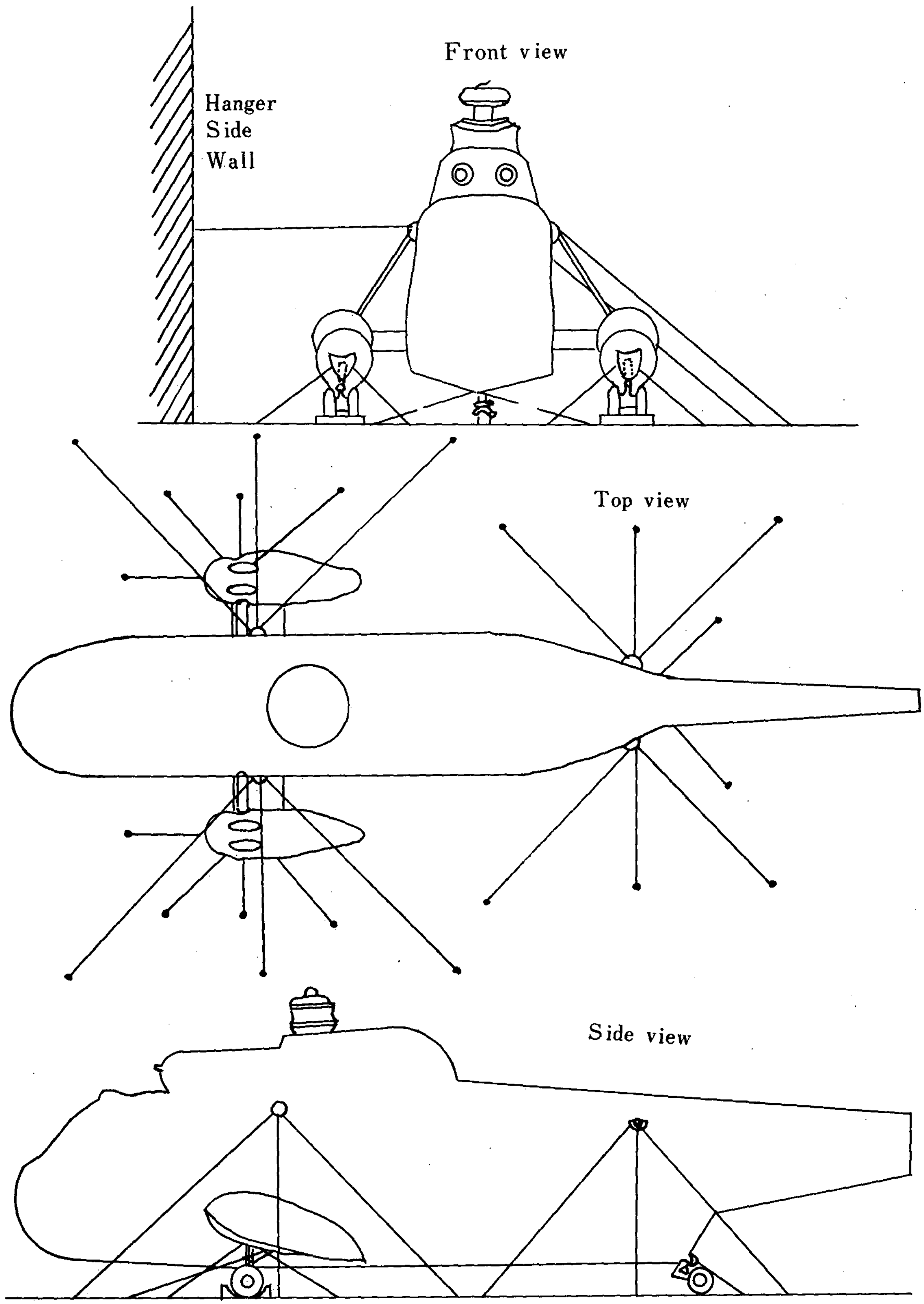
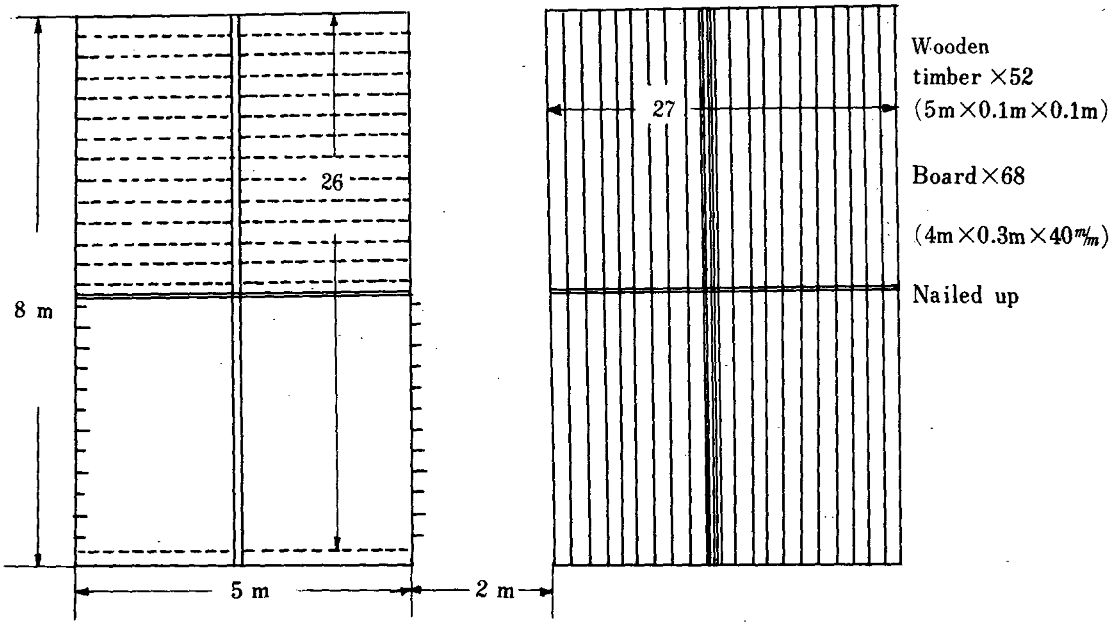


Fig. 3.

Landing Mat (on fast ice)



Heli-Port (Syowa Base)

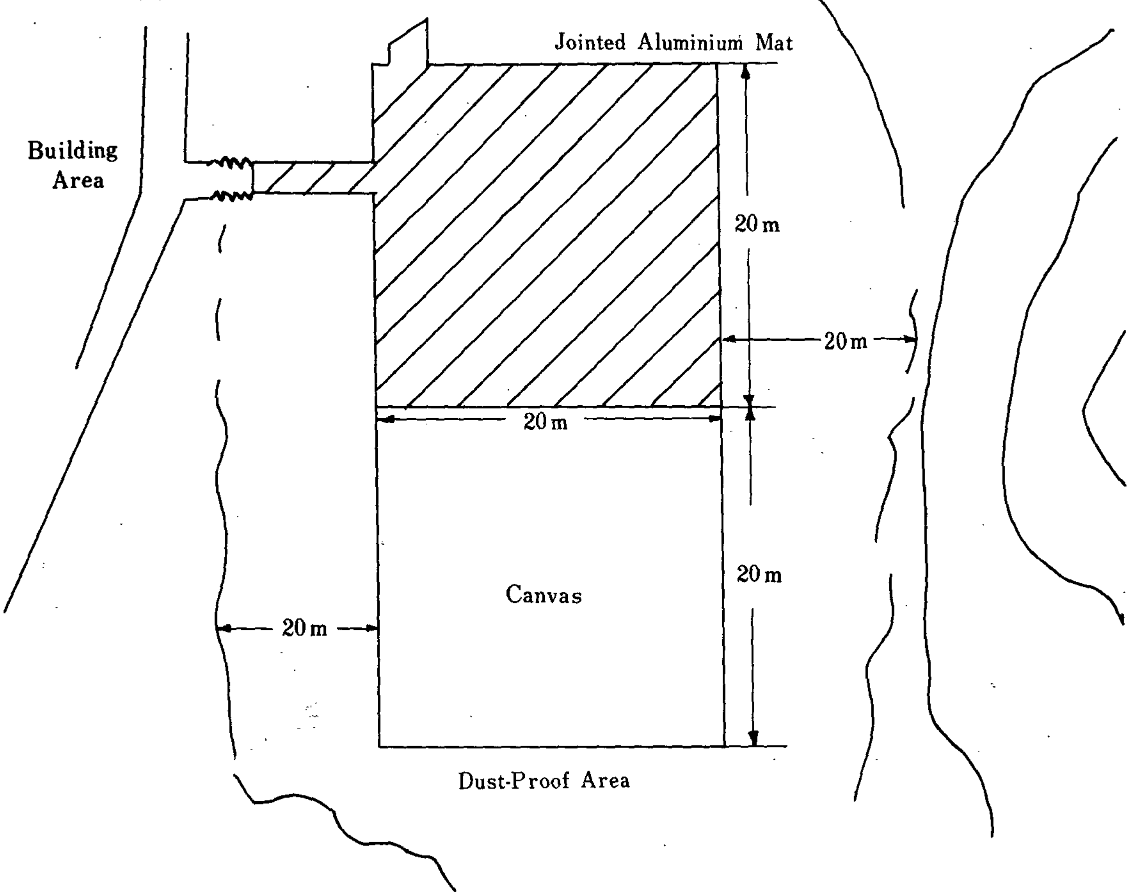


Fig. 4.

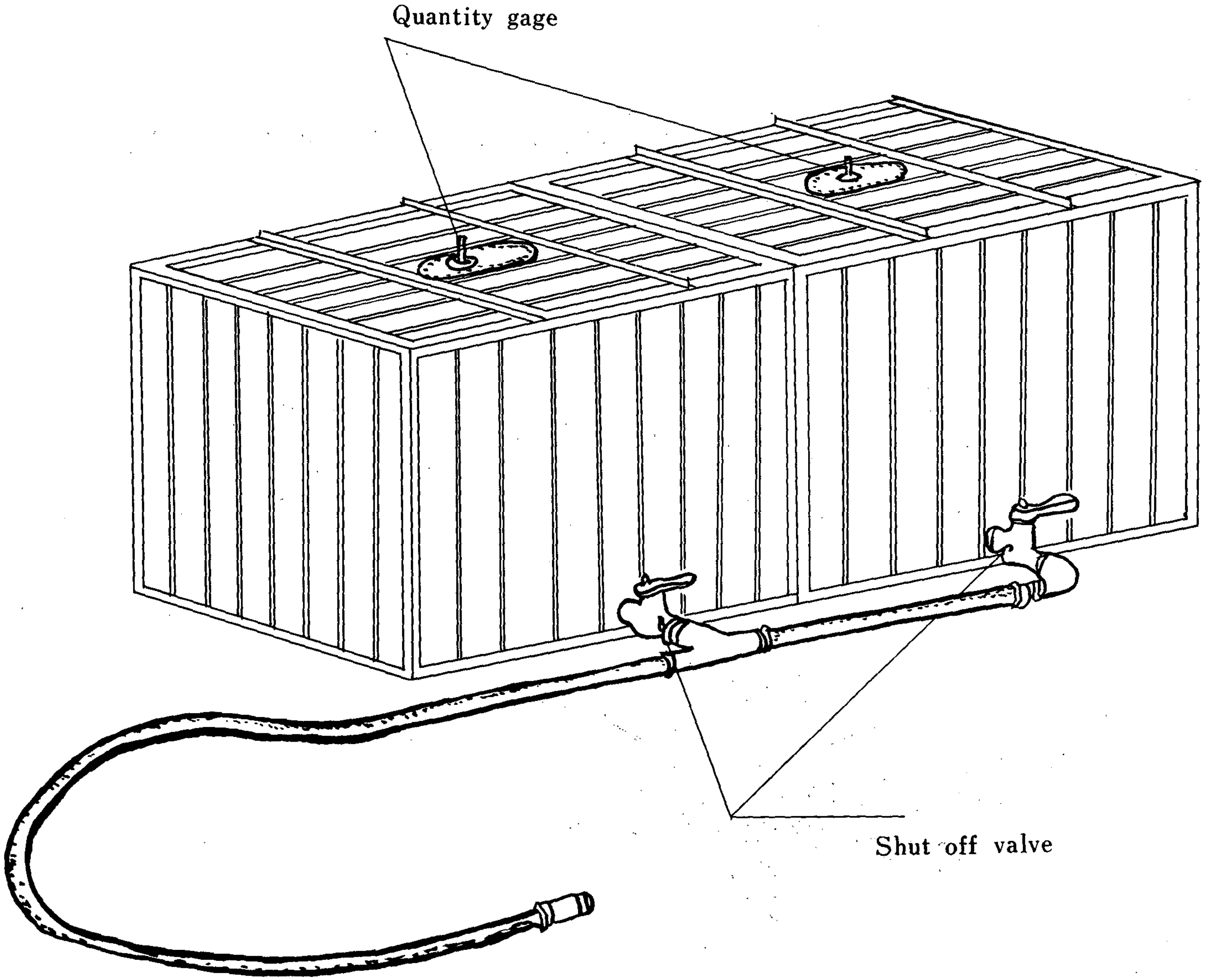


Fig. 5. Diagram of removable fuel tank.

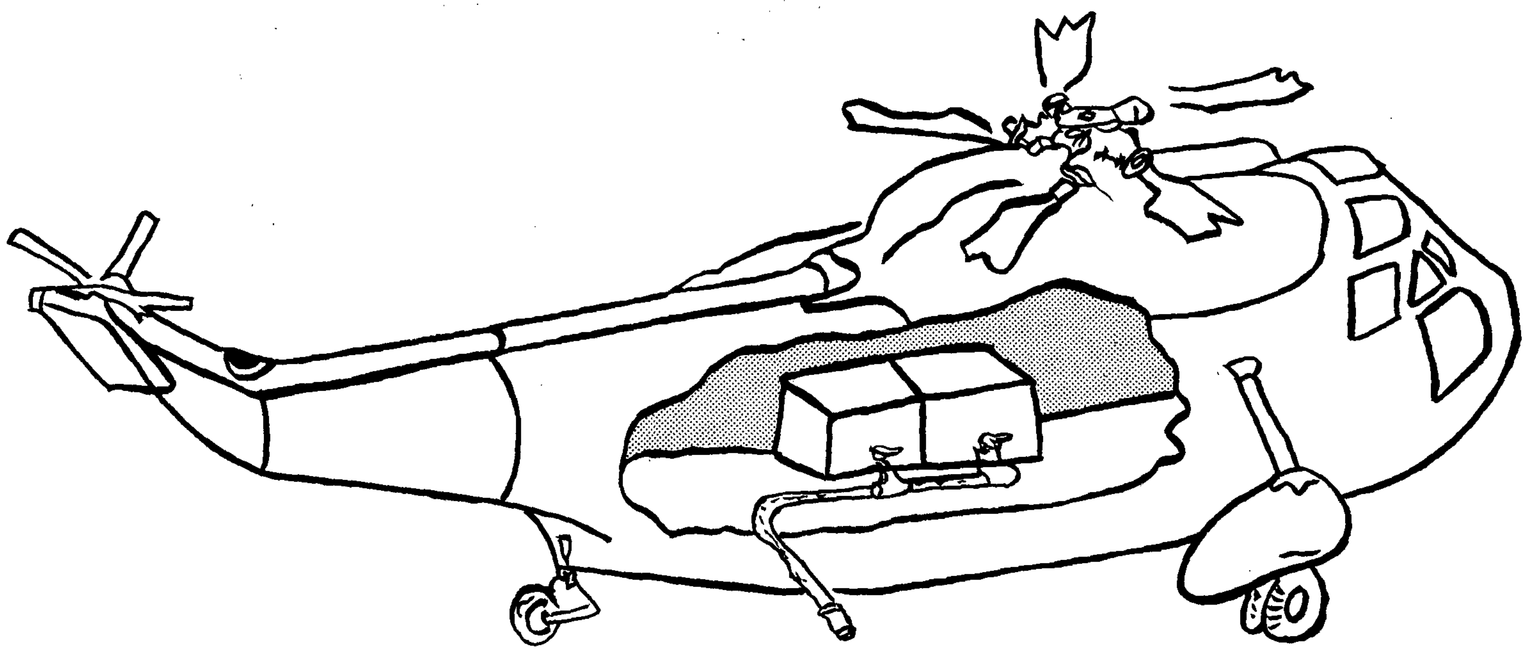


Fig. 6. Diagram of removable fuel tank installed.

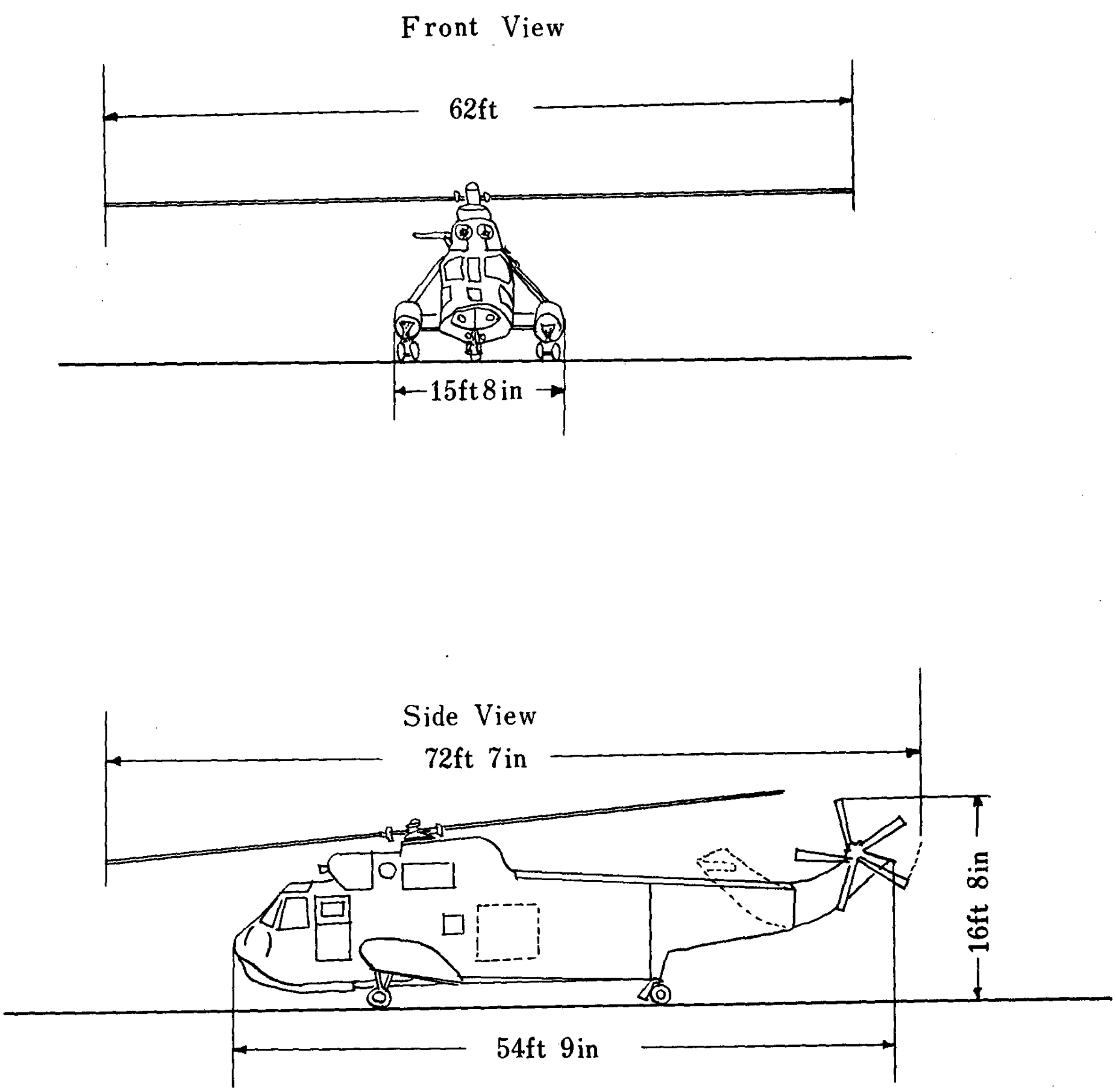


Fig. 7. S-61A helicopter.

NEW RESEARCH EXPEDITION SHIPS FOR THE SOVIET ANTARCTIC EXPEDITION

Representative of Soviet Union

A wide complex of scientific research in the Antarctic carried out by the Soviet Union in connection with the Antarctic Treaty involves, together with stationary works at the Antarctic Continent, marine research in the coastal seas and the subantarctic zone. For this purpose the Soviet Antarctic Expedition for a long time has used mainly the diesel-electric ship OB'. At the same time, being an expedition ship in a broad sense of the word, she carried out a number of other tasks.

A wide complex of oceanographic works in Antarctic waters has been limited because of the ship's obligations connected with the transport of cargo and scientific personnel to the four Soviet stations. That's why since 1967-1968 the Soviet Antarctic Expedition was assigned two new research ships PROFESSOR VIZE and PROFESSOR ZUBOV in addition to the d/e ship OB'.

The ships were built in the GDR in the Matias Tezen shipyard at Wismar and they have the following principal dimensions and specifications:

Length overall	123.89 m
Beam maximum	17.04 m
Depth (from the base line to the upper deck)........	10.81 m
Draft	6.06 m
Displacement	6.934 tons
Propulsion	8,000 hp
Speed	18.2 knots
Power supply plant	2,000 kw
Grew	85
Scientists	79
Endurance	50 days

The ships are built as the UL class of the Register of Shipping of the USSR and have up-to-date equipment such as active anti-rolling devises, an active rudder and jet propeller in the bow. There are 29 scientific laboratories on the ships. Their purpose is to provide a wide complex of research works in aerometeorology (with meteorological rocket launching), oceanography, geophysics. There are radio direction finding systems on the ships for location of various radiosondes and meteorological rockets.

A special boom of 8 m long is mounted in the ship's bow with actinometric sensors arranged on it with the purpose to exclude the influence of the ship's hull on them. The readings of the sensors are transmitted by the cable to the laboratory where recording devices are installed. One of the actinometric devices, pyranometer, is installed on an autonomous hydrostabilized platform. The synoptic and radio-synoptic laboratories, equipped with radio receivers, phototelegraph apparatus and telegraph-teletype apparatus, are at the disposal of analysts of the ship's weather bureau. The apparatus permits to carry out simultaneous reception of meteorological information through three channels and to transmit them using one channel.

The new ships also have equipment for carrying out a full complex of oceanographic research which is necessary for collecting material associated with the study of the structure of water masses and their dynamics. Ten special winches make it possible to conduct wide hydrological observations with the use of bathometers, thermobathygraphs, photothermographs and other instruments. Among the oceanographic instruments aboard the ships there are two thermohaline sondes, automatically measuring water temperature and salinity, while drifting, down to a depth of 500 m, an electromagnetic currnet meter, a radio wave meter and a radio current meter. The hydrochemical laboratory is well equipped with all the necessary instruments including an electro-salinity meter for chemical analysis of water samples.

A deep-water anchor installation consisting of two drums with about 20,000 m of 8 mm wire and a powerful winch ensure the ship's anchorning down to 6,000m. The same system together with two cargo booms can be used for establishing unattended buoy stations to measure currents in the ocean.

Continuous bathymetric soundings can be made during the whole voyage in the hydrographic laboratory with the help of echosounders.

The stern deck accomodates a device for launching meteorological rockets. The electronic computer is capable to process materials obtained as a result of the whole complex of hydrometeorological observations made by the ships. Powerful radio transmitting devices provide transmission of information obtained from any point of the world ocean to the reception centers.

The ships have an up-to-date navigation equipment which provides the high accuracy of the ships' position.

The hull plating of the ship is 16 to 24 mm thick.

Two diesels of 4,000 hp each rotate screws with a speed of 225 revolutions per minute. The power supply plant of the ship consisting of 5 diesel generators of 460 kw each completely provides with energy all the ship's installations and research apparatus in a maximum operational regime. A refrigerating plant permits to store up to 40 tons of perishable goods as well as to cool the air of artificial climate supplied by ventilation systems to living quarters and public rooms.

Active anti-rolling devices are two pairs of underwater wings, protruding from special niches, beyond the limits of the hull from the right and left board with the help of hydroulic devices. The angles of the turn of the underwater wings of the anti-rolling device are automatically set by an electronic unit depending on the period of rolling and the heeling angle.

On a streamlined rudder in a hollow space there is a propulsion installation consisting of a reversible electromotor with a screw. During the performance of this installation operated from the bridge the ship can move with a speed of 2.5 knots. This active rudder can be set perpendicular to the diametrical plane of the ship making the stern to move to the right or to the left.

In the ship's bow in two through cylinder tunnels set perpendicular to the diametrical plane of the ship there is a jet propeller consisting of two reversible electromotors with screws. When the jet propeller is in operation the ship's bow can move to the right or to the left. The active rudder and jet propeller are especially helpful when making hydrological stations.

Scientific staff and crew are accomodated in comfortable single and double rooms tastefully trimmed. The officer mess room accomodates 54 men. A beautiful interior trim, window plants and wall panels make this recreation site and mess room attractive. There are a piano, a TV set and radiogram in the mess room. And it can be used for showing of films.

The mess room for the crew accomodates 43 men and it is also trimmed beautifully and it is adjacent to the saloon accomodating a piano, a TV set and radiogram. A moving apart bulkhead makes it possible, if neccessary, to join the both rooms during public lectures, meetings and film-shows. The meetings of the Scientific and Technical Council and various conferences are conducted in a large conference-hall.

The ships meet all the requirements of the International Convention on the Savety of Life at Sea.

Nine water-tight bulkheads guarantee unsubmersibility during the flooding of any of the compartments. The closing of sliding doors can be made automatically from the wheel-house. Fire-proof doors also are locked automatically when thermal devices work in case of the indoor air temperature increase up to 70° C or by means of switching a special device in the wheel-house. There are temperature sensors in all the quarters and rooms that give fire-alarm in case of fire to the officer of the watch.

There are two motor life-boats each one for 34 men and two boats each one for 50 men with a -operated mechanical screw drive.

Due to the fact that these ships are well equipped with scientific apparatus and expedition equipment and provided with many laboratories these ships are capable to solve a wide range of problems connected with research in the ocean and seas.

In November 1967 one of these ships PROFESSOR VIZE left Leningrad for her maiden expedition voyage for the Antarctic.

En route to the Antarctic and back a wide complex of scientific observations and research on meteorology, actinometry, aerology, stratospheric cosmic ray soundings, oceanography, hydrography, radio propagation and radiometer and medical research were made.

At the same time during this voyage new ship's expedition equipment and instruments were tested in different latitudes and climatic zones. The voyage was a success and it has shown that the new research ships with their navigational characteristics and scientific equipment quite answer the purpose. The use of these ships is planned in both the ice free areas and in the areas of loose brash ice.

THE USE OF U.S. SATELLITE PHOTOGRAPHS FOR
SHIP NAVIGATION IN ANTARCTIC SEA ICE

Vivian Fuchs*

The Weddell Sea is notorious for the persistance and wide extent of the sea ice which is encountered. Other than its discoverer, Weddell, who penetrated to latitude 74° 15'S with the vessels Jane and Beaujoy in 1823, the only ships which had navigated these waters before 1956 were the Scotia (1904), Deutschland (1911) and Endurance (1915). The Scotia was beset off the Caird Coast for two weeks and escaped, but both the Deutschland and the Endurance were beset for mounths and the latter was finally lost when crushed by the ice.

Since 1956 Argentine and United Kingdom expeditions have annually penetrated many hundreds of miles of sea ice to reach the coastal stations established for the IGY. United States vessels have also made a number of voyage for the same purpose. Each year the ships have been compelled to find their way at random through heavy ice. For small polar vessels this has often meant long periods of slow erratic progress or besetment, and even the icebreakers have had to turn back to await easier conditions.

Often helicopters or seaplanes have been used to scout ahead of the ships and this has been of great assistance as, for instance, when an aircraft found a route for the Trans-Antarctic Expedition ship Theron which had been beset for almost five weeks. Nevertheless, such air reconnaissance is limited in the coverage which it can provide, and the basic problem is to knwo exactly where, in a particular year, to enter the ice to the best advantage. Through the years trial and error has shown that the most suitable approach is southward between 10 and 15 degrees west longitude. Usually ships aim at reaching the water lead which forms annually along the coast in the vicinity of Cape Norvegia. Even so, this is a hit and miss procedure which is not always easy.

It was therefore with great alacrity that in 1967 the British Antarctic Survey accepted the United States' offer to provide photographs

* British Antarctic Survey, London, England.

of the region taken from the ESSA-3 satellite which is in polar orbit. We considered that the cost would be offset if we could save even one day of a ship's passage time. As from 1st October 1967 these photographs were sent by airmail each week. As the time interval between successive orbits was approximately two hours, it was possible to differentiate the more rapidly moving cloud from the slower change of the sea ice cover. Interpretation was aided by the provision of lines of latitude and longitude superimposed on each photograph by computer.

When interpreting the pictures it is necessary to recognize that areas of water less than about 5 km across are not visible. Thus it is not generally possible to determine whether an extensive area of ice is unbroken or composed of floes of any particular density. The most satisfactory method of determining what guidance to give to a ship is to begin a study of the photographs early in the season and to follow the very gradual changes. As the break-up proceeds the interpreter will become sufficiently acquainted with the developing situation to be able to recognize and use information from pictures which include considerable amounts of cloud cover.

It has also been found useful to identify and follow a number of the ice forms which appear in increasing water areas. These can be used as indicators of directional movement and the degree of opening and closing of the pack ice in response to wind and current. It is not generally possible to differentiate between single large floes, conglomerations of floes and icebergs. It is, however, worth stating that a ship reported moving from 2/10ths ice to 9/10ths ice in the course of about 100 miles. On the photographs the whole distance appeared to comprise one ice field, but there was a gradation from grey-white to true white which appeared to represent the change from low to dense ice floe coverage. I might also mention that two very large icebergs, each about 45 miles (80 km) by 25 miles (40 km) were observed moving slowly south along the Princess Martha - Caird Coasts. It is thought that may be part of the large iceberg which broke out of Lützow-Holm Bay a few years ago.

In 1967 I began studying the photographs from 1st October, at which time there was little more than a narrow lead of water along Filchner Ice Front and some isolated areas along the east coast of the Antarctic Peninsuala. As the weeks passed the Filchner lead opened and closed, finally becoming a persistent wide lead. Along the Caird Coast isolated areas of water gradually joined up and became a constant lead of open water, from an estimated 5 miles (8 km) to 40 miles (65 km) in width and extending to the vicinity of Cape Norvegia. On the west side of the Weddell Sea the areas of open water which developed early on almost disappeared as the season advanced. They did not merge to form a coastal lead, presumably because once the consolidated pack began to move, it was pressed against the coast by wind and current.

A feature of the Antarctic Peninsula area was the persistent cloud cover, which made interpretation of the break-up spasmodic and to some degree uncertain. Even so it was possible to determine the appearance of water along the coast of Adelaide Island giving access to northern Marguerite Bay. By January the flooding of George VI Sound ice shelf, due to run-off from the mountains, could be seen as a thin dark line in the centre of the Sound.

For the British Antarctic Survey the critical time was the second week of January, when the Perla Dan and the John Biscoe were about to enter the ice on their way to Halley Bay. By this time it had been established that a massive area of ice some 250 miles (400 km) wide extended along the Princess Astrid Coast and widened westward in 20 to 23 degrees west logitude to some 400 miles (650 km), giving this vast area of ice the form of a "hummer head". From the photographs it seened clear that the best route by which to reach the Caird Coast was along longitude 23 degrees west, and this information, together with the position of the western margin of the "hammer head", was passed to the ships. No instruction was given that they should follow this advice, and it was realized that the previous experience of many years indicated that they ought to move into the ice at about 10 degrees west.

In the event the Perla Dan, which two days ahead of the John Biscoe, proceeded to 10 degrees west, where on 7th January she turned southward and made good progress to 66°30'S; here she was stopped by impenetrable ice on the 10th. Meanshile, on 8th January the John Biscoe turned south along longitude 20 degrees west in latitude 58°30'S. She entered ice in about 61°S and maintained good progress until the 11th. At this time a report was received in London that heavy ice had been encountered and no water was visible in any direction except north. A message was sent suggesting that she should try to force a passage for 60 miles (96 km) to the southwest, where she ought to be able to continue southward in relatively easy conditions. This was doen, and the remaining 550 miles (880 km) to Halley Bay was covered in four days, the ship arriving on 16th January.

After she was stopped by the ice on 10th January, the Perla Dan also received guiding messages an by the 14th she had reached the western edge of the "hammer head", where she could turn south again and follow the John Biscoe to Halley Bay where she arrived on the 18th.

From the foregoing account it will be seen that by following the advice given from London John Biscoe gained four days on the Perla Dan. Had the Perla Dan not lost those four days the financial saving would have been six times the cost of the satellite photographs.

What I have described is an extreme form of "back seat driving" and one must recognize that the Captain of a ship finds it hard to accept this.

One must also recognize that the appreciation of the ice situation from the satellite photographs is very different from the appreciation of the Captain on his bridge, or that of a helicopter pilot working with a ship. The satellite pictures provide the broad strategy, and sometimes encouragement, to the Captain when his surface view reveals no prospect ahead. The aircraft pilot acts more as an extension of the Captain's eyes; he cannot see the board strategy but provides a local tactical assessment. However good the strategy and the tactics, the Captain himself still has the moment-to-moment problem of working his ship through the ice - and this, after all, is what finally brings the vessel to her destination.

Finally, I wish to express sincere appreciation of United States technology and the generous way the facilities have been made available to us. The saving has not been pounds alone; more important is the reduced risk of besetment, less likelihood of damage to the ships and more efficient use of them.

Summary

The British Antarctic Survey received photographs of the seas surrounding the Antarctic Peninsula throughout the 1967-68 Antarctic navigation season. The frequency and clarity of these pictures is discussed in relation to the progression of large-scale ice movements during the season. A weekly ice situation report was given to British Antarctic Survey vessels by radio when the plotted ice distribution appeared liable to affect their operations.

SHIP OFFLOADING & DOCKING FACILITIES AT MCMURDO AND PALMER STATIONS

Walter J. Tudor *

Summary

Each year an ever-increasing amount of annual supply and maintenance cargo must be delivered by ice-strenghened ships and offloaded safely onto the Antarctic Continent. Since 95% of the various cargoes for McMurdo Station, and 100% to Palmer Station, are delivered by ship, good docking facilities play a vital role in the success of Operation DEEP FREEZE.

Something of a record was set by the first cargo resupply ship during Operation DEEP FREEZE '65 try McMurdo Sound's Elliott Quay on the ice periphey of Winter Quarters Bay. This ship was able to cut in half the usual time for offloading. Previously resupply ships were escorted by icebreakers to a distance of 8-10 miles from the main camp at McMurdo Sound. Making use of deadmen, the ships moored next to the ice shelf. Their cargoes were then carried over the rough bay ice to camp by tractor-drawn sleds. However, the continued use of this berthing facility, including roads, offloading pads, fuel lines, and bollards, is endangered by the erosion and undercutting of the vertical ice face of this wharf by wave, attack, tidal action, melt water runoff, solar radiation, and warm overboard ship discharge. To protect this ice wharf, 300 feet of permanent wharf facility has been designed for construction during DEEP FREEZE 69. This design consists of (1) steel piles placed on holes drilled in the permanent shore ice, (2) steel deck beams welded to the piles, (3) steel face beams to minus 20 feet below mean sea level, and (4) steel-plate timber bulkhead sections between the face beams.

At Palmer Station, resupply is by means of booming the cargo from the ship to amphibious landing craft which in turn form a ship-to-shore shuttle. To facilitate this resupply and to mainly support a research trawler a rock-filled, steel-sheet cellular pier was constructed at Palmer during DF 67. The design and construction of this pier at Palmer set a milestone by proving that dock construction under very adverse conditions on the Antarctic Peninsula is within the State-of-the-Art.

Future ship logistic facilities design in Antarctica must integrate very carefully the method of unloading, protection of harbor, number of months per year the harbor is ice free, tide range, thickness of ice, need for icebreakers and applicable hydrographic charts. The design must be adequate for operations yet simple enough to be constructed by a small construction force, and require little maintenance. A new era of unique offloading facilities and docking facilities for Antarctica is unfolding.

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Introduction

The Antarctic Treaty includes a provision that all ships at points of discharging or embarking cargoes or personnel in Antarctica shall be open at all times to inspection by designated observers. This provision presents no great problem to a properly docked ship. This treaty also prohibits the disposal of radioactive waste material in Antarctica. Consequently, all nuclear reactor waste materials from McMurdo Station must be taken to the dock in special containers and stored in the holds of the cargo ships for transport to the United States. Again, no docking problem. However, two of the biggest problems carried out under the auspices of the treaty are: (1) The immense "logistics" job facing the Deep Freeze fleet every austral summer season. An entire year's cargo must be transported to the Continent and unloaded. The term "logistics", as used here, can be humorously defined as something that if you haven't got, you haven't got anything! (Dufek, 1957*); (2) The accessibility to the land for ship-landings. In the past accessibility to Antarctica has governed the development of that Continent. Generally speaking, along the Antarctica coastline the land is largely glaciated and ice-cliffs or glaciers fringe all but a small part (less than 1 percent) of the coast. Ship logistic offloading facilities are highly important in order to speed-up developments and research in Antarctica and increase the efficiency of Deep Freeze operations. In Antarctica, ice and harsh environments will always remain a problem with regard to ship transport offloading and readiness for operation. There will be times when tidal currents or winds will push ice flows against the shore, through which it will be necessary to push in order to effect a landing.

Before discussing the docking facilities at McMurdo and Palmer Stations, it is informative to take a look at the characteristics of the ships involved and the types of cargo to be encountered.

Cargo and Ships to be Accommodated

Roughly 80 percent of all Deep Freeze cargo receive a packing or preservation effort prior to shipment. The items for construction effort require less packing since those items under contract usually include provisions for packing and preservation. Most Deep Freeze cargo packing and preservation provides a barrier overwrap for protection against moisture, cushioning with either styrofoam or paper wadding to protect against breakage, and the labelling of the item to provide identification, i.e., various color codes are applied to the corners of the boxes to indicate the station destination.

* Dufek, R. Adm. George J., "Operation Deep Freeze" P. 46, Harcourt, Brace & Co., New York 1957.

Materials from the same project and of the same type are packed together. Structural, electrical and mechanical items are not mixed together in a box. Any item packed in a box is carded. The box is then given a location on the ship.

MSTS ships going to McMurdo and Palmer Stations are given full ship cargo loads. Heavy lift requirements place limitations on the size and weight of large or massive cargo items. These ships have no capability for discharging items of extreme weight on the ice other than with the cargo handling gear on the ship. While some cargo is carried by the icebreakers, most is delivered by cargo ships and tankers of the MSTS.

One typical ship making the annual resupply to Antarctica is the fully,antarcticized USNS WYANDOT (T-AKA 92). The WYANDOT is a C2-S-B1 hull type. She is 459 feet overall, has a 63-foot beam and draws 24 feet fully loaded. Her crew numbers 50 when she is on regular cargo runs, but when operating in polar waters, she carries 5 additional crew members. This 7,313-deadweight-ton cargo ship can steam at 15.5 knots.

The WYANDOT has been extensively altered for Antarctic duty by receiving a full tensile steel outer skin, a nickel-bronze ice propeller, and an ice pick - a steel protuberance over her rudder to protect it from floating ice. She has four 30-ton booms and carries LCM-6's on deck. She has reefer space for 400 measurement tons of freeze and chill cargo in No. 3 lower tweendecks, and has walkaround space in all holds so that damage control personnel can reach the hull should the ship be damaged by ice when fully loaded.

The other annual cargo resupply ship, the USNS TOWLE, has a length of 455 feet, beam 62 feet, and rated speed 16.5 knots. Her gross tonnage is 7.771 and cargo capacity is 453,210 cubic feet.

Past Docking Procedures at McMurdo Station

Offloading of cargo from ship at McMurdo Station was accomplished over sea ice and barrier platforms. The ships moored directly against the edge of the bay ice just as they normally would along the side of a pier or quaywall (see figure). The mooring lines were secured to the ice with sea anchors or by using buried timbers (deadmen). Deadmen are usually preferred, because the timbers can be left in the ice upon departure and need not be dug up again.

A method occasionally employed by ice breakers and ice-strengthened cargo ships when mooring to the edge of the ice shelf is to force the ship into the ice until she is jammed securely from the bow back to about amidships. Ice anchors can then be set to keep the ship from sliding back out of its dock. However, the usual case was the cargo ship which eased in and moored along side the annual ice. Crew members then buried timbers in the ice and secured the ships lines. Hatches were opened by the Seabee stevedores of Deep Freeze, and the ships 30-ton booms began swinging the tons of supplies out from the hatches onto the waiting sleds for thier 8-12 mile run to McMurdo.

In the early days of Antarctic exploration, ships had to wait for nature to open McMurdo Sound. As an example, Scott's ship the DISCOVERY, with 49 men aboard, reached the pack ice at the international date line on New Year's Day, 1902. A week later, he was through the ice to the open Ross Sea. It was summertime in the Antarctic, and he proceeded down the coast into McMurdo Sound. Here he was able to set up a building on land to augment his ship at what he called Hut Point. His hut was thirty feet square in area, with a pyramid-shaped roof and a small porch enclosing the wooden building which still stands but now as a memorial.

Now the icebreakers cut a channel from the Sound to McMurdo Station and allow the ships to come in a little earlier then in years past. Deep Freeze 65 was the first year in the history of the operation when it was not necessary to unload cargo in the sea ice and haul it to McMurdo on sleds or to have tankers stay off as far as ten miles and pump their fuel ashore.

Present Docking at Hut Point, McMurdo Station

Early in the Deep Freeze 65 season, the USS Glacier (AGB-4) broke out the ice in Winter Quarters Bay to the tidal crack, and the remaining fast ice on the shore was prepared for ship berthing and cargo handling. Called Elliott Quay in honor of Capt. J.B. Elliott, Jr., USN, the quay provided the following facilities for the ships servicing McMurdo: (1) Berthing for up to five ships at least one of which could be a cargo ship of the Towle or Wyandot class; (2) Capability for working two tankers and one cargo ship simultaneously; (3) Sufficient wharf space and approach ramps to accommodate larger tractortrailer combinations and other heavy equipment needed for cargo handling; (4) Adequate area immediately adjacent to the quay for potential use as a cargo-segregation area or cargo-staging area. Roads, off-loading pads, fuel lines, bollards and even telephones have been installed to facilitate offloading operations.

Something of a record was set by the cargo ship USNS TOWLE during operation Deep Freeze 65. As the first ship to try out McMurdo Sound's new Elliott Quay, she was able to cut in half the usual time for off-loading onto the Antarctic ice. In previous seasons, a cargo ship spent a minimum of 8 days in "port", while the slow process of unloading went on. But the TOWLE spent only 4 days, 4 hours and 13 minutes discharging her cargo of 2,089 long tons and 6,404 measurement tons because of the new quay.

These Elliotts Quay facilities have been used in Deept Frrezes 65-68 but there presently remains one major problem, this being erosion and undercutting of the ice footing by wave and tidal action and also by the overboard discharge from the ships. As each season progresses, the ice edges of the quay calves making cargo operations hazardous due to the irregular distances between the ship and quay (see figure). There is also the danger of portions of the quay breaking under the weight of vehicles and their cargo. In places, because of the excessive distances between ship and quay, the ship had to be shifted to reduce the distances. A solution to this erosion problem has to be found or there will no longer be ample space to work cargo at the quay.

Permanent Dock Construction at McMurdo

A 300 foot section of permanent wharf facility has been designed and the material assembled at McMurdo Station for construction during Deep Freeze 69. The design selected for an initial portion of 900 foot long wharf structure consists of (see figure): (1) steel piles placed in holes drilled in the permanent shore ice; (2) steel deck beams welded to the piles; (3) steel face beams to minus 20 feet below mean sea level; and (4) steel-plate timberbulkhead sections between the face beams. Some of the other schemes considered were: (1) Aerial tramway with tower, winches, and cables; (2) Pontoon pier with pontoon floats requiring storage on shore at the end of the season; (3) Inland dock excavated into Hut Point; (4) Finger pier on piling; (5) Cofferdam cells with volcanic ash fill, (6) Cantilevered pier; (7) Sheet pile bulkhead; (8) Tower-and-cable supported suspension dock; and (9) Submerged drydock, covered with fill.

The U.S. Naval Civil Engineering Laboratory (NCEL) has cored into the ice footing to examine the consistency, stratification, and internal temperatures. This Laboratory has also installed test piles in the ice to determine tangential adfreeze values. These field values have been correlated with experimental values determined in NCEL's snow and ice Laboratory. As a result of these tests and further design studies, it was determined that placement of the piles into an augered hole and then allowed to back freeze was superior to steam-jetting or driving the piles.

Cargo Offloading at Palmer Station

Palmer Station is the only United States station to be supplied entirely by sea. The annual resupply cargo ship is escorted from Puntas Arensa, Chile, to Anvers Island by icebreaker. When Arthur Harbor is choked with thick ice floes the cargo ship lies about one mile offshore. During this time,the two turbine-powered HH-52A helicopters (convential helos would have taken longer) from the icebreaker shuttle the cargo ashore as follows. The lighter, unitized cargo is boomed from the cargo ship hold to the flight deck of the icebreaker where cargo handlers load the cargo into cargo nets. A helo then hovers over the net and lowers her cargo hook to which the net is attached. The helo then winches in the cargo hook and flies to shore (see figure) where the cargo net is lowered to cargo handlers that release the cargo net allowing the helo to return to the icebreaker for another shuttle load. By flying on half-full fuel tanks, the cargo weight can be raised to 600-800 pounds per cargo net.

When the wind, current, and tide clears Arthur Harbor the cargo ship offloads directly into LCM's and LCVP's which shuttle the cargo to shore. At the temporary station, a small tractractor was used to winch the conex boxes (102 x 75 x 82½ inches, with a tare weight of 1550 pounds and maximum capacity of 9,000 pounds) from the hold of the landing craft onto the shore (see figure).

The station is refueled with DF-1 by a floating fuel hose going from the icebreaker to the shore and then on land to bladders or tanks. The total hose length (ship hose and station hose) may reach over a mile. The icebreaker can maintain a pumping rate of about, 5,000 gallons per hour using the ship's fire and bilge pump.

Trawler Pier at Palmer Station

The mission of this station is oriented primarily to the sea and to marine programs that can be supported by an ice resistant wooden trawler stationed at Palmer as sea-ice conditions permit. Thus, it was necessary to provide an engineered and economic design of a functional shore facility at Arthur Harbor that would be primarily marine oriented, and yet located and constructed in such a manner as to facilitate the work of a trawler at the least possible operational and maintenance cost.

The environmental conditions are tied closely to the geographical location of Palmer Station. This location results in a mean annual temperature of +20° F and an average temperature of +10° F in the winter. During the summer construction season, the temperatures are never far removed from freezing and surface temperatures may rise to +40° and +50° F for short periods of time. There is no fast ice (ice permanently attached to the shore) along the station site. A maximum design thickness of 2 feet was estimated for the winter and brash ice. Water in the surrounding area is usually open even when Arthur Harbor might be clogged with wind and ocean current driven ice floes.

It was essential that the design of this wharf be simple but adequate in order to not only, (1) support and integrate the operations of the trawler and shore based biolab but also to (2) facilitate cargo resupply (3) be stable on a relatively steep, hard-rock bottom slope (4) resist and weather the probable wind, waves, and currents, especially the critical ice condition and (5) utilize the natural occurring supply of rock and boulders. It was further necessary that the wharf be designed for construction by a small Mobile Construction Battalion Detachment.

Therefore, the design had to be prefabricated to the greatest extend feasible, requireing minimal manpower efforts for operations and maintenance.

A rock-filled, steel sheet cellular design, (see figure) was considered most favorable. For this type, a crane is required for pile placement, and for proper toeing-in of the sheet piles, a trench was blasted along the front of the cells. The rock-filled, timber crib wharf scheme, was the second most favorable design and was somewhat more economical but presented certain difficulties in the underwater fabrication, stability, and field erection. The use of concrete, precast and poured-in-peace was also considered but because of climatic and logistic problems was not favored for this type of construction. A pontoon wharf, a self-elevating barge, a tramway, and other berthing schemes were examined but were found not feasible. Before mentioning some wharf details, it is interesting to note the characteristics of the ship for which this wharf is to be custom built.

The overall research trawler length will be 125 feet with a beam of 30 feet and have a draft of 12.5 feet. The hull is to be constructed from extra heavy oak, with steel bulkheads, for toughness against ice impact and abrasion. A sail was provided as an auxiliary power if the propeller is damaged or if the engine or shafting were put out of action. Aboard the trawler, there are to be compartments equipped for research studies in phytoplankton, microbiology and zoology as well as for recording underwater sounds and to perform gross anatomical studies.

Steel Sheet Pile Wharf Design

The factors leading to the selection of a steel sheet cellular wharf design are several. The 3/8" web steel sheet piling section chosen has the toughness and resilience and interlocking strength (8000 lb/inch) to enable it to withstand rough handling and battering during construction, and the subsequent stresses and impacts of service. It is a finished product ready for use as shipped by the manufacturer. The steel section can be stored, handled, setup and placed in comparatively small units, simplifying problems of erection and equipment. Its installation is less dependent on facorable temperatures or weather conditions and may be independent of other construction operations. The use of a circular erection template was required.

Ordinarily, in cellular construction the filled structure represents a gravity wall that does not require a horizontal support at the toe. However, in this case it was necessary to secure additional support at the toe by means of a trench in the rock bottom. The trench is designed to be blast-excavated by a submerged line of commercially obtained, shaped charges. Cathodic protection is not provided for the steel sheet piling because of the low corrosion rate in these antarctic waters.

The outer cells have timber and rubber fender to prevent possible damage to the trawler when docking or moored alongside. The daily tidal variation is approximately 4 feet and the water currents are regligible.

Alternate Wood Crib Wharf Design

Timber cribwork is suitable for a rock bottom such as that existing at the site and has an advantage in that it requires no special equipment or skill for fabrication and erection. For instance, the entire cribbing for a whaef can be transported on board a cargo ship in 10-foot modules or the modules can be assembled on shore from pre-cut and drilled timbers and then launched, floated to the wharf site and ballasted. Each crib structure consists essentially of horizontal timbers laid up in alternate courses to from pockets. The individual timbers selected for the crib design were 10 x 10's or 10 x 12's and were fastened with split ring connectors, bolts and drift pins. The cribs are strengthened by the addition of corner verticals. In order to eliminate extensive blasting and dredging, the overall wharf crib can be designed with its bottom "tailored" to fit the existing bottom as disclosed by soundings. Untreated timbers were to be used because of the low biological activity. This design, in the final analysis, was not selected because of reason previously stated.

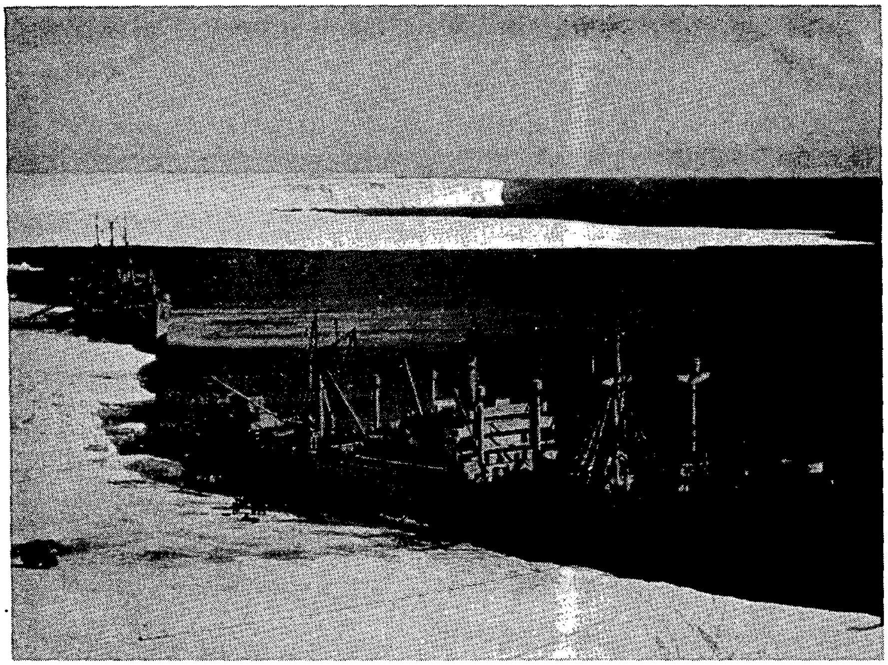
The construction pier of this facility was of considerable importance, not only becuase of the significance the facility holds for Antarctic science, but also because it represents a design of a uniquely engineered facility suited in this part of Antarctica.

Future

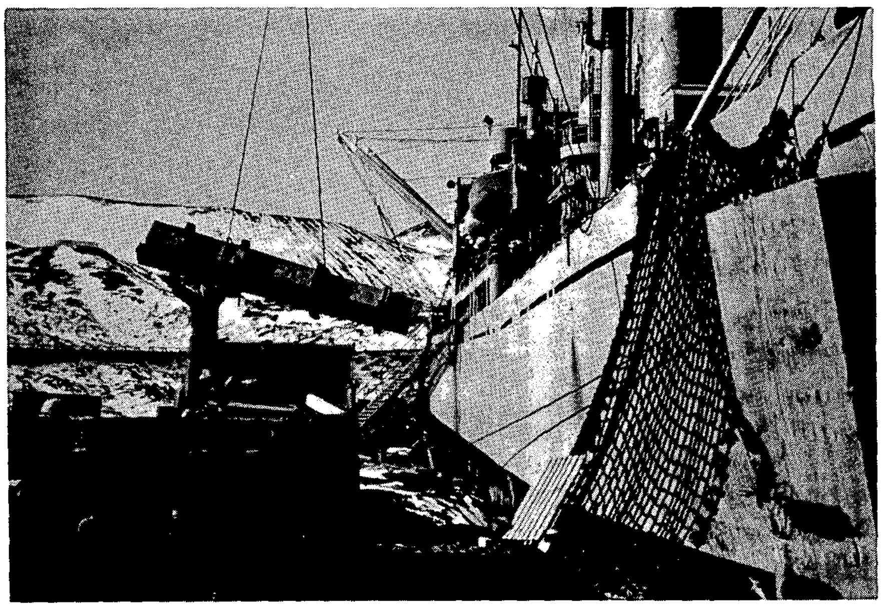
The biggest unknowns in the future design of docking facilities in Antarctica are the innumerable ways in which ice can affect the pier or wharf structure. The most significant force 6 to 8 feet of annual ice that can cause crushing and bending of structural members. Permafrost conditions and problems have not to date presented obstacles. Because of the tide and ice spray, the frozen ice on the structural members can cause large downward vertical forces at low tide and upward buoyant forces during high tide. There are ice sheet bending forces introduced by ice breakers and expansion of entrapped water as it freezes. The impact by berthing ships not aided by tugs, and the wave attack, and the impact by large floating ice sheets and small bergs are parts of the environment to be contended with. Engineering construction on the ice also involves many things that disturb the thermal regime. The creation of permanent shadows on ground area, and the radiation of heat down through uninsulated structural members in the ice may create new thermal conditions which result in a change in the level of the thermal regime.

With the increasing use of containers and the lessening use of break-bulk dry cargo handling, it appears reasonably that a container-wharf may find a place at McMurdo Station. These containers withe cross-section 8 x 8 ft. and lengths of 10, 20, 30, and 40 ft. greatly reduce the man-power required by cargo handlers. The usual stateside container-port and marshalling yard concept will have to be modified to Antarctic duty providing a suitable shipboard crane. A shore-based portal crane does not appear practical, although a mobile crane may be able to handle the containers efficiently.

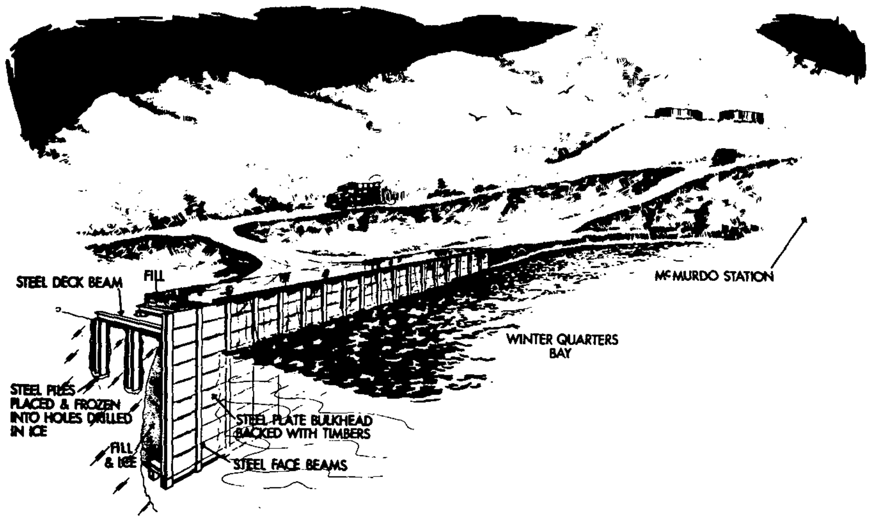
A new era of unique offloading and docking facilities for Antarctica is unfolding. Antarctica waterfront facility design still represents a new frontier and offers adventure, excitement, the tests of endurance and the challenge of the unknown.



OFF-LOADING ON ANNUAL ICE BEFORE DF65
8 MILES FROM MCMURDO STATION



OFF-LOADING CARGO ON ELLIOTT'S QUAY
MCMURDO STATION DF68



WHARF CONSTRUCTION ON SHORE ICE SHELF
MCMURDO STATION, ANTARCTICA

Winching Conex Boxes Ashore — Temporary Palmer Station

Helicopter Cargo Shuttle at Palmer Station

Small Craft Pier at Palmer Station

AN ANTARCTIC SURGERY: SOME DESIGN FACTORS

G.D.P. Smith* and D.J. Lugg**

Abstract

This paper discusses factors influencing the design of Antarctic medical buildings: such factors include treatment of patients, operations, nursing and physiological research. Climatic conditions and anaesthetics techniques call for particular care in the design of operating theatres. Siting and functional layout of medical buildings is described, also fittings, equipment and services.

1. Introduction

The Australian National Antarctic Research Expeditions (ANARE) has now completed over 20 years of continuous manning of its stations both on the Antarctic continent and sub-Antarctic islands. Severe accidents and illnesses have been relatively rare when one considers the type of activity at the stations, and the period during which the stations have been manned. Despite the low morbidity (the fitness of the men chosen and the healthy climate have no doubt contributed to this) improvements to the medical resources have taken place each year since the first expedition to Heard Island in 1947. In 1964 a modern surgery was erected at Mawson, followed by one at Macquarie Island in 1968, and a new medical suite at Repstat in 1967. The buildings are the result of close collaboration of the ANARE design group and the medical officers who have spent one or more years in the Antarctic. The late Dr. Z. Soucek, as Senior Medical Officer of the Antarctic Division, gave very valuable professional advice during the development of the current design of the Antarctic medical buildings.

2. Size of Expeditions

The medical suite must cater for an expedition complement which has varied in number from 4 to 33 during the wintering period. At changeover this number is greatly increased by both the new party, supernumeraries and members of the relief ship's crew.

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3. Isolation of Expedition

The evacuation of personnel from the sub-Antarctic island stations can be accomplished with some difficulty throughout the entire year by ship, the Australian Navy and the Merchant Marine having repatriated expedition members on several occasions. On two occasions, seriously ill patients have been evacuated from ANARE continental station by air. Pardoe(1) has described one of these emergencies, and both he and Budd(2) have pointed out the difficulties of evacuation from ANARE continental stations. Normally, however, as there are no permanently based aircraft capable of flying to the outside world, evacuation is limited to about six weeks in the summer months when the expedition ships can penetrate the pack ice. As evacuation is not commonplace, the treatment of serious and protracted illnesses may have to be carried out for periods of up to eleven months. The medical suite must therefore be capable of providing long-term specialised treatment and nursing facilities.

4. Medical Building Design Features

The conditions treated at ANARE stations are varied. Minor traumatic injuries are common because of the type of work done at the station, and dental emergencies are frequent. Not all of the emergencies are minor ones; fatal accidents and near fatalities have occurred. Appendicitis, chest injuries, multiple injuries, severe burns and trauma, frostbite, polio, schizophrenia, lung cancer and cancer of the bowel have all occurred at ANARE stations. The current ANARE medical buildings, therefore, are designed to provide stuitable facilities for the following functions.

4.1 Consultation and minor treatment

The medical suite needs a good consulting room and casualty-type treatment area for minor conditions, as well as a more sophisticated area for operating and nursing. ANARE medical records show that counselling forms a large part of the Medical Officer's practice, and the consulting room is designed to this end - pleasant surroundings of a para-medical nature. This area is equipped with desk, chairs, and examination couch.

4.2 Surgery and anaesthetics

Operations have been performed for reduction of fractured limbs, excision of an injured eye, craniotomy for ruptured intracranial aneurysm, and amputation of frostbitten extremities. An appendicectomy is carried out about every two years. In the early surgery buildings, the main room, which was used for general medical work, also had to be used as an operating theatre whenever an emergency arose. This entailed much time and work.

Pardoe's[1] description of the conversion of the Mawson surgery to a sterile operating theatre, is typical of this problem. The present design incorporates an operating theatre which can be kept separate from the rest of the suite, hence it is always in a "clean" state and requires very little work to bring it to a "sterile" state. An autoclave is also provided, which precludes the necessity for sterilization of instruments in a kitchen pressure-cooker.

The problems of anaesthesia in Antarctica have been reviewed by Nunn[3], and the anaesthetic practice at ANARE stations has been fully described by Lugg.[4] As is the case at most wintering Antarctic expeditions, the ANARE stations have only one medical officer. If any anaesthetic is required, the medical officer must start the process and then supervise the maintenance as he proceeds with the operation. Prior to sailing from Australia, two expedition members are trained in the use of anaesthetic agents: depending on the individual, training ranges from the use of open ether and halothane to intravenous anaesthetic agents.

The problem of volatile agents, such as ether, not being able to be used because of the type of heating system present (Houk[5]) has been completely eliminated by heating the surgeries by non-inflammable systems. Gases used during anaesthesia (oxygen, introus oxide) are supplied from cylinders, and the theatres are quipped with conventional portable anaesthetic machines. No problems of altitude are encountered at ANARE stations, because all are at sea level.

Operating theatres are designed to conform to the Standards Association of Australia Flammable Medical Agents Safety Code (AS CZ9). The combining of these precautionary features with functional convenience has produced an adequate facility. Current design features include:

Dimensions: 12 ft x 12 ft floor area x 9 ft ceiling height.

Electrical: A high level of illumination is provided by fluorescent ceiling units, augmented by operating floodlights. Wiring, switchgear and power outlets are installed above the 5 feet-high hazardous zone.

Mechanical ventilation and air conditioning:

Heating is supplied by a panel radiator on the station's hot water central heating system. Nine changes of air per hour are effected by a heated fresh-air inlet just below ceiling level and an exhaust fan and duct a floor level. The requirement laid down in AS CZ9 has now been reduced to two changes per hour. A humidifier maintains a relative himidity of 50%.

Water supply: Hot and cold water is supplied to a stainless steel sink. Outlet cocks are equipped with elbowoperated handles.

Equipment: Operating tables, which are of modern design, trolleys, instrument cupboards and other equipment, comply with the conductivity requirements of AS CZ9.

Floor covering: Anti-static, carbon impregnated, vinyl floor-tiles are laid over an earthed grid of conductive copper foil, the whole being laid to meet AS CZ9 specifications for resistance to earth (25,000 Ohms - 500,000 Ohms). The exceptionally dry atmosphere at Antarctic stations accentuates the problems associated with static discharge.

4.3 Sick bay

In the past, difficulties have been encountered when serious illnesses have been nursed in a sleeping cubicle in a standard sleeping block (6) The main problems are the difficulty in nursing a sick patient in a bunk some five to six feet above the floor, the lack of ready access to medical equipment and supplies (at some stations the surgery is a considerable distance from the sleeping quarters), and the difficulty of isolating an infective case (e.g. polio) from the rest of the station. The two-bed sick bays in the new medical suites provide satisfactory facilities for the accommodation and nursing of patients. The provision of a low-level bunk, as well as a hospital bad, allows the Medical Officer to occupy the sick bay when a critical case requires close observation. The second bed may otherwise serve as extra-patient accommodation.

4.4 Medical research

The medical officers have carried out a considerable amount of medical and biological studies over the years. This includes human physiology, immunology, and haematology, as well as biology. Bacteriological and virological studies have also been pursued, and the provision of a separate research room, apart from the main medical area, is very important when these are under study. These research areas are equipped with sink, benches, storage cabinets and suitable power and light facilities.

4.5 Medical library

A comprehensive medical library is kept in the consulting room.

4.6 Equipment

X-ray equipment;

dental equipment;

autoclave and other sterilising equipment;

anaesthetic equipment;

operating table, light, surgical instruments, etc.;

hospital beds, examination couch;

refrigerator;

research - microscope, freeze drier, centrifuge.

4.7 Siting

Medical buildings are usually sited close to kitchen and laundry facilities. The Repstat medical suite occupies portion of a standard, elevated 36 ft x 24 ft building, the remainder of the building being a food store which is separated by a sealed, insulated wall. Entrance and internal doors are sited with a view to the movement of patients between the functional areas, and ready access for stretcher cases.

4.8 Services

Heating is provided from the stations' hot-water central heating systems, and 240 volt, 50 Hz, AC power is supplied. Water sources vary according to station resources, but in all cases a hot and cold supply is reticulated to the operating theatres and research laboratories.

4.9 Floor coverings

Anti-static vinyl tiles or sheeting are laid as described in section 4.2. The other rooms are covered with sound-reducing vinyl-faced cork sheeting.

4.10 Structural design

Medical buildings are basically pre-fabricated panel, insulated, standard ANARE buildings of current design[6]. These buildings are erected at the manufacturer's premises before packing and shipping to Antarctica. During this trial erection, the ventilating equipment is fitted and cupboards, benches, and furniture installed. During this period, ANARE medical officers inspect the completed premises and plan the functional operation of the various facilities.

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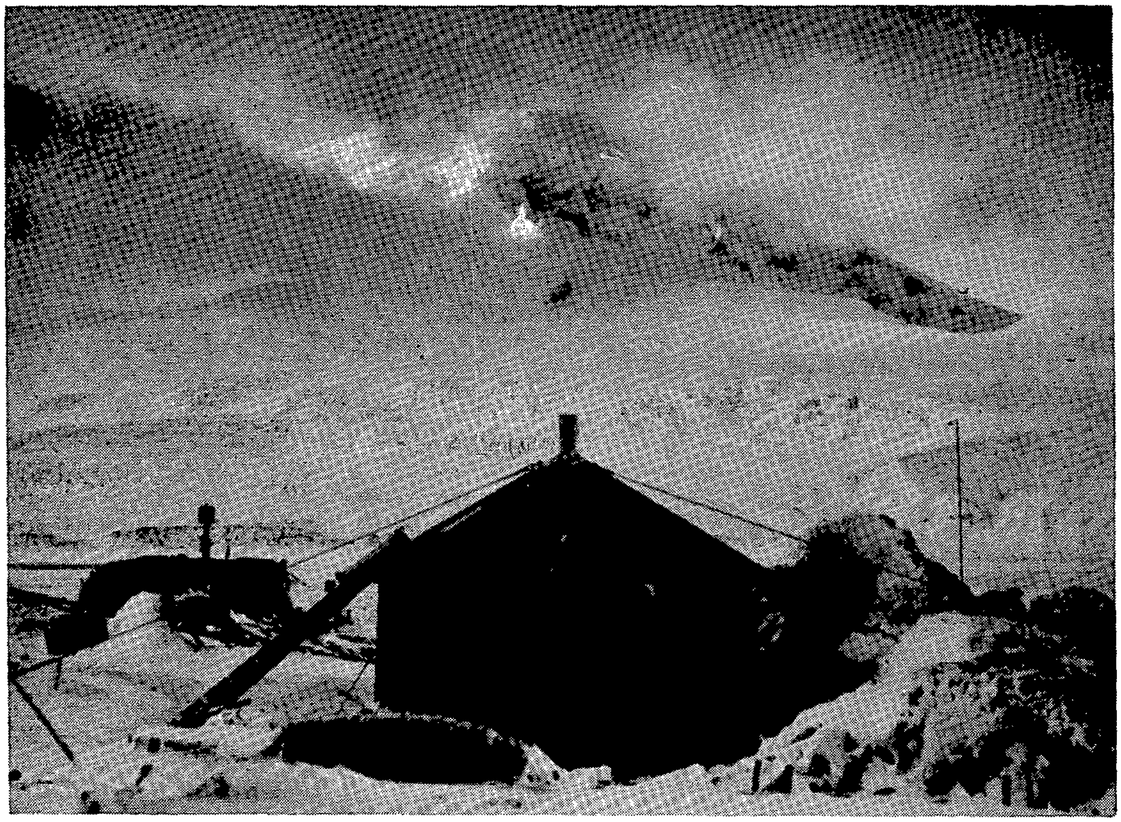
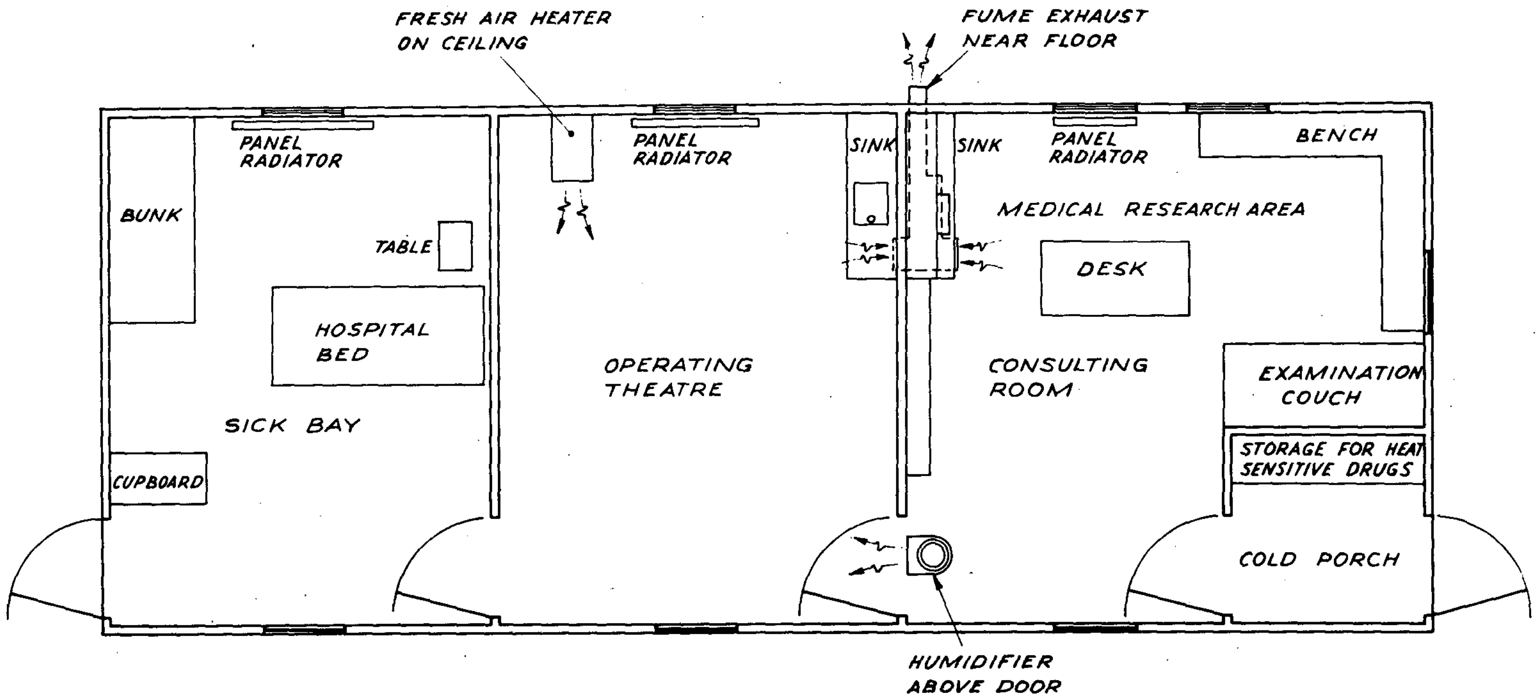


ANARE photo 383

Fig. 1. First ANARE medical building at Heard Island.
This tougue-and-groove pine building had been erected by the crew of the South African whaling vessel KILDALKEY in January 1929. In 1947, the first ANARE medical officer, adapted it to suit his activities.



ANARE Drawing 2/68/10

Fig. 2. Layout of Macquarie Island medical building.

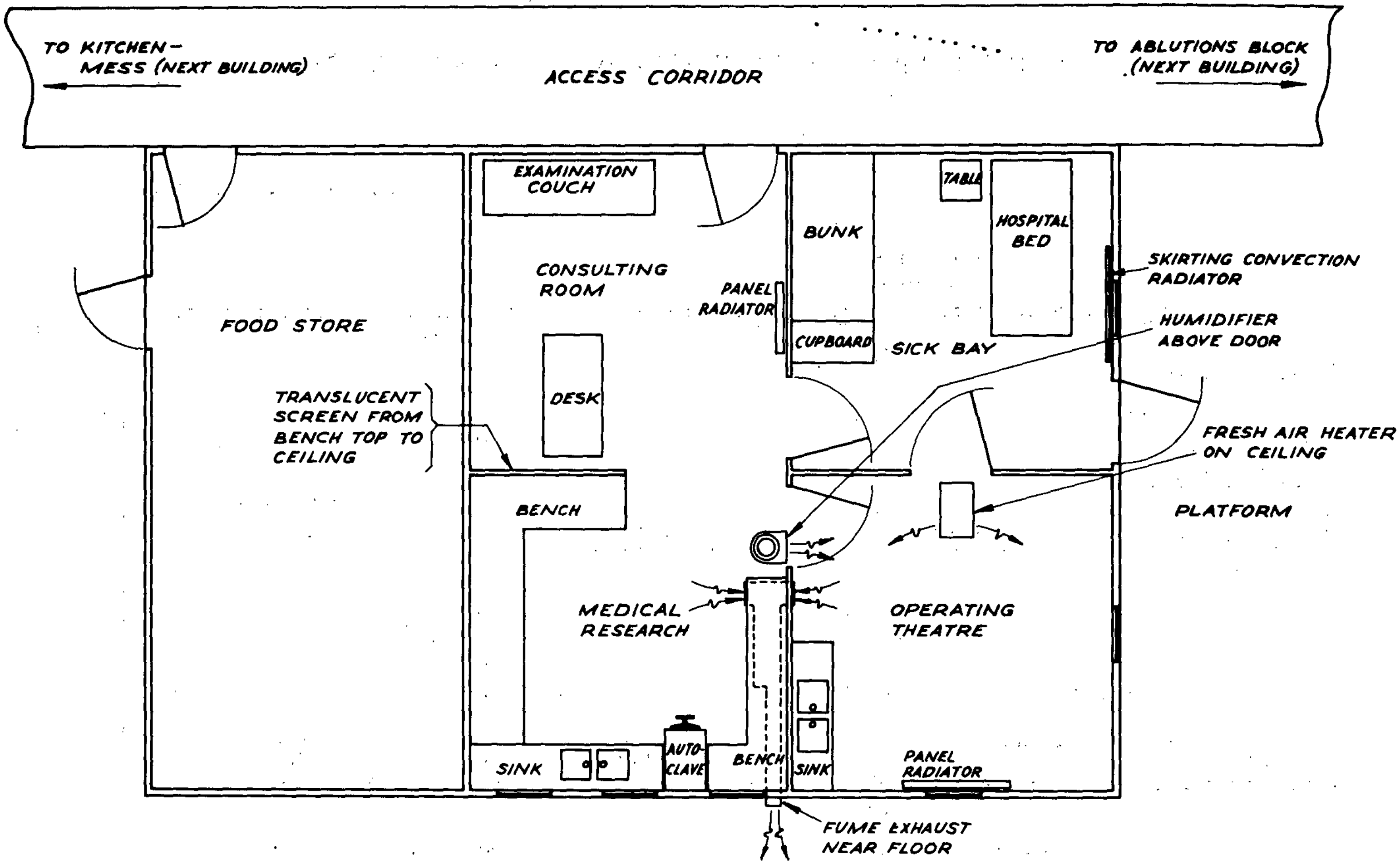


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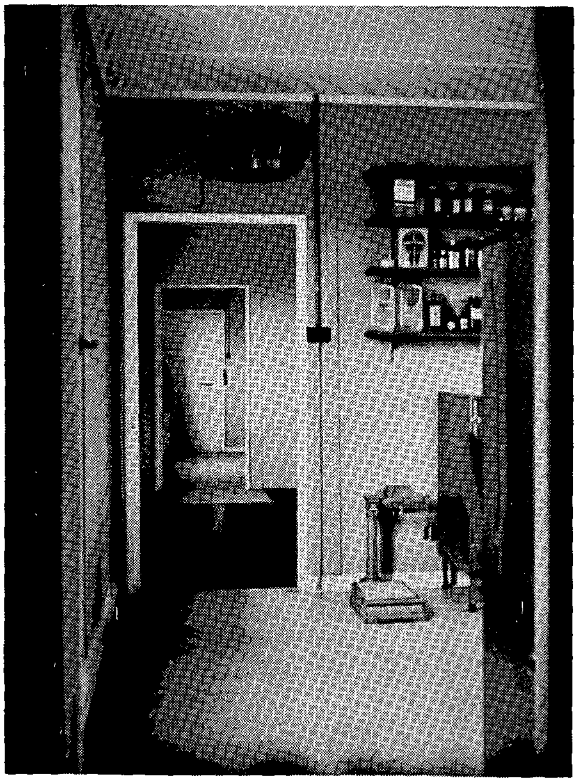
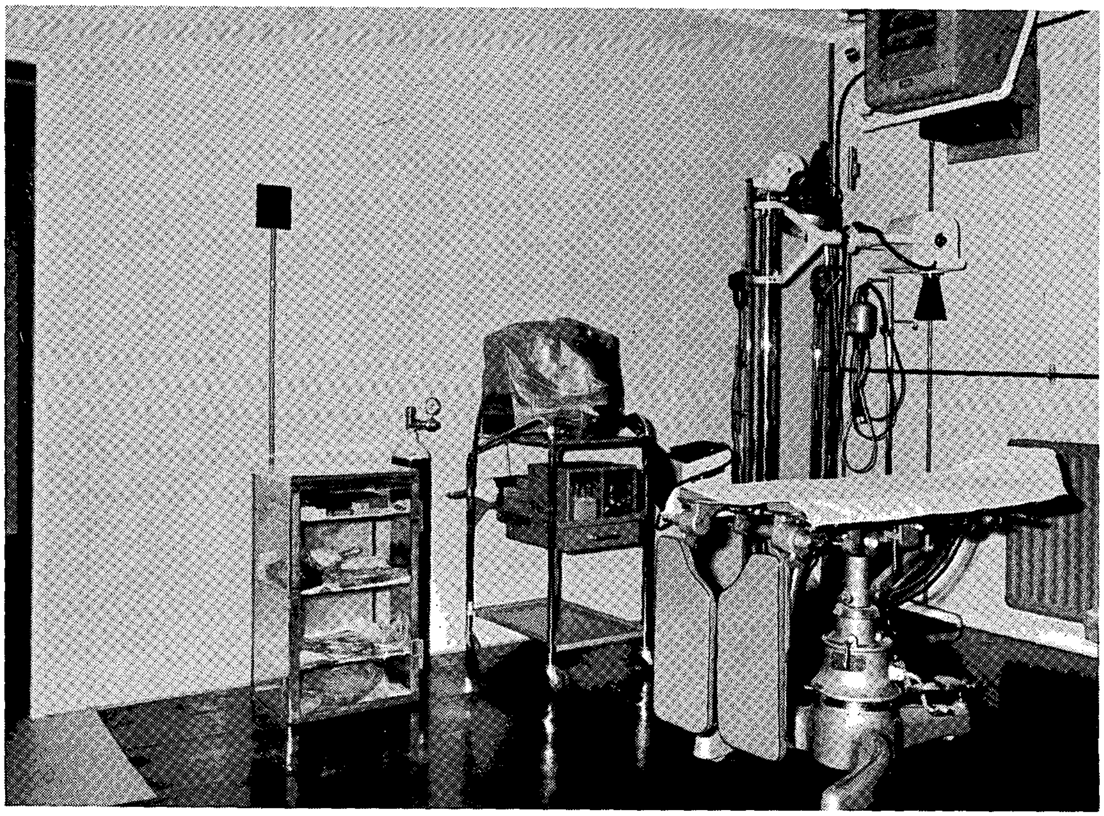
Fig. 3. Layout of Repstat medical suite.



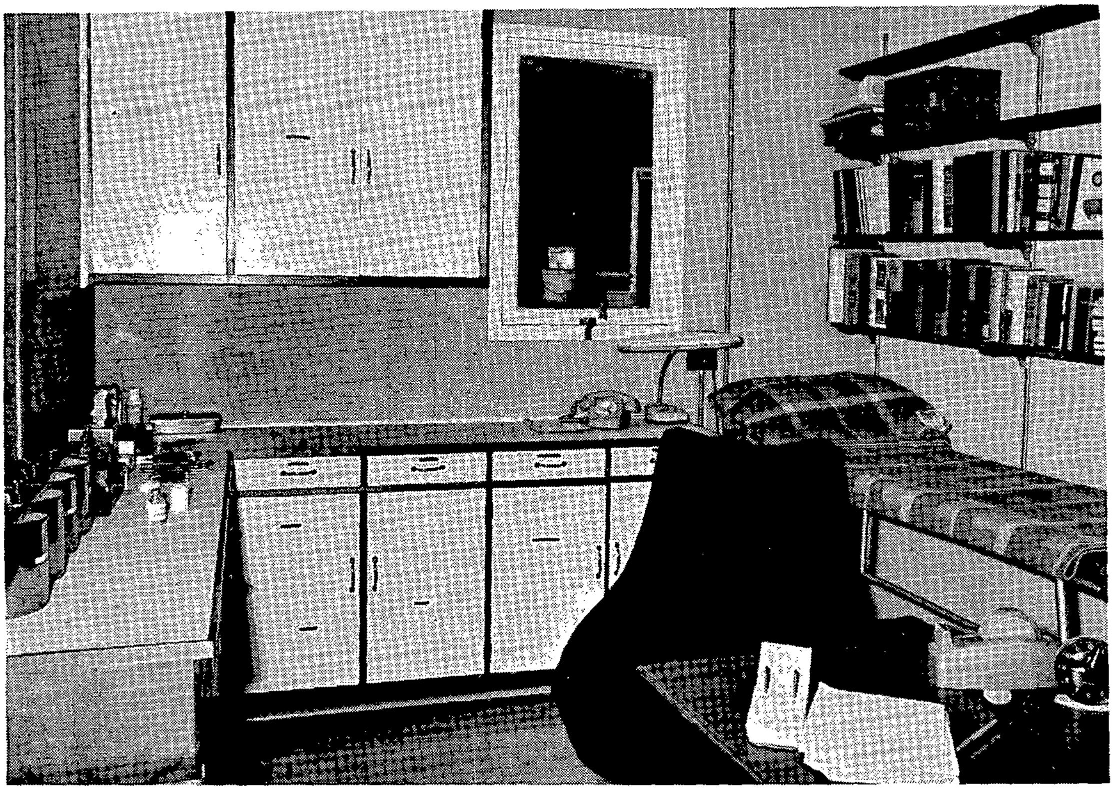
ANARE photo 17890

Fig. 4.
View through Macquarie Island medical building. Doors in line allow convenient movement of patients.



ANARE photo 17891

Fig. 5. Operating theatre, Macquarie Island medical building.

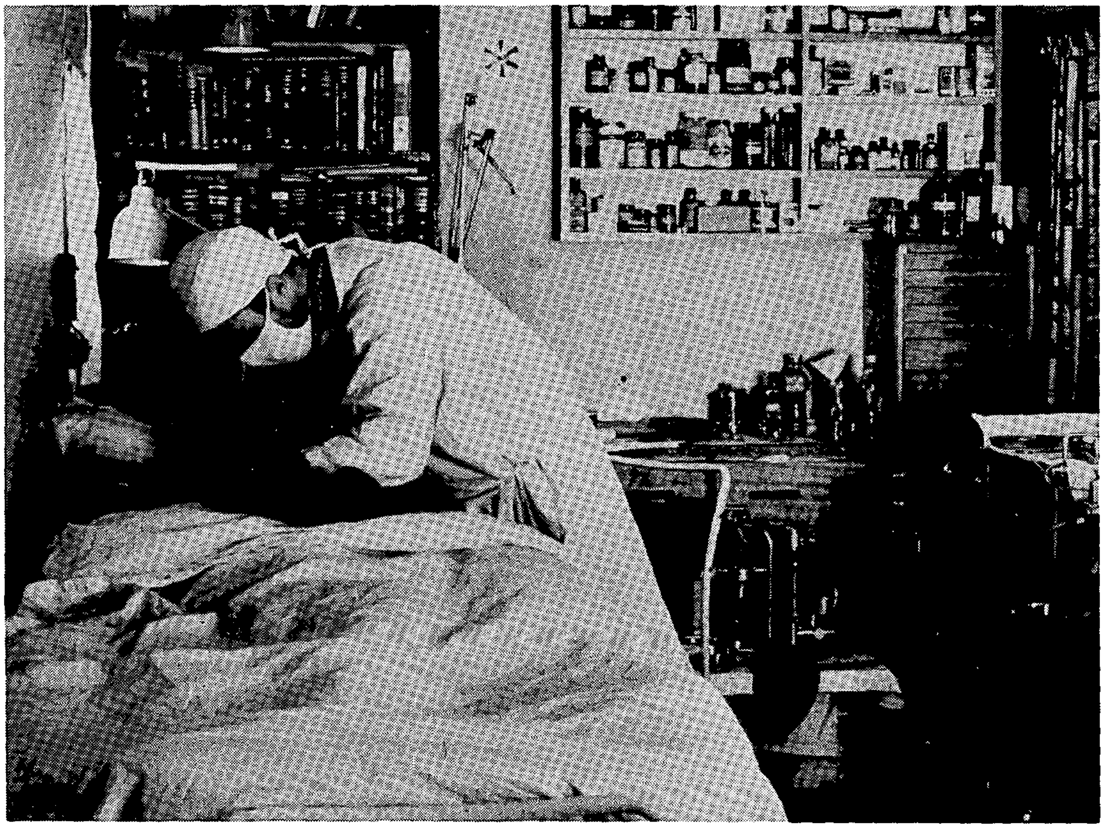


ANARE photo 17897

Fig. 6. Consulting and research room, Macquarie Island medical building.

Dept. of Works photo 1590-D

Fig. 7. Medical research laboratory in new Repstat medical suite.



ANARE photo 17077

Fig. 8.

A patient being nursed in an early ANARE medical building.
The desirability of a separate nursing area is clearly indicated.

FIELD TRAINING IN AUSTRALIA FOR ANTARCTIC EXPEDITIONS

N. Linton-Smith*

Abstract

ANARE men are all trained in the correct use of camping and other field equipment, and the special camping rations, before leaving Australia. Normally, training is given when snow is out of season and only expeditioners with very special roles are trained in the snow. The use of mountaineering techniques and safety equipment is emphasized, so preparing all expeditioners for a crevasse accident and rescue.

Each member of the wintering parties attends a camp in Australia, where he is instructed in the correct use of Antarctic camping equipment and some of the gear used on traverses in Antarctica. The extent of the training given depends on the type of expedition being prepared, the experience of the men, the amount of time that can be spared and the avaiability of equipment. Also, snoe is found only in the south-eastern states of Victoria and New South Wales, and reliable snow fields exist only at levels above 4,500 feet. Suitable areas for snow-training camps are not easily accessible and the season is usually limited to a duration of three months or less. The recruiting programme of the Division is timed so that the majority of expeditioners join us at the end of the snow season. These men must then attend training camps in spring or summer with no snow available. In fact, it is susally very warm.

Some expeditioners are engaged earlier and are given snow fields training because of special roles they will play in Antarctica. An example of this is the Amery Ice Shelf expedition, a four-man party which will spend all of 1968 in the field at a distance of some 300 miles from the nearest station, Mawson, having only surface transport available to them in the event of evacuation becoming necessary. Two members of this expedition were taken to snow-covered Mount Hotham, together with the Wilkes glaciologist and the author, who planned the exercise and instructed the group. A week was spent under canvas. Instruction was given in the correct use of camping equipment, skis, motor toboggans, rations and clothing. Survival techniques, such as the building of igloos and snow trenches, were practised, and new equipment was tested. Most of the time was spend skiing because this activity is the most difficult to master. The need for safety at all times was stressed, especially while skiing. The men were thus enabled to become familiar with their new environment so that they could perform any normal task competently and safely.

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Melbourne, Australia.

Owing to the lack of snow, the spring and summer camps take a different form. The camps are held in hilly, forest country, the duration is two days each, and about thirty men are accommodated at each camp. The men live in ANARE tent, using ANARE rations and other equipment. As travelling over snow cannot be practised at this time, various aspects of snow-craft are studied and demonstrated.

The first half-day is spent in travelling to the camp site and setting up camp after the men have been instructed in the correct use of all the equipment. The next day is spent on a bush walk of approximately fourteen miles. This walk is also a mapreading and compass exercise, under the direction of the Georgraphic Officer, in which certain map reference points have to be identified on the track and compass bearings have to be taken. The next half-day is occupied with mountaincraft and crevasserescue demonstrations, breaking camp and returning home.

Each man is issued with a copy of the FMC Basic Instruction Manual, published by the Federated Mountain Clubs of New Zealand, for use by mountaincraft instructors. In the Australian-occupied part of Antarctica very little mountainclimbing has been done or needs to be done, and a thorough knowledge of mountaincraft is not needed by most expeditioners. However, every man on field trips in Antarctica will have to be able to contend with crevasses, and the Division aims to give him sufficient knowledge of mountaineering techniques and equipment in order to cross crevassed country safely on foot or in vehicles, and to effect rescues from crevasses. The training therefore starts with a demonstration of the basic tools of the snow-and-ice climber, such as karabiners, safety rope, pitons, piton hammers, ice axes, crampons, slings and prusik loops. Heavier and more sophisticated equipment, such as lightweight aluminium ladders, rope-climbing clamps, light-weight pulley hoists and rescue harnesses are then demonstrated. The men are taught the following knots: the reef knot, clove hitch, figure-of-eight, tarbuck and bowline.

A cliffside or quarry face, about 40 feet high, is used to simulate a crevasse-rescue operation. To do this the instructor and another man rope themselves up as on page 20 of the FMC Manual and station themselves, one at the top and the other at the bottom. Two methods of recovery are demonstrated: the single-rope method in which the man ascends a single stationary rope, using two prusik footloops and one prusik shoulder loop, and the two-rope method in which the man ascends by means of footloops at the bottom of each rope, the ropes being drawn up one after the other by the man at the top, prusik loops being used to anchor them. Both methods are described on pages 20 to 24.

The participation of expeditioners in these exercises is keen, outdoor interests and activities being one of the criteria considered in making personnel selections.

SAFETY MEASURES IN THE SOVIET ANTARCTIC EXPEDITION

Representative of Soviet Union

Soviet polar explorers started Antarctic exploration haveing a long-term experience gained in the Arctic. The repeated participation in the Arctic expeditions, construction of polar coastal stations and ice-drifting stations in the Central Arctic Basin, airborne and marine expeditions to the ice-invested waters of the Arctic Ocean created certain standards of human behaviour in the peculiar environment of the polar zones.

From the very first days in the Antarctic the Soviet polar men have begun to acquire the practice of life and work in the new environment, which differs slightly from that of in the Arctic and at the same time has much in common with it. Much of the Arctic experience, therefore, could be transfered to the Antarctic.

The accumulated experience had to be summarized and systematyzed and made in a convenient form to be used by the numerous members of the Antarctic expeditions, comprised of scientists and technical personnel. With this aim in view the handbook called "The Rules of Safety for the Expedition Personnel" was worked out.

"The Rules" summarizes the main duties and standards of behaviour for the Antarctic expediton members during their stay in the Antarctic. "The Rules" also outlines survival instructions in emergency situations such fire fighting, frostbite, monoxide poisoning and first aid treatment. In addition "The Rules gives recommendations for safe work methos in different condition particular attention is given to the work in the most dangerous sectors.

The expeditional ships often approach Antarctica when the fast ice is getting thinner and is criss-crossed by the crevasses. The traffic on this rather thin ice offers some difficulties. Therefore "The Rules" presents the detailed characteristics of the fast ice in summer season, the methods of calculation of the ice thickness, capable to bear the vehicles of different weights. "The Rules" also gives instructions for the leaders, all members of the expedition in dangerous situations to prevent casualties.

The route selection for the tractors with loaded sledges is of primary importance. This route is usually chosen round the crevasses and at some distance from the icebergs. Ice-specialists are always taking part in the transport operations, measuring ice thickness and observing the state of ice. In case of ice weakening en route the road is transfered to the new safe locality. All the road stretching usuall for 25-30 kilometers is marked by special poles.

Crossing a crevassed area is always dangerous ! This peril awaits the Soviet polar men immediately in the Mirnyy area. The crevasses encircle the station, they cross the terrain near the road, where people and trains move, they are near the air-strip and even cross it. This behooves all the personnel of the observatory to be extremely attentive and careful, to observe the safety rules while moving along the observatory area, especially when the visibility is poor during blowing snow and in the dark period. Beginning with the darkness onset the so called life-lines are stretched along all the possible routes of the members of the wintering party, to insure their safety. Thus, holding these life-lines a person can move in any desirable direction without the least risk to lose the way or enter the treacherous area. These life-lines are of great help to those members of the expedition who due to their duties have to go outdoors under any weather conditions.

All the dangerous areas around Mirnyy Observatory are listed in "The Rules" which has special agenda showing the plan of Mirnyy area with all crevasse areas marked. "The Rules" also gives the strict instructions which should be obeyed by the expedition members to insure personal safety.

There is only one road from Mirnyy to the south inland. This road crosses the crevasse area. The width of safety zone en route from Mirnyy inland along a stretch of 25 kilometers is not more than 1 kilometer, therefore the traffic is permitted only en route marked by the poles. The poles with black metal cylinders are installed along the whole road from Mirnyy to the point which is 105 kilometers from the station with 0.5-1.0 km intervals depending on the state of the road and crevasse number. From the point 105 km to a distance of 245 kilometers the road is marked by poles with 2 kilometers intervals, and from 245 to 260 km the poles are installed every 5 kilometers. As the snow depth grows the poles are changed, the additional ones are installed and the old ones are made higher, Thus, the treacherous crevasses area can be traversed by the tractor sledge trains with the least risk, if the trail party obeys the rules of safety, and the tractors follow the pole marked route and do not move aside. When the visibility is good the poles are seen from the distance of 2-3 kilometers with a naked eye and with the binocular as far as 5 kilometers and more.

The long-term experience with such poles in the Antarctic suggests that they are reliable and useful means of safety. The height and diameter of the cylinder should not be less than 300mm the height of the pole is 2.5-3.0 meters.

Since the Soviet Antractic expedition has to organize annual resupply trip to its inland Vostok Station tractor traverse, we are anxious to insure safety of our trail parties, that are exposed to greater peril which lies in the follwing:

1. if the party deviates from the true course there is always a possibility of its entering a crevasse zone.

2. With poor visibility or in blowing snow the tractors that are following in the rear are likely to lag behind or lose the way.

3. the people are likely to fall under the moving tractor or sledge either to lag behind the train.

4. while working with tow ropes and heavy trailer equipment the serious injuries are liable to happen as well as frostbite on the hands and face.

5. the danger of carbon monoxide poisonning in the living quarters of the train is always presnet, as they use for the stoves coal and bottled gas.

Bearing in mind all these possible perils and the distance from the main station with the possibility of fast medical aid excluded, the trail party should strictly obey all the rules of safety, listed in a special instruction.

All the cases that are likely to happen in the traverse are listed in "the Rules", detailed recommedations are given, which instruct the personnel how to prevent the accident.

Considering the fact that expeditions working in Antarctica have no reliable crevass detection system to cross the hazardous areas encircled by the crevasses is permitted only following the preveously installed poles. "The Rules" orders to move from pole to pole, to miss even one pole is strictly forbidden.

Peculiar conditions of Antarctic field work behoooves every member of the expedition to obey the safety rules and discipline norms. All the trail partics arc obligatory provided with a portable radio station. The radio constacts with the main base should be made regularly in a fixed time. If there is no contact at a fixed time or the party does not return in time, the emergency situation is announced at the station and a rescue party leaves the station to search for the lost. The rescue parties are always manned with the healthy, strong-built polar veterans, that have special training. These parties are provided with emergency equipment and food supplies, radio station and medicines. The physician is always present in a search-rescue party.

To search a lost party, tarctor or an aircraft in disaster in Antarctica is always a very complicated task. The absence of surface reference points, complicated navigation procedurers, frequent snow storms make the rescue operations more difficult. On that account the most reliable and effective search is the search from the air. In this connection the Soviet Antarctic Expedition considers the recommendations on the standartization of the ground-air signal symbols for the communication of the surface and air parties adopted at the Boulder Symposium to be extremely timely and useful. We completely approve the suggested signal code, except one symbol designed by figure "12"-probably safe to land here. The symbol suggested is a triangle. But in practice of the Soviet aviation this signal of safe landing is accustomed to designate by the letter "T". If therefore there are no objections, we suggest to adopt the symbol "T" instead of a triangle. The technological aids of the Soviet Antarctic Expedition is constantly arowing. The number of dangerous areas and situations increases from year to year. "The Rules" has the sections that outlines the safe methods of work in the dangerous situations and areas. For instance, safety rules were worked out for those who uses the bottled gas in traverses for cooking and heating. Special safety rules exist for hydrogen production for balloon filling during radiosonde observations. New Safety rules were formulated for fuel taking from new fuel oil reservoirs, constructed in the Antarctic, considering the peculiar environment of the continent.

Special continuous attention is given to fire prevention and fire fighting both at the main bases and in traverses. Procedures of fire prevention and fire fighting used in the Soviet Antarctic Expedition were described in our report to the Logistic Symposium in Boulder, Colorado. Therefore it is not necessary to repeat it. It is worthwhile mentioning here that the newly built Molodezhnaya station consists of noncombustible and poor combustable materials, thus greatly decreasing the fire danger.

As the present report shows much attention is given to insure safe life and work conditions in Antarctica. These conditions, however, are so complicated and changeable, that they behoove everyperson coming to this continent to be very attentive and ready to meet an unexpected danger at any moment. The leaders of the expeditions ought to brief the expedition members on the possible dangers and to teach the people to escape them. This is the principal aim of this handbook "The Safety Rules for the Personnel" of Soviet Antarctic Expedition, brief content of which is persented in the present paper.

6. PERSONAL EQUIPMENT

ANTARCTIC WEARING APPAREL EQUIPMENT

Herbert Otto Horsch and Alfonso Obermeyer

The different working conditions in the Antarctic Zone required the consideration of a new equipment which, in the most standard possible way, might be adapted to the geographic and local climate requirements.

According to the demands of the different occasions where it would be used, the following groupings were considered:

1) Garrison equipment for the members at the Bases.
2) Working group equipment, for the personnel who only integrate the Summer Campaign.
3) Crew equipment, to be used up to 65°S.
4) Crew equipment to be used South of the 65°S.

Due to the fact that part of the equipment is composed of similar garments, they were grouped in order to provide them according to the following list:

ITEM	LIST	BASES PERSONNEL	SUMMER CAMPAIGN	Crew of Airplanes C-47 type Up to 65°S	OTTER-BEAVER S. of 65°S.
1	Anti-dazzling eye-glasses for the snow	2	1	1	1
2	Common dark glasses	2	1	1	1
3	Boots for flight	1(1)	-	1	1
4	Antarctic rubber and canvas boots	3	1	1	1

(1) Only provided to crew personnel

ITEM	LIST	BASES PERSON-NEL	SUMMER CAM-PAIGN	Crew of Airplanes C-47 type Up to 65°S	OTTER-BEAVER S. of 65°S.
5	Thermal Boots	6	2	2	4
6	Small felt boots	2	1	1	1
7	Brown rubber-heel half boots	1	1	1	1
8	Small cap lined in fox fur	1	-	-	1
9	Angora wool scarf	2	1	1	1
10	Long woolen drawers	3	2	2	2
11	Long-sleeve woolen undershirt	3	2	2	2
12	Waffleweave undershirt	2	1	1	1
13	Woolen shirt	2	1	1	1
14	Drill cotton working shirt	3	2	2	2
15	Antarctic equipment for flight	2	1	1	1
16	Antarctic equipment for work	2	1	1	1
17	Antarctic equipment for patrol	1	-	-	1
18	Woolen swathing band	2	1	1	1
19	Woolen five finger gloves	6	2	2	4
20	Thermal mitt gloves	2	1	1	2
21	Fox fur mitt gloves	2	-	1	1
22	Working gloves	4	2	1	2
23	Cotton socks	6	2	2	2
24	Socks made in goat- angora wool	4	2	2	2
25	Extra thick combed wool socks	4	-	-	2
26	Ear-cap made in goat-angora wool	2	1	1	1
27	5mm felt insole	4	2	2	2
28	10mm felt insole	4	2	2	2
29	Silk scarf	2	1	1	1
30	V-shaped collar sweater	1	1	1	1
31	Thermal high collar sweater	1	-	-	1
32	Warm underwear made in light material with a synthetical interior lining (drawers and undershirt)	1	-	-	1
33	Reversible waistcoat with Duvet insulation	1	-	-	1
34	Parka with protector made in Duvet and hood lined in fox fur with interior wire	1	-	-	1
35	Equipment consisting of various elements for personal tidiness.	2	1	1	1

Flight equipment. (1)

It is composed of:

- Parka
- Trousers
- Small cap
- Gloves
- Boots

This equipment was made as a result of the pilots' requirements to be provided with a light and comfortable equipment, which would allow them to pilot the plane with garments fit for flight requirements.

The parka normally used by the Air Force was taken as a basic model. It was made longer, with wrist-pressing cuffs, with zipper and buttons, with removable hood and buckles with straps to regulate the size of the waist and of the double cuffs.

The trousers have woolen cuffs at their ends so as to gird rather than press.

The small cap has an interior wool lining and ear-laps.

The gloves are a kind of mitt, made of canvas and with interior thermal lining.

The boots are made in rubber and nylon, and they are lighter then those used at the Base, in order to provide greater sensibility at the commands.

This equipment allows the crew to perform flying activities comfortably and to use them outdoors in temperatures of up to -10°, -15°C. Besides, in extremely cold temperatures, this equipment is also used as the interior part of the Base or Patrol equipment, therefore performing a double function.

Besides using it for flying, it is also employed as garment in the dwelling-house and as uniform for the trip to the Antarctic Zone.

(1) This equipment is made in red, colorfast, nylon material, insulated and waterproof.

Warp	- Minimum 60 threads
Weft	- Minimum 30 threads
Weight	- Minimum 80 grs/m^2

The interior lining is made in 100/100 polyester fibre with a minimum of 200 grs/m^2.

The front zipper is removable and extra reinforced.
The clasps are made in blue bronze.
The interior and inferior trousers' cuffs are made in red ban-lon.
Interior pockets are made in soft, 200 grs/m^2 red wool.
The seams are made in 3 strand nylon thread.

Working Equipment. (2)

It is composed of:

- Coat
- Trousers
- Small cap
- Gloves
- Rubber and canvas boots.

It is the most used wearing apparel in the Antarctic Zone, made in water-proof cotton material. It has zipper and clasps, which make it easier to put on or take out and thus make to adaptable to the temperature of the working place. The hood and the fastening straps at the collar, waist and inferior part, prevent the possibility of the air getting through.

Whenever required, the nylon flying equipment serves as interior protection. Boots are made in rubber and water-proof canvas and are fit for intensive use. The trousers are spacious and with abundant pockets of various uses. An opening in the side pockets, which makes it possible to reach the interior nylon trousers, in case it is used for warmth.

(2) This equipment is made in red, colorfast, nylon material, insulated and waterproof.

Warp - Minimum 27 threads
Weft - Minimum 25 threads
Weight - Minimum 260 grs/m^2.

The front zipper is removable and extra reinforced. The seams are made with 3 strand nylon thread.

Patrol Equipment. (3)

It is composed of:

- Anorak
- Trousers
- Gloves

The anorak is lined in silk, same as the trousers. Thus it allows the tasks which involve movements out of the Base, to be performed with less garments than with the working equipment, and it is sufficiently hermetic as to prevent the wind to get through. This equipment is completed with fox fur mitt gloves. It is the usual equipment for walking in the field.

(3) It is made in red, waterproof, colorfast cotton material, and the tighteners are made in chrome-colored leather.

Extra reinforced zipper
Blue bronze clasps.

Summary

Here a report of the elements of the antarctic clothing equipment are detailed. These elements have been approved to be used by personnel destinated to the Antarctic, as for the combination in the use of this elements for the accomplishment of various work's so as:

-Equipment for crew personnel.
-Equipment for ground working personnel at the Base.
-Equipment for ground patrol personnel on campaigne.
-Equipment for personnel working in extreme cold temperature conditions.

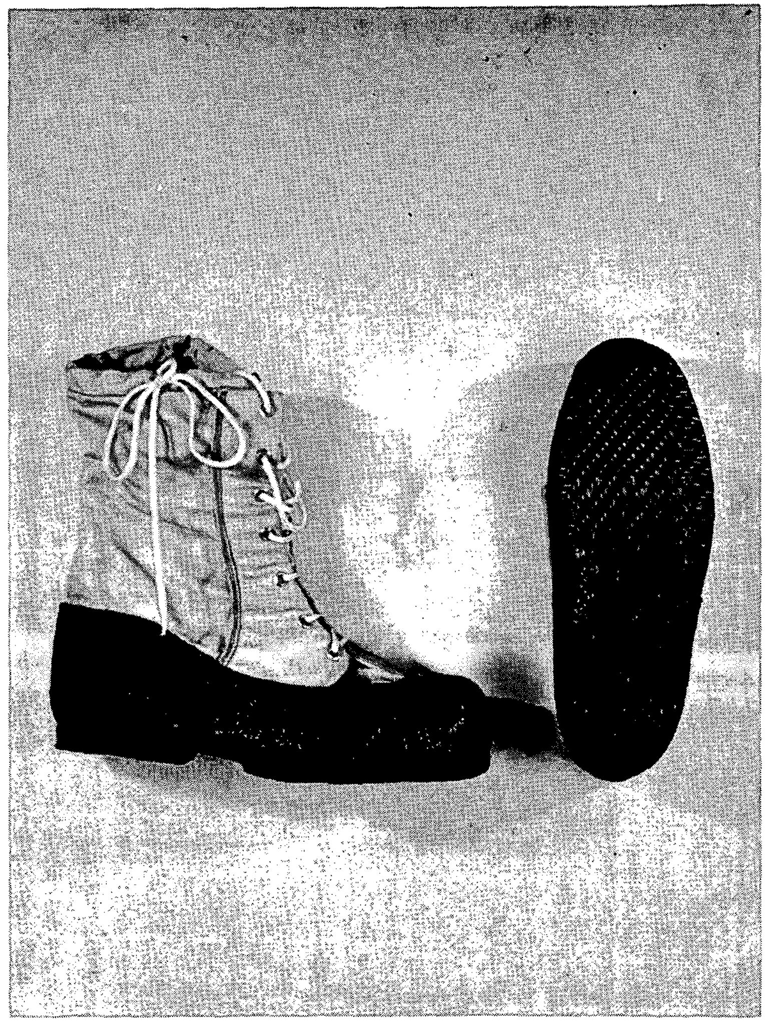
Flying equipment's trousers.

Flying and working equipments' small cap with wool lining and ear muff with laps.

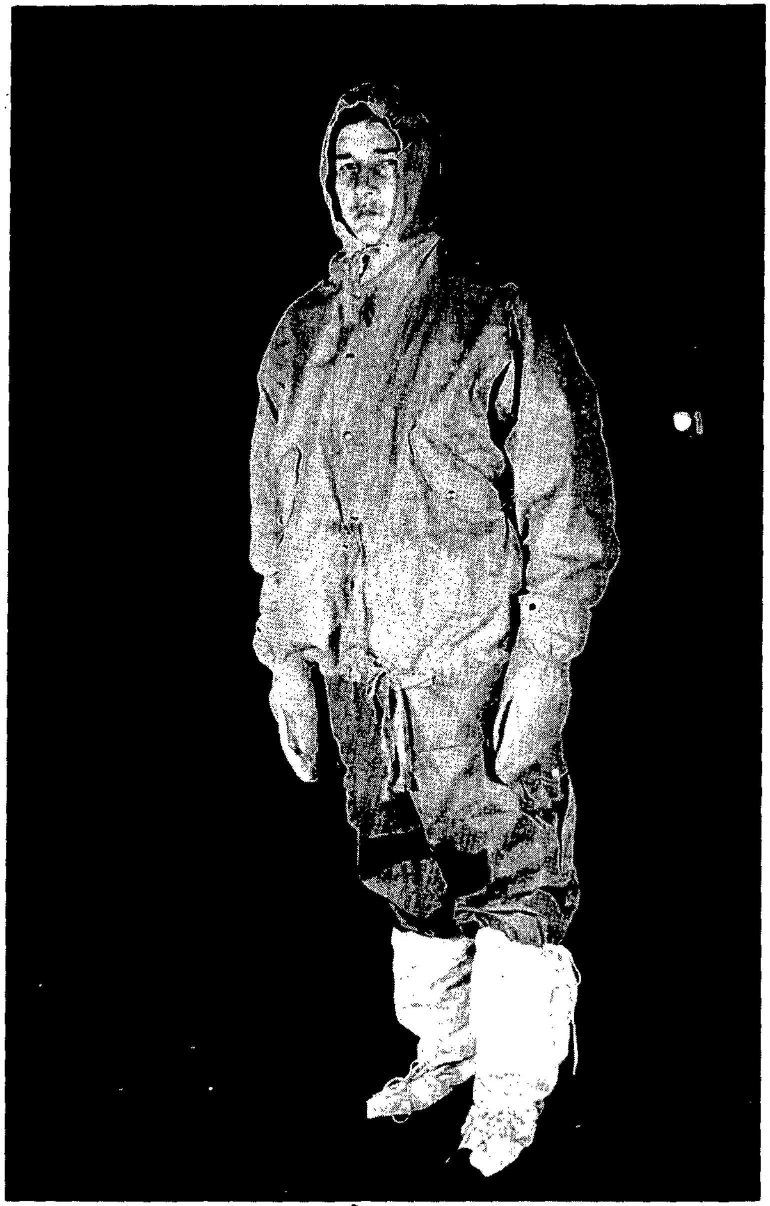
Flying equipment.

Flying equipment's parka.

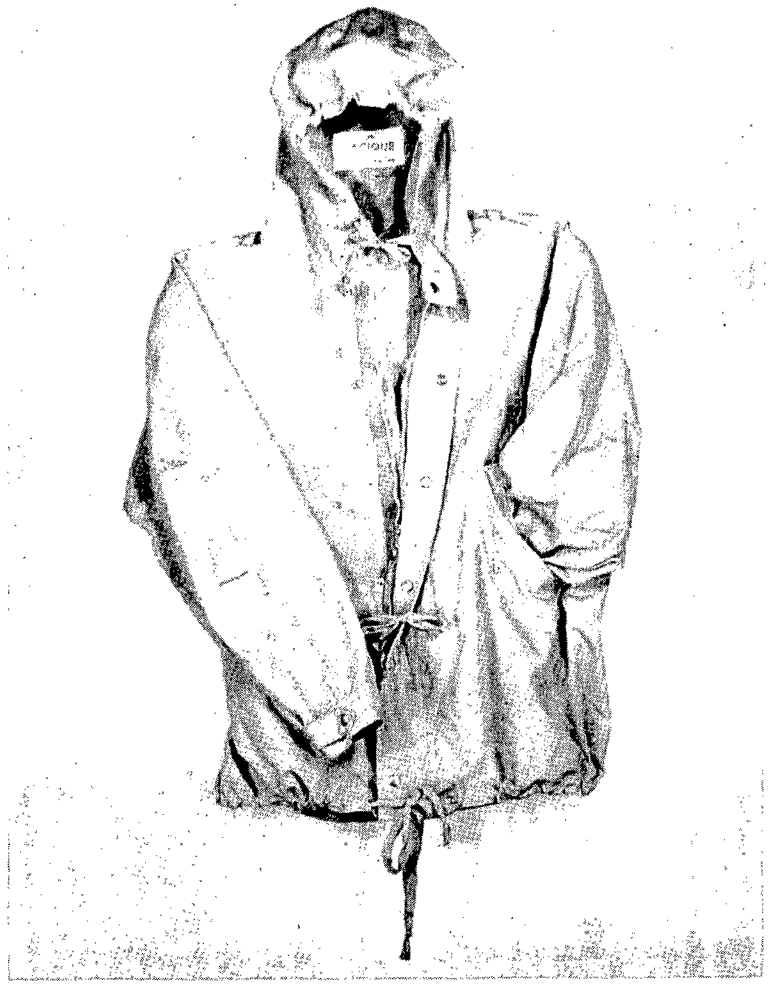
Canvas thermal mitt gloves.



Rubber and nylon boots for flying.

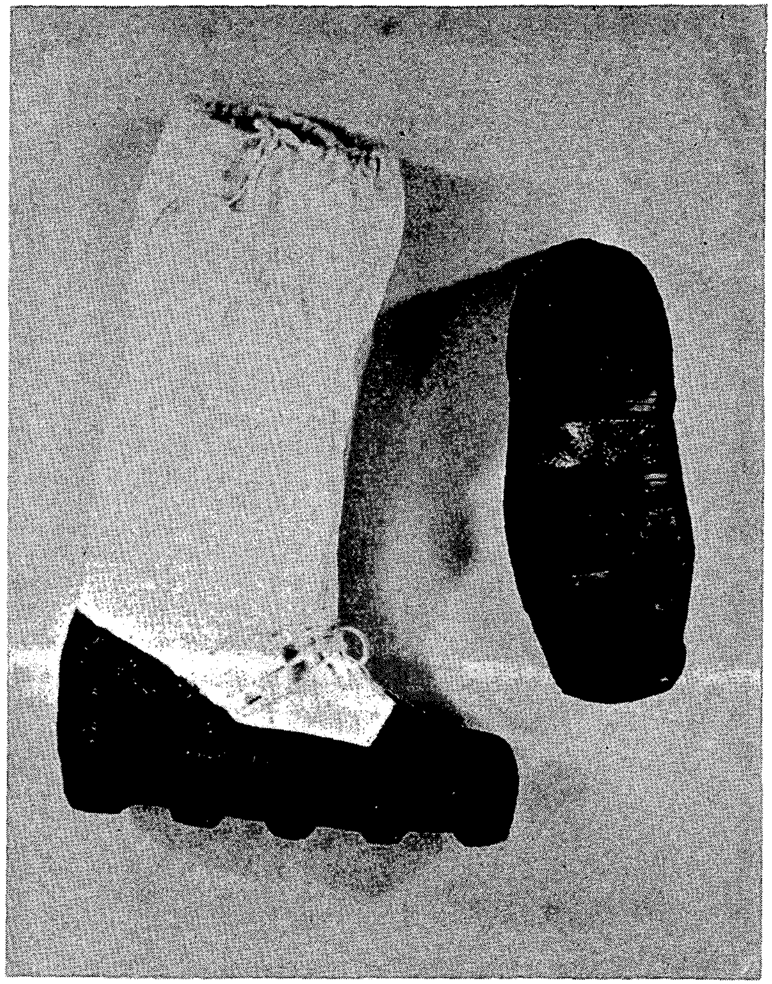


Working equipment.



Working equipment's coat.

Working equipment's trousers.

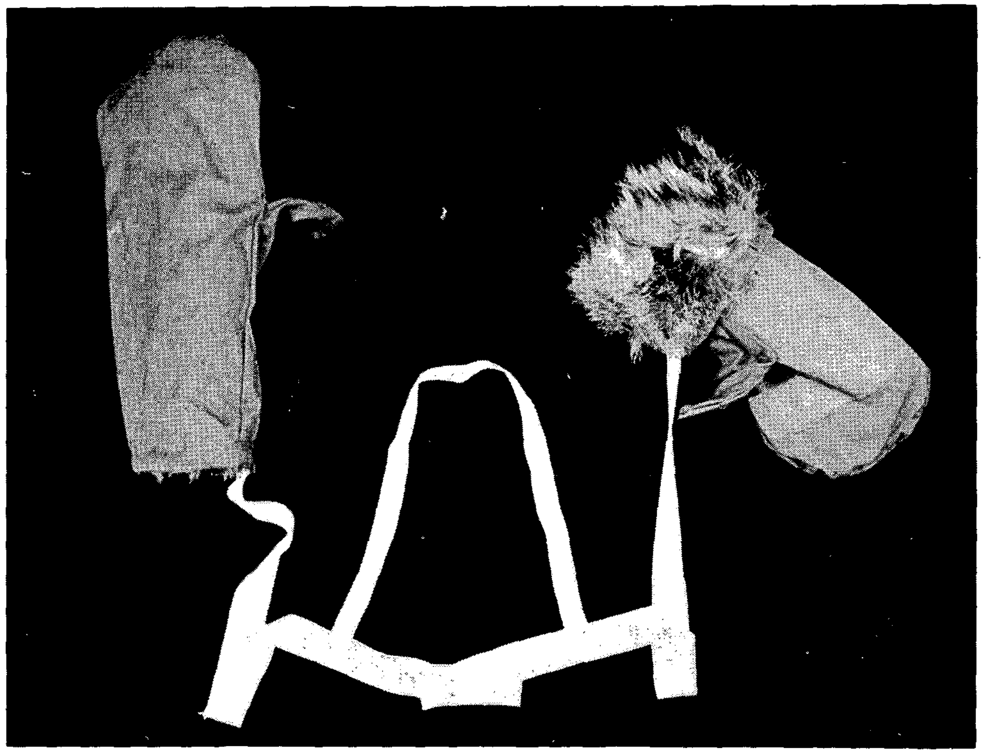


Boots made in rubber and waterproof canvas.

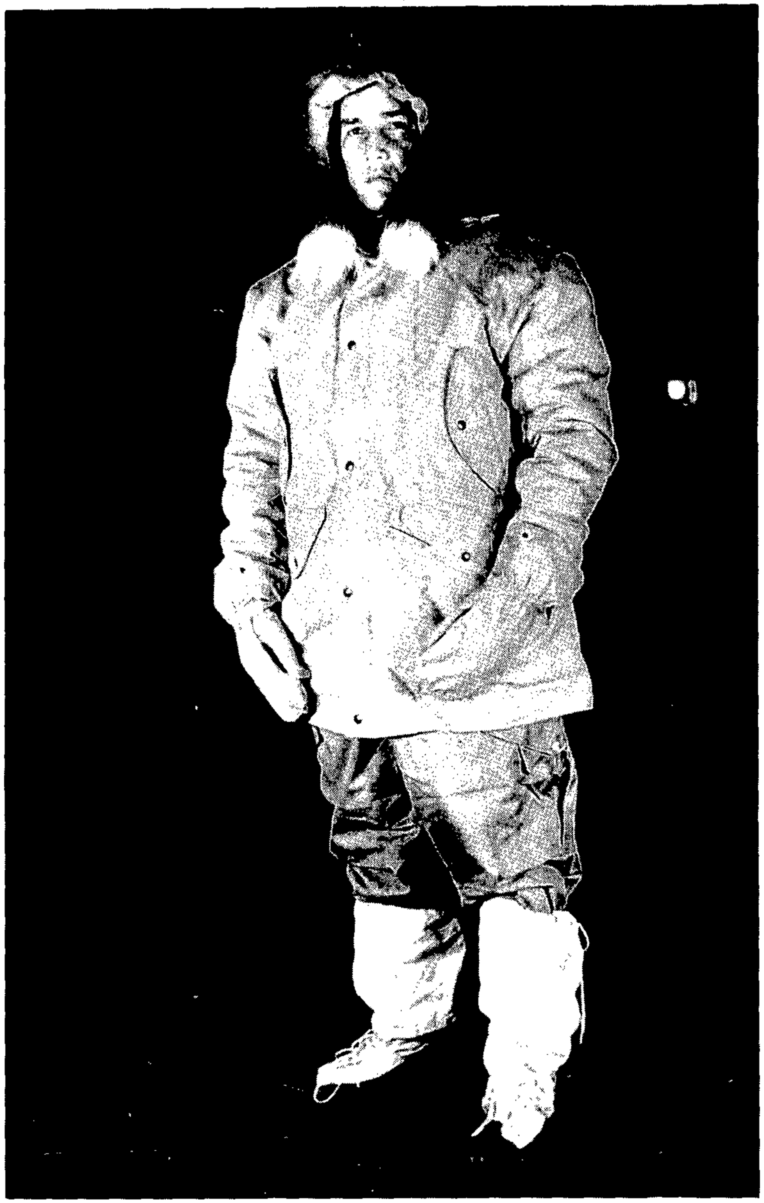
Patrol's equipment.

Patrol equipment's anorak.

Patrol equipment's trousers lined in silk.



Fox fur gloves, with fasteners.

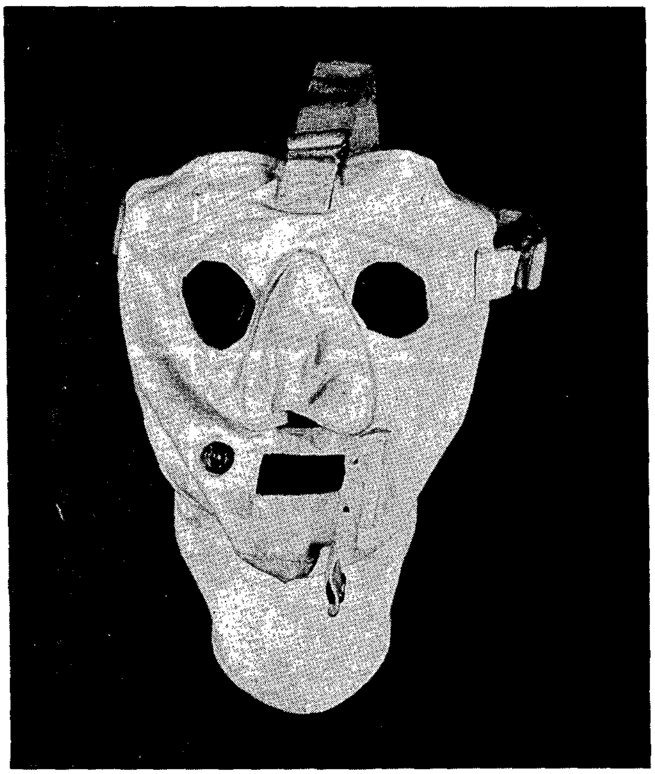


Parka with protection made in Duvet and Hood lined in fox fur, with interior wire.

Parka.

Fox-lined cap.

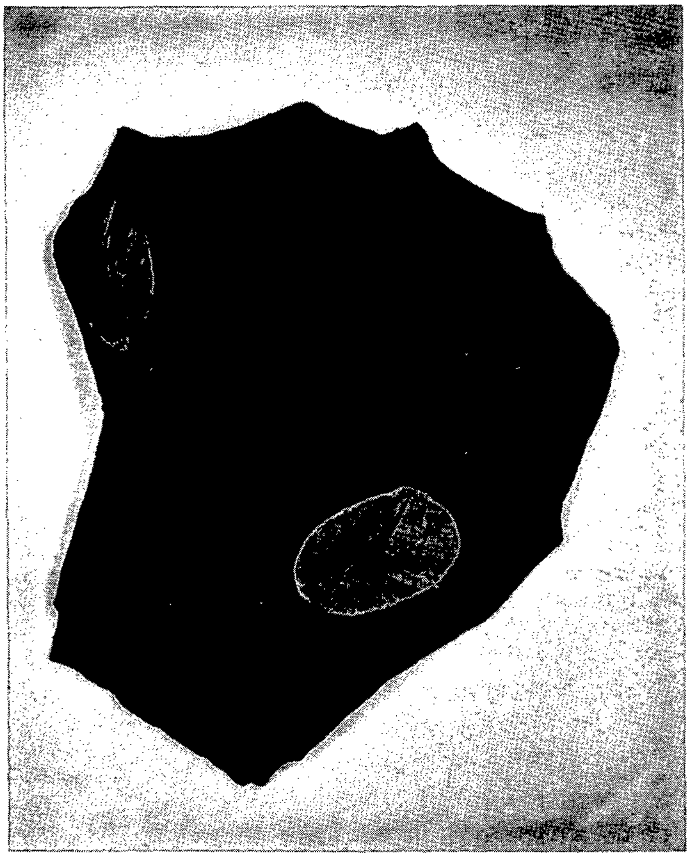
Thermal boots.



Chamois leather antiblizzard mask.

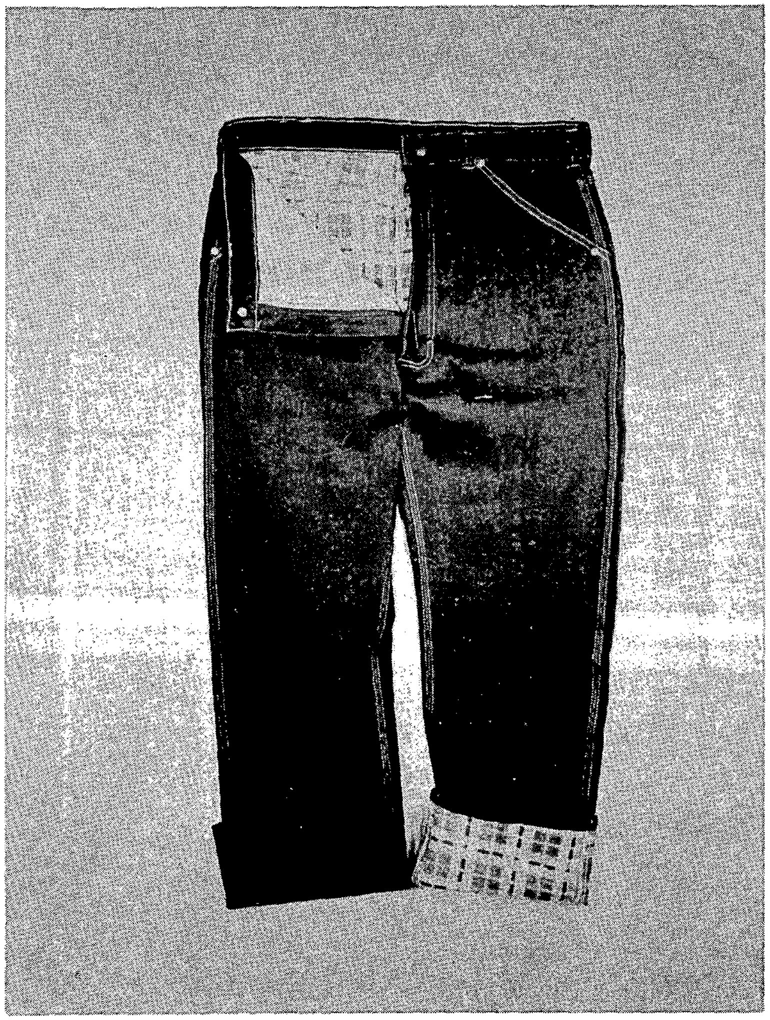
Eye-glasses for the snow with side protection.

Ear muff.



Sweater made in angora goat wool.

Reversible nylon waistcoat with warm lining.



Lined blue jeans.

Silk lined woolen shirts.

PRESERVATION OF MEATS IN ANTARCTICA

Cirilo Aversano and Enrique Jorge Pierrou

Abstract

This paper reports on the Antarctic experience carried out at the Islas Orcadas (Orkney Islands) Station of the Argentine Navy which permitted to work out a new technique for the preservation of meats by direct application of natural cold.

Such experiment was carried out with beef meats placed in a tunnel made in a glacier very close to the Station, where they remained a whole year.

The preserved meats were brought back to Buenos Aires, and they still keep their perfect condition in a local packing house.

Introduction

This experience, carried out in Antarctica, made it possible to work out a new technique for the preservation of meat by direct application of natural cold, and had as its object that of attaining the preservation of meats by the use of the natural cold of the ice, increased by air draughts even colder than the ice--colder than -30°C (-22°F).

The original work plan was carried out entirely at Naval Station Orcadas, and the meats were not only preserved the year round but the technique for Antarctic preservation could be developed one hundred per cent in its functional aspect, that is, the unknown aspects of the problem and the mystery that surrounded it were disclosed with the construction of a freezer being completed in the very core of a glacier.

The experiment consisted in carrying out a physical task--the freezer itself, which is an installation of the Station proper--and also in an intellectual task which encompasses the physico-mathematical interpretation, the final deductions and the Antarctic preservation technique, and of all this the inferences and implications of the problem.

I - How Foodstuffs were Preserved in Ancient Times

In these days of gas or electric refrigeration, the ice factory is only an unavoidable likeness or a grim feature of the best crime stories. Mr. A.C. Hilton, who has carried out research work on its nature and uses writes:

"Through the times several methods of preserving foodstuffs have been devised, particularly as regards perishable products such as vegetables and fruits, meat and fats.

"We all know nowadays many methods, but with the exception of salting, smoking and sun drying, the history of the use of ice will possibly be the most interesting. In connection with this, I recently had the opportunity of seeing some ancient earthen constructions which arose my interest.

"I was spending some days in Norfolk, and in the course of a family conversation the name of a landmark known in the place as the "mountain for ice" was mentioned. Nobody knew the origin of such a name, only that it had been passing along from generation to generation. The next day I decided to visit it. It consisted of a big earthy mound topped by trees many of which can be more than 100 years old.

"There was no opening in it, although it was easy to notice there were excavations in its summit. Inquiries made revealed that an oak beam had been unearthed. In spite of this the excavation work was abandoned because they entailed a possible risk.

"As I could not obtain further information on the spot, I headed for the nearest public library. The mound was located a short distance away from the XII century ruins of a priory, and other evidences in the neighboring lands and in the ruins pointed out that the mountain for ice was located in the landed property of the priory. As there did not exist enough historical records about this property in particular, it only remained to conjecture what use these ancient monasteries made of their mounds for ice. Maybe they used the ice to preserve the carps they took out from their ponds during the summer. They might likewise preserve in fresh condition for short periods their butter, wines, fresh meats, fruits, vegetables, etc.

"It was easy to discover the method by which the ice was obtained and stored. During the severe winter period they took out the ice from brooks, rivers, ponds or lakes closer by, cutting it into big slabs and carting it up to the mountain for ice. There it was crushed and compressed until it formed a solid mass, which was covered with straw. Often-times, if it was not possible to obtain ice, the same method was employed with snow. Supplies generally lasted until summer was well advanced, and in order to cut the quantities that were necessary, a pick was used.

"In this particular case, details of construction of the mound for ice could not be established on the spot, because the door or whatever other type of entrance there had been, had long since crumbled. As a matter of fact, and apart from the name in itself, besides the general shape and size of the mound, there also existed the possibility that it had been any other thing, inasmuch as on the subject different stories were told locally: underground tunnels, buried treasures, phantasmagoric incidents. This notwithstanding, new investigations carried out on the spot brought to light a mound for ice of a later period-- X VIII century-- which was found in good condition. Likewise, an early edition of Encyclopedia Britannica showed the construction of one of these mounds.

"Further still, it was soon learned that mounds for ice varied very much as regards their shape and size. Some might consist of a wide space with stone walls, some 20 feet below ground level with stairs leading to it; others had perhaps the shape of a well (known as "icewells"), being necessary to have a stair or ladder as ice gradually descended upon the advance of summer. All this was revealed when my inquiries made some persons to try to locate old photographs which showed mounds and wells for ice.

"In the majority of the cases, the entrance faced the N or NW side, while some possessed an additional vertical pipe with the object of speeding up the task of filling the chamber.

"Generally speaking, it would seem that success favored this method because several wells and mounds are still in existence in East Anglia. The system was neither unknown in the continent, having been extensively used in Italy. The Illustrated London News - 25 June 1949".

II - Background Information and Bibliography

There is some background information among which similar experiences carried out at The Camp Century, Greenland, by the United States; also the efforts of Admiral Byrd and Mr. Wallace, to carry U.S. agricultural surplus products to Antarctica. As regards bibliography, reference can be made to that which is included in Encyclopedia Britannica - III Edition (1797); and the article by Mr. A.C. Hilton titled "Icehill and icehouse--How our ancestors preserved their food" which refers to the year 800 A.D.

III - Commencement of the Test

The test was carried out during 11 months and 18 days. The meats were loaded on board the Argentine Navy ship ARA BAHIA AGUIRRE, cut in quarters duly classified, carried to Orcadas Naval Station, and later, by the same means of transportation, brought back to Buenos Aires. That is, those meats made a round trip of approximately 16 months in all types of transportation, conditioning and waitings on board ship and beaches in the station area, where, as it can be verified, operational facilities are not really ideal for this type of handling tasks.

During the last three months, for the main purpose of the test, the preservation of the meats became a secondary problem, because the main, the fundamental one was the development of the technique and the physicomathematical theory that interprets and explains it.

IV - Location of the Freezer

The place chosen was a glacier named "La Monja" ("The Nun"), located at Scotia Bay, Laurie Island, Orcadas del Sur (South Orkney Group). This place was chosen because it combined outstanding conditions from all points of view as compared with those existing in other Antarctic bases and stations.

Use was made of the SE end of the glacier named, some 80 m from Scotia Bay and at a height of 15 m over sea level. In that place the freezer was carved by pickaxe and taking out the ice in buckets from within by means of a tackle. One hundred and fifty metric tons of ice were removed in all, and 50 linear meters of all type of excavations were made, 12 meters approximately in a vertical direction, and 40 m in a horizontal direction. All this to make use of a freezing chamber of 5 cubic meters only. That is to say that 150 tons were removed to finally reach the usable space. It is evident that the elementary method employed is wholly responsible for such a situation because in some future construction, in which the experience obtained will be taken into account, the situation will be entirely different because the material excavated will be taken advantage of entirely, that is, that the construction will be almost 100 per cent usable.

V - Structure of the Freezer.

The freezer is made up of three stories, which could be called sub-ice stories (SH), beginning from the surface of the glacier, and also of a combination of additional sections--carpenter's and blacksmith's shops, and branching out and draining systems.

1st) The first sub-ice (SH_1)

It is made up by a big trench 3.60 m in length, and oriented across the glacier, with a SE-NW azimuth, one meter wide on the floor and two meters above, by 2 m to 2.60 m in height. The walls and floor are made of ice and the ceiling is made of wood, with braces, columns, planks and insulating and waterproofing layers. This ceiling measures 6 x 2.60 m and rests on the surface of the glacier, covering the big trench mentioned above. It has a 20° inclination, which is the natural gradient of the place.

Two doors give access: the main or N one, and the emergency or S one. From both of them start iron steps made fast against the ice.

A rack runs along the ceiling. This is a forebay for control, access and handling; its floor was made slanting in its N part and with its outlet in the drainage tunnel, the purpose of which is to drain the water that might seep in by some defect in the "cut-water". In the ice wall a trough was hewn which gathers the drippings of the snow in summer.

2nd) The second sub-ice (SH_2)

In the S extreme of the first sub-ice commences a cylindrical well 8 m in depth and 1.50 m in diameter. A horizontal door gives access to a ladder which goes down to the bottom through the center of the well; this ladder, in turn, continues upward permitting, to use in emergency cases, the S door. The floor of the 2nd sub-ice lies on the bottom of the glacier, and in that place a chamber of a greater diameter (2.50 x 2 m) was constructed in the shape of a dome. From this chamber and in the direction of the center of the glacier, commences a third excavation, which is that named 3rd sub-ice.

3rd) Third sub-ice (SH3)

This is made up by a horizontal tunnel 3 m in length, 170 m in height and 0.70 m in width. A vertical and insulating door separates it from the deep chamber of the 2nd sub-ice. A special rack for carcasses runs through the center of the tunnel all along the ceiling permitting to hook and move the meat pieces.

It also has racks leading to the 1st and 2nd sub-ices with the object of taking out or moving the carcasses inside the tunnel. A conveniently placed tackle permits the loading and unloading operations.

4th) Advective tube

The outer cold air is led inside the 2nd and 3rd sub-ices by means of a special device known as an advective tube. This device, which is very ingenious, consists of a tube 12 m in length which emerges outside some 2.30 m. It is made of wood in its upper half, and of zinc in its lower half. In the upper end it has a wind vane with a bronze mesh to strain the snow. As it is fitted telescopically it can be oriented in the desired direction.

An occlusion aluminium valve makes it possible to cut or to open the air inlet.

The combination of additional parts is completed with thermometers and other control and maintenance instruments.

The advective tube, together with the temperature of the ice, are the fundamental elements of the principle in which the operation of the freezer is based.

VI - Operations of the Freezer

From the very instant that the construction work of the freezer was commenced, useful practical experiences and valuable instrument data began to be obtained, such experiences being noted down and the data recorded daily.

Among them were, the control of the proper temperature of the ice at different depths, using a drill and special thermometers. Control of absolute ambient temperatures in the 1st, 2nd and 3rd SH, maximum and minimum graphs. Control of incoming cold air temperature (advection) and temperature of the outgoing air (exahust), comparison which serves to adjust the "natural motor". Control of the relative and absolute humidity of the environment, barometric pressure, etc. All graph records were analyzed and in a certain moment 20 precision instruments of all types were providing permanent information of great value. This notwithstanding many unsuspected technical difficulties had to be overcome, because of the very special ambient created by the depth of the ice, such as that originated by the closure and water tightness within the 3rd SH, where, upon carrying out the daily observation of very sensitive and delicate instruments, on getting close to do the readings, the nearness of the human body and its breathing caused alterations in the records.

Though graph records with more inertia substituted the absolute observations, it was necessary to know what happened upon sending the cold air from outside, and in that way, to be able to appraise its operation, as well as the changes inside because of the addition of such cold air masses which, by means of the "advective" tube were sent to the 2nd and 3rd SH, when outside the temperature descended below -6°C (21.20°F) and without committing the instrument erros pointed out above.

To that end an H50 radiosonde was used in order to obtain in the pertinent receiver the records for temperature, relative humidity and barometric pressure simultaneously at the rate of 7 coded transmissions per minute which were later decoded.

It was set to work from outside, and from the radio station the emission was followed noting down the results. Chronometrical operations were made with the advection elements and other parts which contribute to the proper functioning and utilization of the natural elements. With this test, the accuracy of the operation of the freezer was established, which assured the movement of cold air and its accumulation on the ice.

VII - Functioning of the Advective Tube

Outer cold airs are let inside the freezing chamber by means of the device already described, called "advectibe tube". Its name stems from the meteorological term advection which is given to the horizontal contribution of an air mass having a temperature higher or lower to the prevailing one at the time. The advective tube, inasmuch as it has a wind vane for the admission of air, oriented in the direction of the prevailing wind, is intended to take advantage of the advection of the cold air.

This tube starts to function by opening its air passage when the outer temperature is lower to that inside the freezer, and, consequently, that of the ice. Then a continuous or discontinuous stream of cold air, more or less violent, depending on prevailing conditions, penetrates and lowers its own temperature even more if the tube has been constructed aerodinamically so as to take advantage of the adiabatic expansion of the gases and the funnel effect.

Being inside the freezer in those circumstances, the first thing that is perceived is the noise of the ice, a sort of crisp and brusque cracks similar to those of a wooden board when it breaks, and then virtual splits. These splits were studied and followed in depth, drilling their declivity planes, which are generally those that separate two annual layers or strata of the ice. This phenomenon was not very pleasant the first time because of the fear the unknown generates, the fear being that an ice slide would occur any moment, but later, upon becoming familiar with these noises, it was ascertained that there is no safer place than a cave hewn in the ice. Meteorological predictions were made daily in order to establish whether the advective tube had to be left open or closed during the night. This operation was manual because of the makeshift nature of the installation.

Such tubes must have automatic thermostatic valves which permit to take advantage of useful temperature up to the very last minute.

The freezing tunnel (3rd SH, meat storeroom) behaves like a true motor and its adjustment is accomplished by checking the temperature of the incoming air (advection), and that of the outgoing air (exhaust). When the two of them are equal, it is the moment in which the phenomena concur to saturate the absorption capacity of cold by the ice.

VIII - Physico-mathematical Considerations

In order to have a proper idea of the experience carried out, and of the accuracy of the conclusions arrived at, it is necessary to consider some physico-mathematical aspects of the work.

As instrument observations were obtained, their relationship and connections with the known physical laws which express them and which anticipate what will happen in the future were established.

Foreseeable results were drawn out from pure theory, and they were checked against the instrument readings, without previously knowing the conclusions of one and the other. The coincidence was permanent.

For the development of the theory, the following values and constants were used:

a) Ice density
b) Specific weight of the ice
c) Conductivity coefficient of the ice
d) Specific heat of the ice, and variability field for low temperatures
e) Friction coefficient of the ice
f) Conduction laws
g) Problem of the wall and of the FOURRIER bar
h) Thermodynamic principles, expansional cooling.

The study carried out was intense, and many were the daily and systematic experiences which were made with the object of improving the efficiency of the natural freezing chamber, and of thoroughly knowing its behavior under extreme conditions.

Upon commencing the experiments, the 3rd SH chamber had a temperature of -4°C (24.80°F). This air temperature of the inside space is approximately that of the ice of its walls. It can also be assumed that, possibly, carrying out a sounding in the cave of the glacier with adequate instruments, the more be the pressure, the lesser will be the temperature, by elementary law, inasmuch as the minimum temperature will be in the lowest part of the glacier. The freezer constructed had from 10 to 12 m of ice above, but it is possible, because of the conditions of the place, to obtain 40 to 50 m more. Naturally, the difference would be one or two degrees (C) less with respect to the verified -4°C (24.80°F).

This effect, and that of the funnel, which will be explained later, are concurrent elements for the functioning of the future freezing tunnel and the advective tubes. The conduction of cold from a mass of air to the ice walls is accomplished when the difference of temperature between ice and air is of 1 degree C, and at the rate of 4 thousandths of small calories per second and per sq.cm. When the difference of temperature is 2°C, at the rate of 8 thousandths of small calories, and so on proportionately.

This means that the conduction is directly proportional to the difference of temperature in question. Time T of application of the energy is another of the directly proportional factors. The conduction of cold in the gigantic mass of ice which surrounds the freezer is accomplished by the conduction of frigories in a directly proportional manner to the difference in temperature (Dt), to the time (T) of application of the energy, and to the conductivity coefficient of ice (It) and is inversely proportional to the thickness(e) of the ice, in the normal propagation direction, and over the surface (S) the result is expressed in small frigories.

$$F = \frac{Dt.\ T.\ S}{E}$$

Besides the descending relationship of temperature which exists at a distance (x) from its source, it turns out to be equal to the descending relationship which it would have for (x) equal to 0, multiplied by the base of the Napierian logarithsm (e) raised to minus (a) by (x), (a) being a constant coefficient for each substance. In this manner, a negative increment or descent in temperature that exists in a given direction can be obtained, for instance: 10 m away from the surface of the wall of the chamber.

Summarizing, between 2 points the distance of which from the source grows in arithmetical progression, the descents in temperature are in geometric progression. The discussion of this formula does not permit to establish the descents of temperature differences for distances considered between zero and the infinite.

Ice of -4°C (24.80°F), upon receiving a mass of cold air, behaves as trying to reestablish the thermic balance; the first centimeter of ice receives, as time elapses, thousands of degrees which instantly it relinquishes to the next centimeter, and this to the next and so on, that is, that the energy of a mass of air, for instance, of -5°C (23°F) is absorbed by the ice, and the colder the inflow mass, so much more rapid it will be absorbed, and greater will be the sensitive thickness of the ice. (The specific heat of ice is half a small frigory, which means that half a small frigory is necessary per gram of ice to lower the temperature 1°C).

From the point of view of the functioning of this natural freezer, it can be said that, air masses below -4°C (24.80°F) were availed of only in a 10 per cent of the total that could have been used if the present freezer had been constructed in optimum conditions. The difficulty which prevented the total use of the cold air masses was precisely the fact of the chamber having been constructed in depth, because in this way the air does not circulate in a natural manner as it would do if the construction were horizontal.

Apart from this, the advective tube used had an insufficient flow wind vane, and above all, it had an occlusion and inlet valve operated by hand instead of being thermostatic and automatic.

Times of concurrence of this meteorological phenomena, that is, the number of hours in which the cold air mass acts, are not constant and logically depend on weather changes. Another inconvenience is that the temperature of the mass of air is not uniform; hence the enormous importance of the automatic functioning.

All masses of air of -6°C (21.20°F) are highly usable.

Graph records obtained show temperatures taken in the freezing chamber and their variations during the intervals in which the air inlet through the advective tube is closed, the temperature low recorded in the thermometer tends to rise very slowly and to remain constant somewhat below the temperature mark which it had before the process commenced.

Actual example:

Temperature of the chamber: - 5°C (23°F)

The time of origin we will call hour h. We open the valve of the advective tube, and a mass of air of -10°C (14°F) rapidly commences to enter. At hour h + 18 we close the valve. If we look at a trace of the thermograph we can verify that the temperature descended from -5°C (23°F) to -10°C (14°F), and that, to return to -5°C after h + 18, it required one hundred and eighty hours.

These phenomena which could be verified visually by means of instruments, permit to corroborate the theoretical assumptions which arise from physico-mathematical computations.

Summarizing, the theoretical development was as follows:

The quantity of frigories +F (F positive) which the freezer received turns out to be equal to the difference in temperature considered by the time of application of that energy T = 18 hours, by the temperature difference of the ice Dt, by the surface S, by the conductivity coefficient of the ice L, divided by its thickness e

$$+F = \frac{Dt.\ T.\ S.\ L}{e}$$

Upon closing the advection, it is possible to notice, mathematically speaking, that the energy delivered +F will be equal to -F (F negative), that is, the same energy as that propagated by the ice. This permits us to equalize the two formulae:

$$+F = -F = \frac{Dt.\ T.\ S.\ L}{e}$$

where +F (F positive) is the energy expressed in frigories, responsible for carrying the temperature from -5°C (23°F) to -10°C (14°F), and that -F (F negative) is the energy expressed in calories, responsible for bringing us back from -10°C to -5°C as a consequence of its propagation in the ice.

If we consider the conductivity coefficient, as I (one) constant, and the unit thickness and surface for both formulae, we can put down that the 18 hours multiplied by Dt = 5 degrees, divided by 0.5 with which by extreme definition propagation operates, gives us the computed time of 180 hours, verified in many and fiferent oppotunities.

$$Dt.T = Dt_1.T_1;\ T_1 = \frac{Dt.T}{Dt} = \frac{Dt.\ T}{0.5} = \frac{5 \times 18}{0.5} = 180 \text{ hours}$$

The formula always coincided with practical experiments, and nothing else could be expected.

About what has already been said, it can be pointed out that, being the theory elaborated in agreement with the phenomenon, it will permit us to predict the functioning of a future freezer constructed in such a way that the freezer will take full advantage of the energy available.

A conclusion of all this is that the device turns out to be a motor which the more it works the better it operates and the more it yields, the reverse of the conventional ones which wear away.

It was also studied what became known as the "sensitive thickness", that is, the distance (x) from the source up to where the transmission of the cold in the glacier ice which surrounds the freezer is being felt; in other words, the limit distance for a thermometer put in place for the purpose to perceive the cooling of 1°C of difference. This value is very important and arises from this formula:

$$F = \frac{T. S. L}{e}$$

All the variables have been tabulated in such a way that at any moment the thickness of overfrozen ice surrounding the chamber can be determined and, therefore, the accumulated energy in frigories can be also determined, as well as the time of delivery of same in order to sustain the low temperature necessary in spite of the loss of propagation or conducticn by the cold wave.

Through hundreds of yearly hours, the sensitive thickness will reach to hundreds of meters of the freezer wall, with which an accumulation of frigories to go through the summer and into the next winter can be obtained. Then in the winter the accumulation can be charged anew.

The proper temperature of the ice at the place, and the computation of usable frigories as it arises from meteorological observations in the area, are the pillars upon which rests the technique which permits the creation of a new microclimate inside the freezing tunnel. It will never be possible to evade the conditioning factors. This principle in its whole conception is a novelty and its worth consists in: "Changing the original temperature of the ice in a given place, averaging it with masses of cold air which are added to it when the ice does not have originally the optimum temperature desired."

The temperature of the ice is the mean isotherm of the place, and the temperature which the ice of the freezing chamber reaches will tend to be that which will result from averaging such a mean with all the lower temperatures which are added to it.

The phenomenon is similar to an electric accumulator. The ice, because of a physico-chemical peculiarity of its matter and state cools itself, that is, it charges itself of frigories, which is equivalent to shedding heat or thermal energy with great rapidity; instead, it heats itself, sheds its frigories or absorbes thermal energy between 6 and 40 times more slowly than in the reverse process.

During the cold weather, therefore, we loaded the ice with frigories +F positive, overfreezing it, using the advections of cold air by means of the advective tube conveniently oriented, thus making it circulate through the interior of the freezer. During summer the freezer will discharge itself through -F negative.

This assures a permanent functioning and a range of temperature lower than that of the original ice.

IX - General Results

The conclusion of this work is to have cleared the unknown part of the problem; the fundamental and positive aspects are that it permitted to develop a technique for the use of natural conditions which make it possible to determine if a place is suitable or not, and how to build in order to obtain the advantages desired.

For the construction of a natural freezer, as a structure in itself, its time of completion, with adequate elements, is rapidly compared with what it would demand to build a conventional freezer for equal capacity, besides its exceptional economy. Suffice it to think that the structure proper, which practically does not require building materials, is all these things: the engine, the insulating lining, the building and the land; furthermore it does not require fuel nor any maintenance worthy of being taken into account, etc; it could even operate endlessly without being attended to.

The hollow in the ice and the cold air is all there is to it. It is only necessary to add the elements of advection, conditioning, supply, insulating doors, controls and very few other things.

The "La Monja" ("The Nun") Glacier, at Destacamento Naval (Naval Station) Orcadas was surveyed, and it was established that a dozen freezing tunnels could be constructed in it with a capacity of 100,000 to 150,000 tons of meat in each.

X - General Considerations

As a consequence of what was observed in the course of the experiment, it can be conceived that the practical and most efficient solution to the problem is the construction of a freezing tunnel.

Having sprung from the combination of two original ideas--putting to use the cold proper of the ice, on the one hand, and putting to use the advections of cold air masses, on the other--it has resulted in a contrivance that captures, synthetizes and potentializes these two phenomena into an ice engineering accomplishment which may be called "freezing tunnel".

Therefore, that gap, possibly cylindrical in shape, opened in the ice, would be the machinery that stores and applies the cold in the same way that, in another order of things, the wheel of a wind mill uses the wind to take out water.

To behave like a true machine, a tunnel should have to meet such requirements as regards size, diameter, shape, orientation, proper temperature, etc. as would permit it to take full advantage of the energy supplied and to potentialize this through the engineering artifice of hewing the ice, besides closing it tightly when necessary for its insulation. Conditions that such a construction must meet have been established, in order to take full advantage of natural conditions.

Antarctica was conquered through the enterprise of pioneers, after the era of discovery, until finally the ambitioned stage of survival and possession arrived more than 60 years ago. Afterwards, long distance communications assured the functional permanence, and, currently, means of transportation pose the main problem. When this problem is solved, this land--Antarctica--will be definitely incorporated to civilization. Despite the fact that transportation is the acute point of this problem, it can be estimated that the present maritime, air, land and combined means have put an end, operatively speaking to the era of isolation. At least, as regards many places, there is no valid inconvenience for a commercial and economic communication almost permanent.

With existing means the era of winter isolation could be brought to an end, and those territories gradually incorporated to society. Hence the great importance of operations in marginal and extreme periods.

XI - Advantages and Economic Consequences

1. The investment necessary to build freezing chambers in which to deposit and preserve large production surpluses would be too great, and would exceed the possibilities of most countries. Antarctica instead is free and at our disposal.

2. In the ideal case that the former possibility could be carried out, the gradual increase in production might reproduce the phenomenon indefinitely.

3. The building of those constructions would demand a very long time.

4. The basic cost of maintenance of such installations is high, and delaying a product in a freezer might make it to be so dear that the value of the cold would possibly be equal or greater than the original value of the product, which would turn impossible its marketing on an economic basis. This is to say that the paradox would arise that if in a given moment there was a great amount of meat, for example, in the chamber, instead of having a considerable wealth, we would be facing a real misfortune.

   This will never happen in Antarctica, and even if the product remained there 100 years, not a penny would have to be charged as preservation expenses. Quite to the contrary, its value would increase permanently and indefinitely (deposits of edible Mammoths).

5. From what has been stated in 4., it follows, conversely, that in the case of not using it, it would mean a saving and a permanent reserve. If we

could make this saving and reserve over a number of years, it might come to be of great value, apart from other consequences.

6. That, because of an elementary common sense, the investment in operational technologic elements--reefer ships--would have a great versatility; transoceanic commerce.

7. That the operational cost, naturally and conclusively indicates that it would be negligible, as compared with the other factors in conventional freezers.

8. That, eventually, a steady traffic would not be necessary, but the periodic storage of surpluses, and, above all, the assurance of having solved a problem of such a magnitude.

9. That if, hypothetically, economic means were available for the construction of huge freezing chambers, it would be convenient to give a thorough consideration to the problem before making such a disbursement because in a short time it might happen the same that occurred to the meat preserving plants when the freezing machine made its appearance. Science in this atomic age will basically change the freezing technique and that of transportation, and the time will arrive when the conventional plants become obsolete. In accordance with what has been previously stated, the same will not happen in Antarctica; quite to the contrary, the technological advance rapidly turns it all the more beneficial and usable. "Conclusively for a given permanence, technology draws us away from the conventional freezer, and brings us closer to the natural freezer."

10. From the experiments accomplished it was determined that the disbursement of funds for a natural freezing chamber is 20 times lower than that for a conventional one; its maintenance 100 times cheaper. By comparison: an artesian well and a water gasoline pump.

11. When the preserving capacity of Antarctica becomes entirely used, stock farmers, not only will be able to capitalize withholding wombs, but also in the other extreme, by making "savings" in kind (meats) with the certainty that such "savings", instead of turning out to be burdensome and the product being consumed by the price of the cold storage, will get to yield interests, especially if the deposit (or "savings") is made a long term one.

12. What has been said under 11 would bring about unsuspected consequences as regards bank credits for the farmers, meat packing plants, and also the stability of prices in benefit of the consumer. It would eventually be a real exhaust valve in the case of surpluses, a strategic stock of perishable foodstuffs, easy to preserve, to defend and to keep away from contaminating radiations.

13. Lastly, the comparison of costs in the Argentine Republic speaks for itself in clear-cut figures.

	Per kg
Cost of frozen preservation, per month, approx.	\$60.00
Cost of frozen preservation, per month, in Antarctica................................	0.00
Cost of maritime freight to London (15,000 km) approx....................................	18.00
Cost of maritime freight to Antarctica (round trip Orcadas-Buenos Aires) (7,400 km approx.)	8.00

Doubtless, when preservation of foodstuffs in Antarctica is fully availed of, it will be the most formidable commercial boon of all times.

Photos 1. and 2. Beef quarters given as a present by C.A.P. (Corporacion Argentina de Productores de Carne -- Argentine Corporation of Meat Packers) for the experiment.

Photo 3. Structural carpentry roof of 1-SH. Uruguay Bay in the background.

Photo 4. View of the same roof over the hillside of "La Monja" ("The Nun") Glacier.

Photos 5. and 6. Views of the outer aspect at surface level. The door of access, indicator mast, advective tube, cutwater, rope line, etc. can be seen.

Photos 7. and 8. Views of the outer aspect at surface level. The door of access, indicator mast, advective tube, cutwater, rope line, etc. can be seen.

Photo 9. Interior of 1-SH where the driftwind comes in through the S end. A beef quarter can also be seen hanging from the rack; and to the right a minimum thermometer and one thermograph.

Photo 10. View of 1-SH during the excavation of II-SH

Photo 11. Feeding hood with closed valve.

Photo 12. II-SH taken from above, the hanging bulb being a 500-candle one.

Photo 13. Installed advective tubes with feeding hood oriented to the S.

Photo 14. Operation of removing the feeding hood.

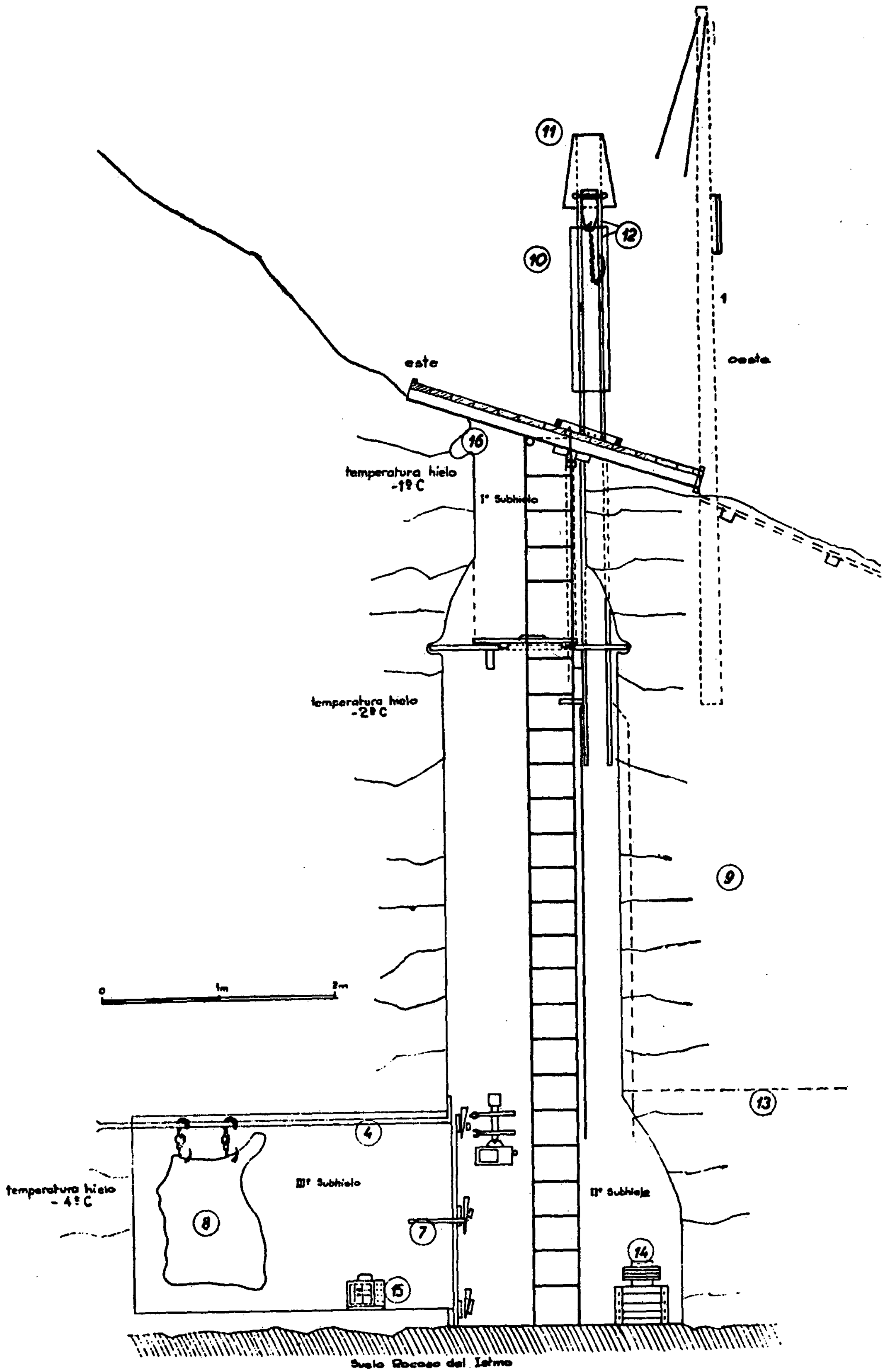
Photo 15. Excavation of the cutwater.

Photo 16. Rigging up the support for the deposit of falling snow.

Photo 17. Inauguration of the freezer.

Photo 18. View of the cutwater taken from inside.

Photo 19. Outlet of sewage tunnel. Recently formed stalactites can be seen in the foreground, and through a photographic phenomenon caused by the ice, luminosity and reflection, the man seems to be suspended in the air.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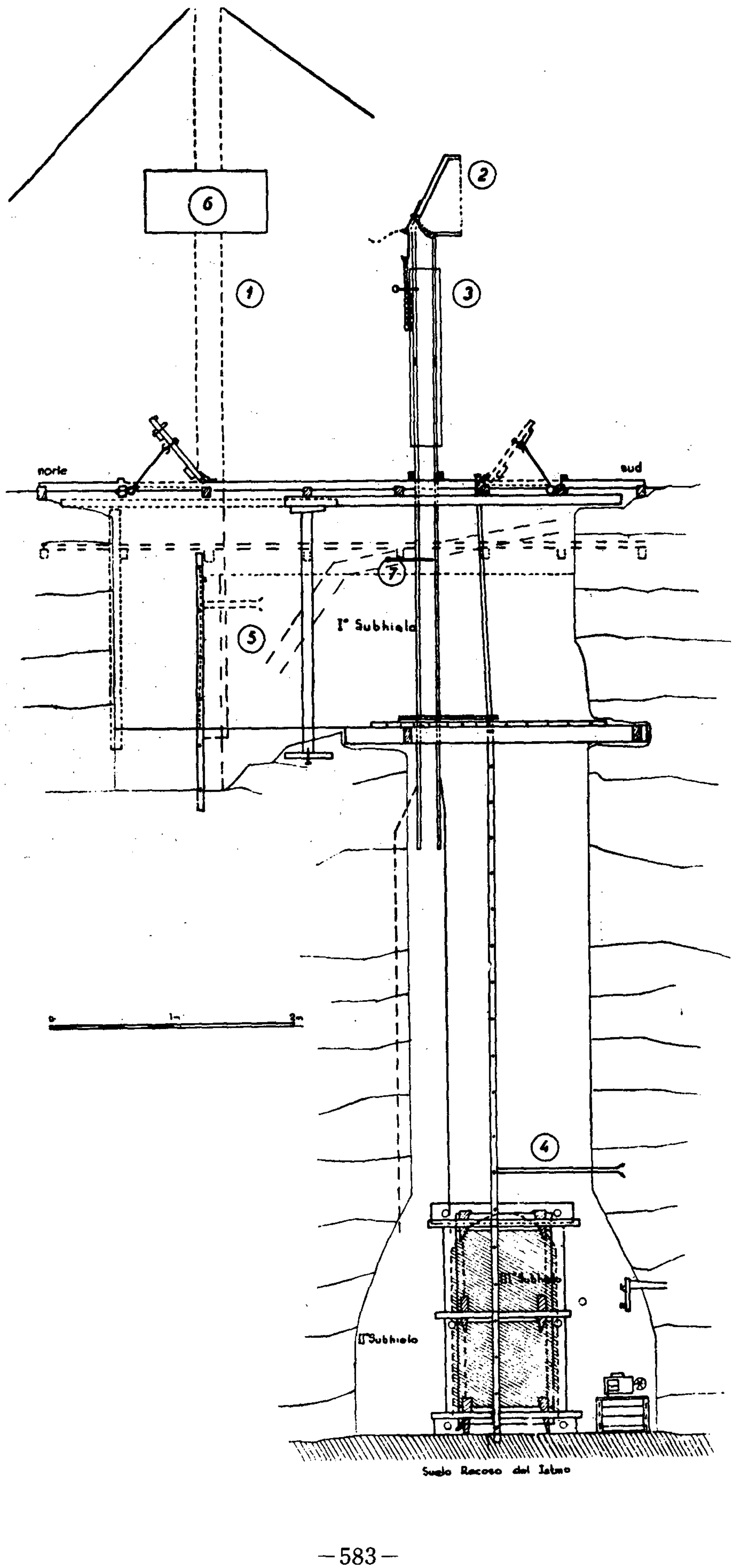

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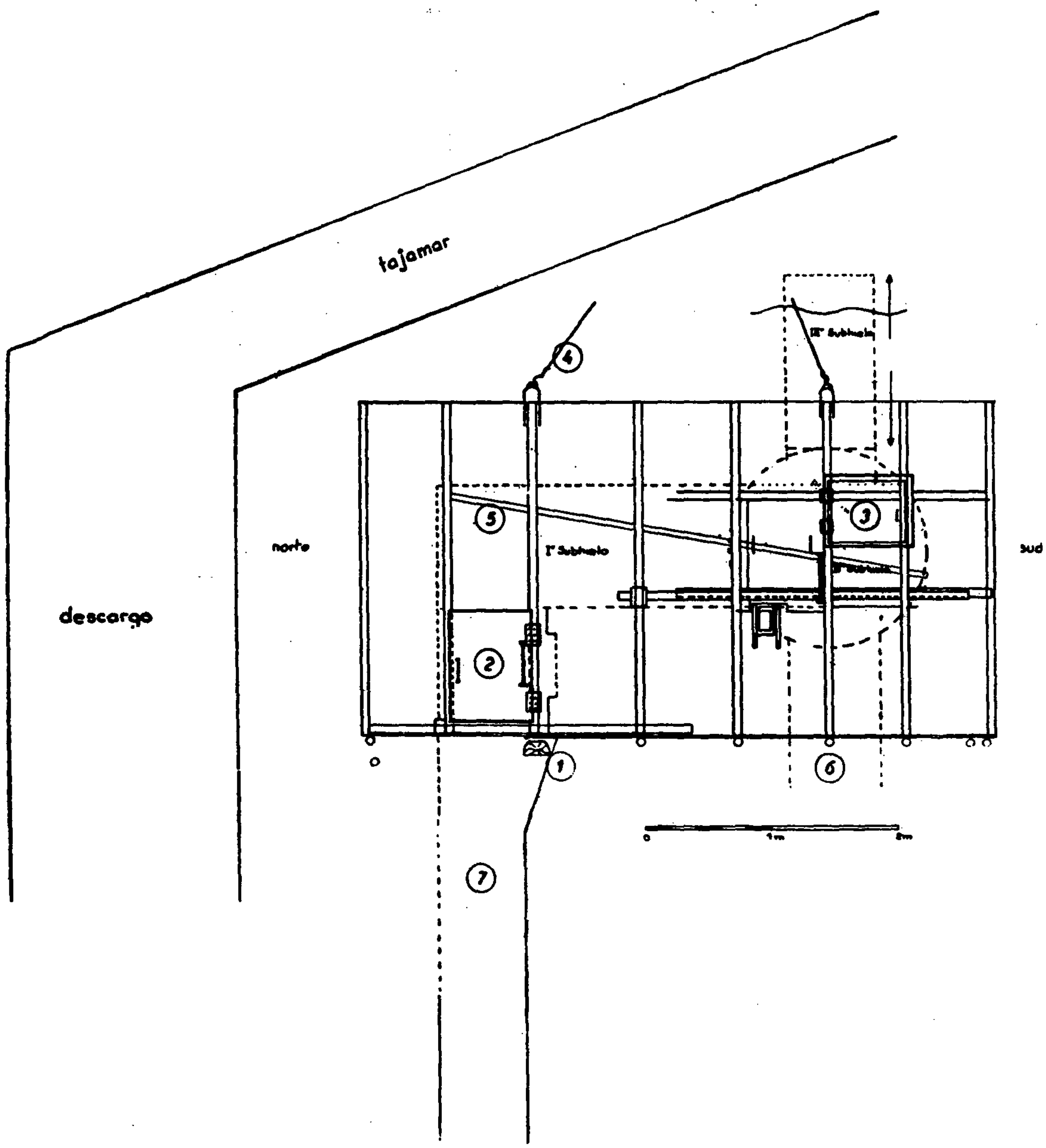
tajamar
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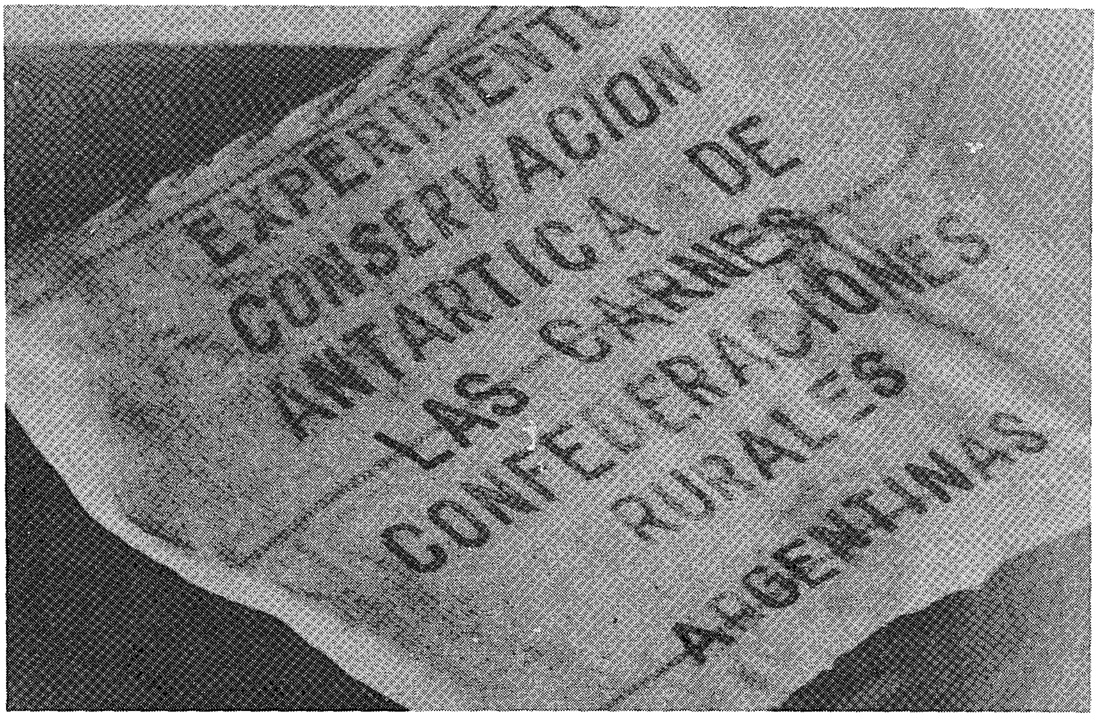

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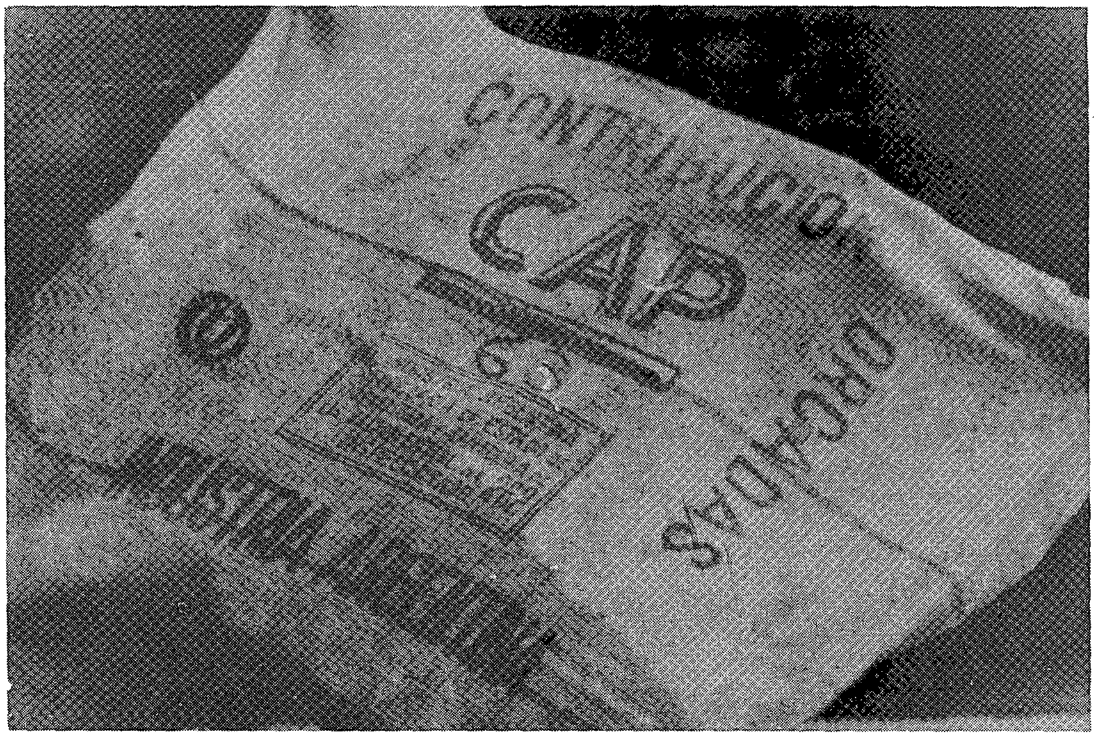

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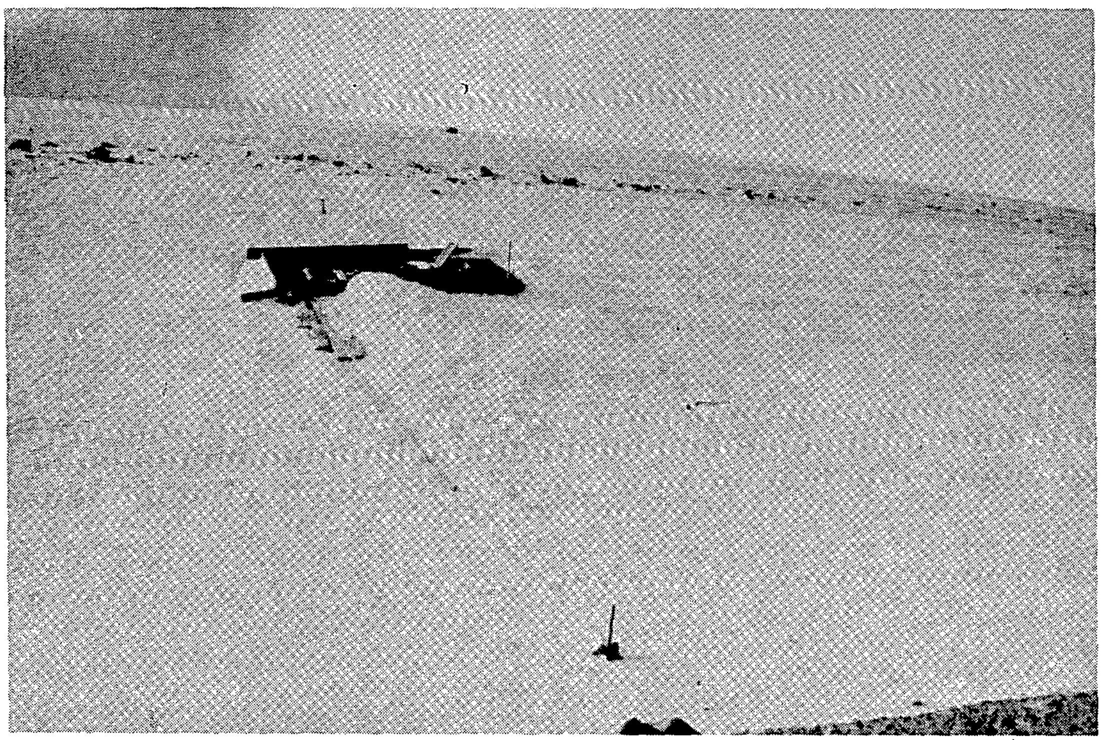

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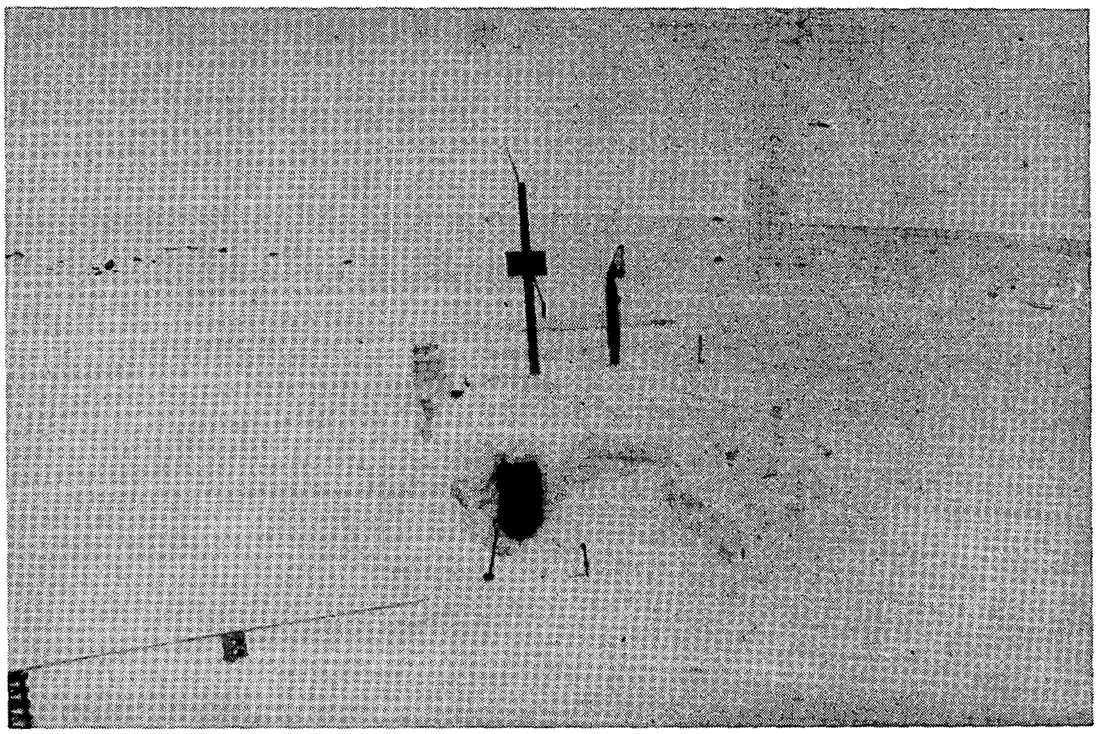

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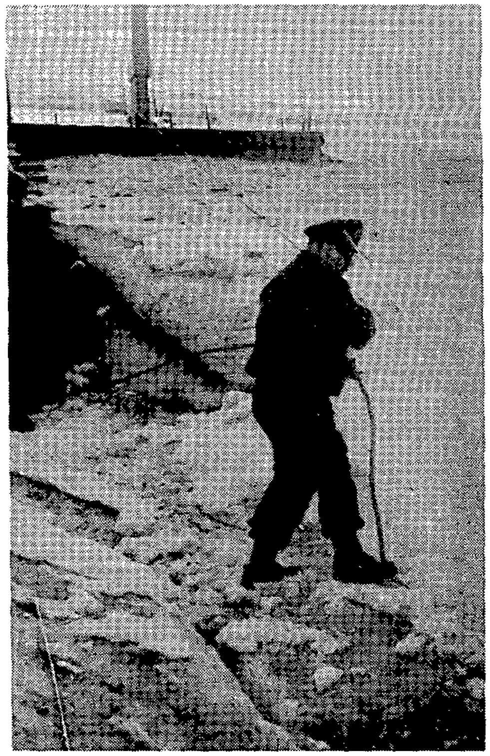

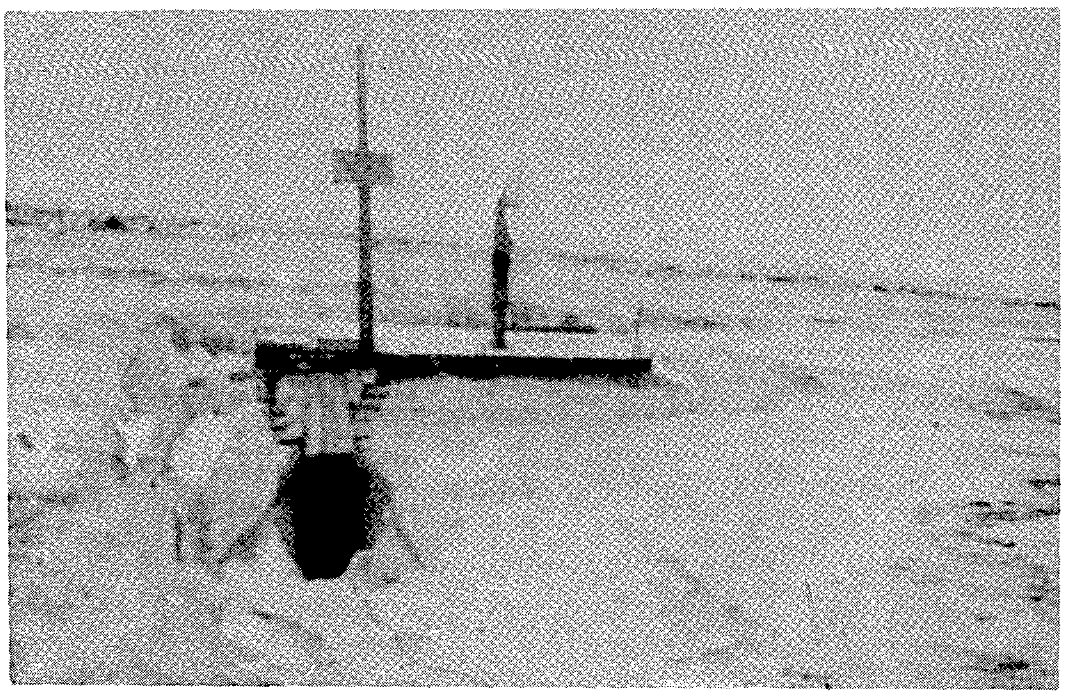

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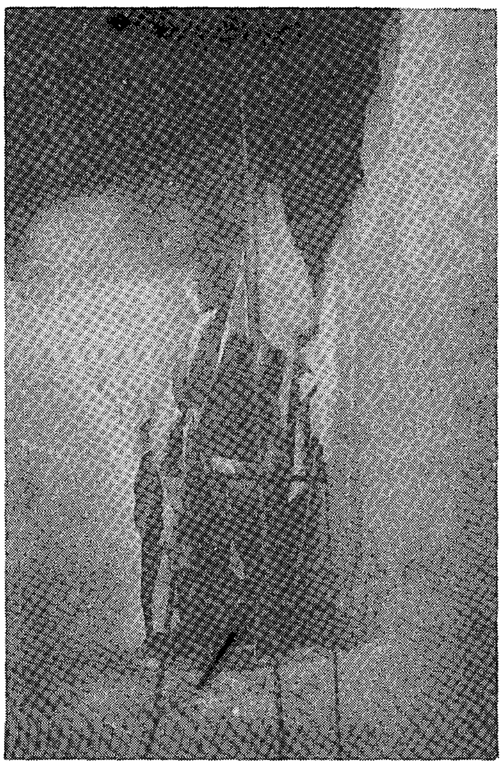
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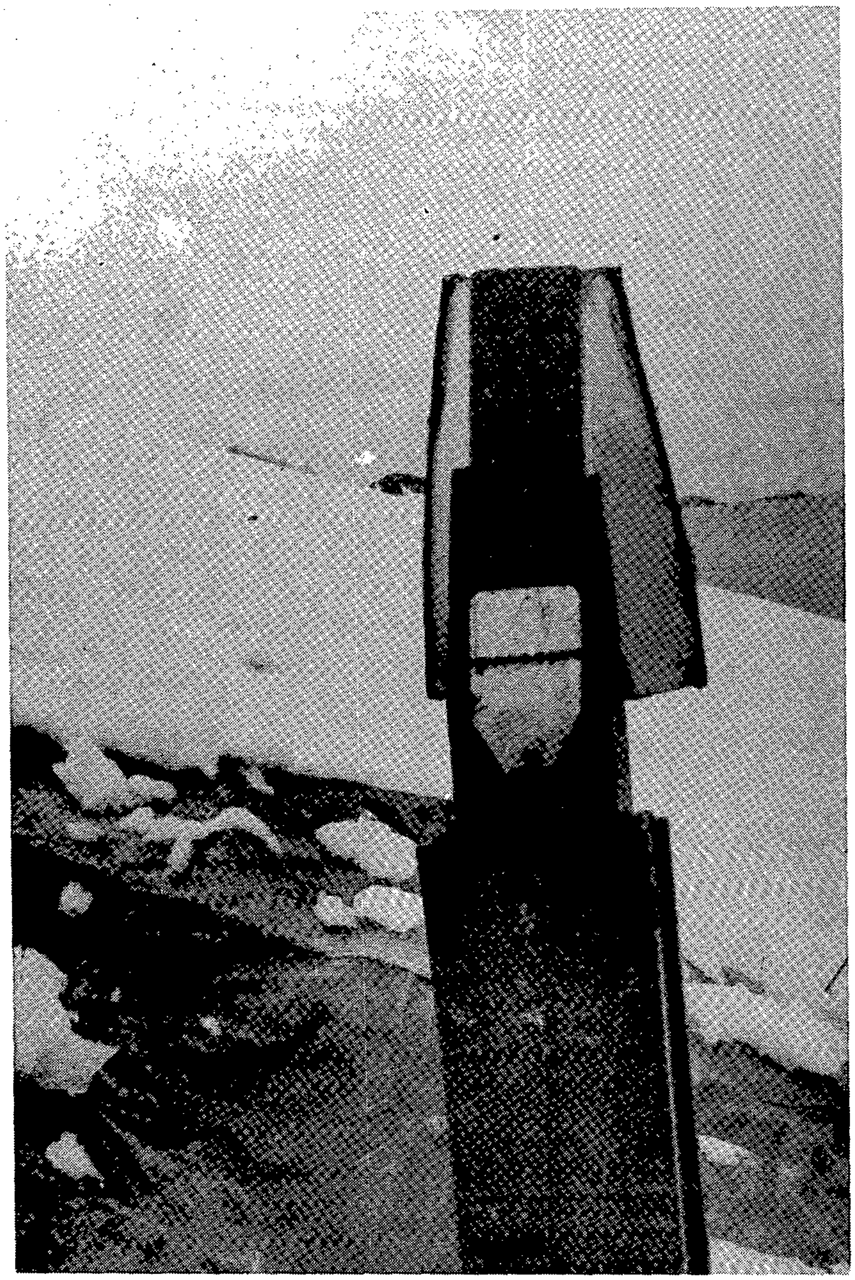

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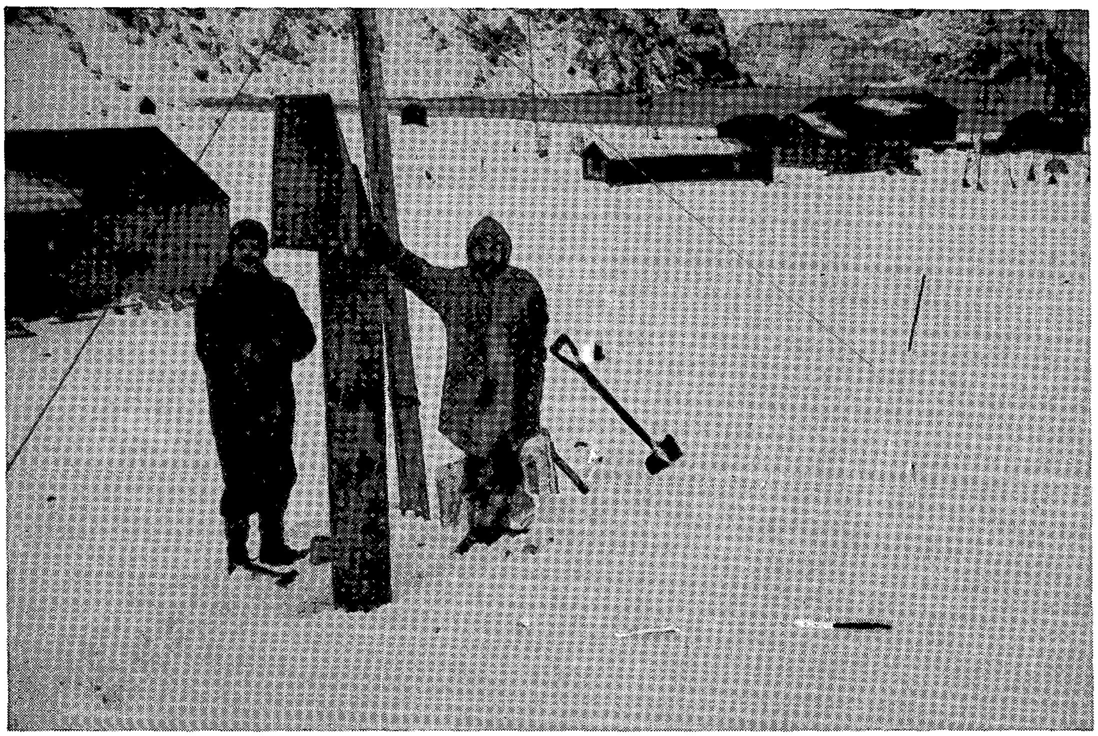

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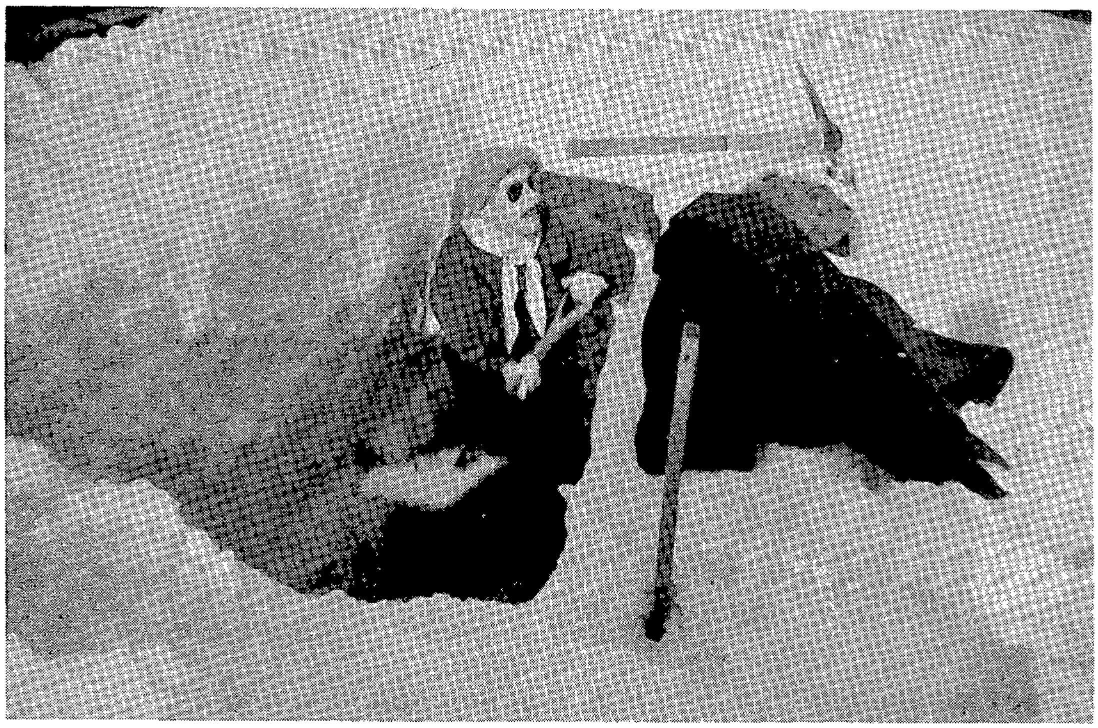

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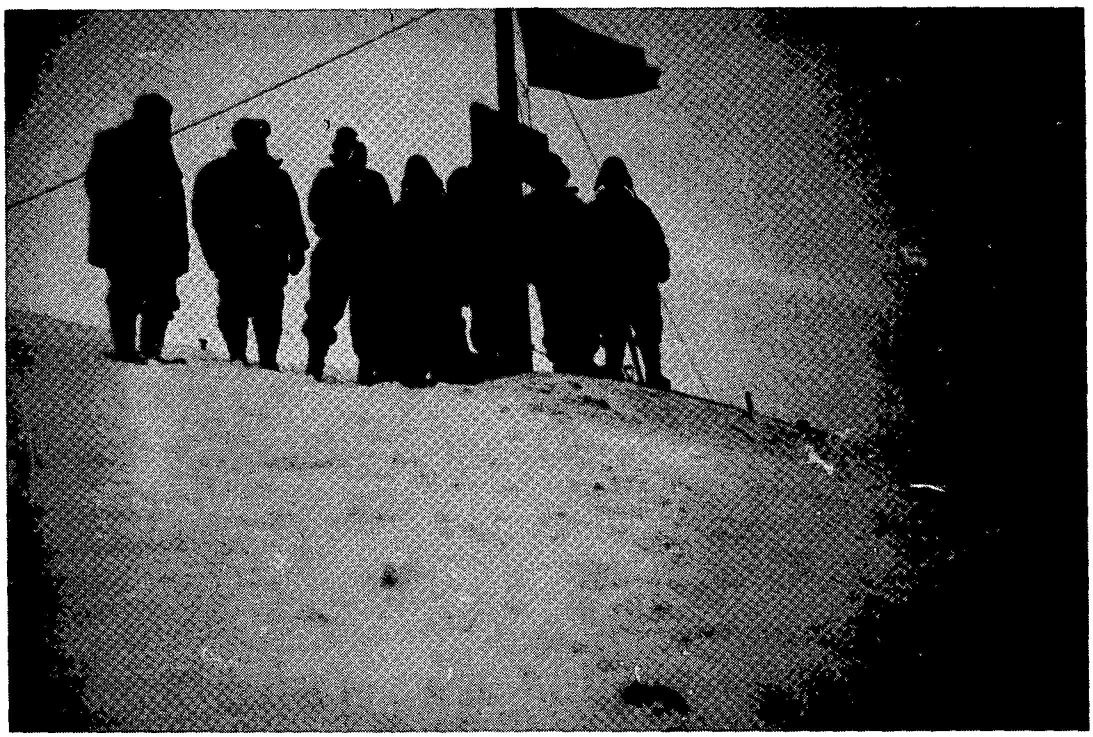

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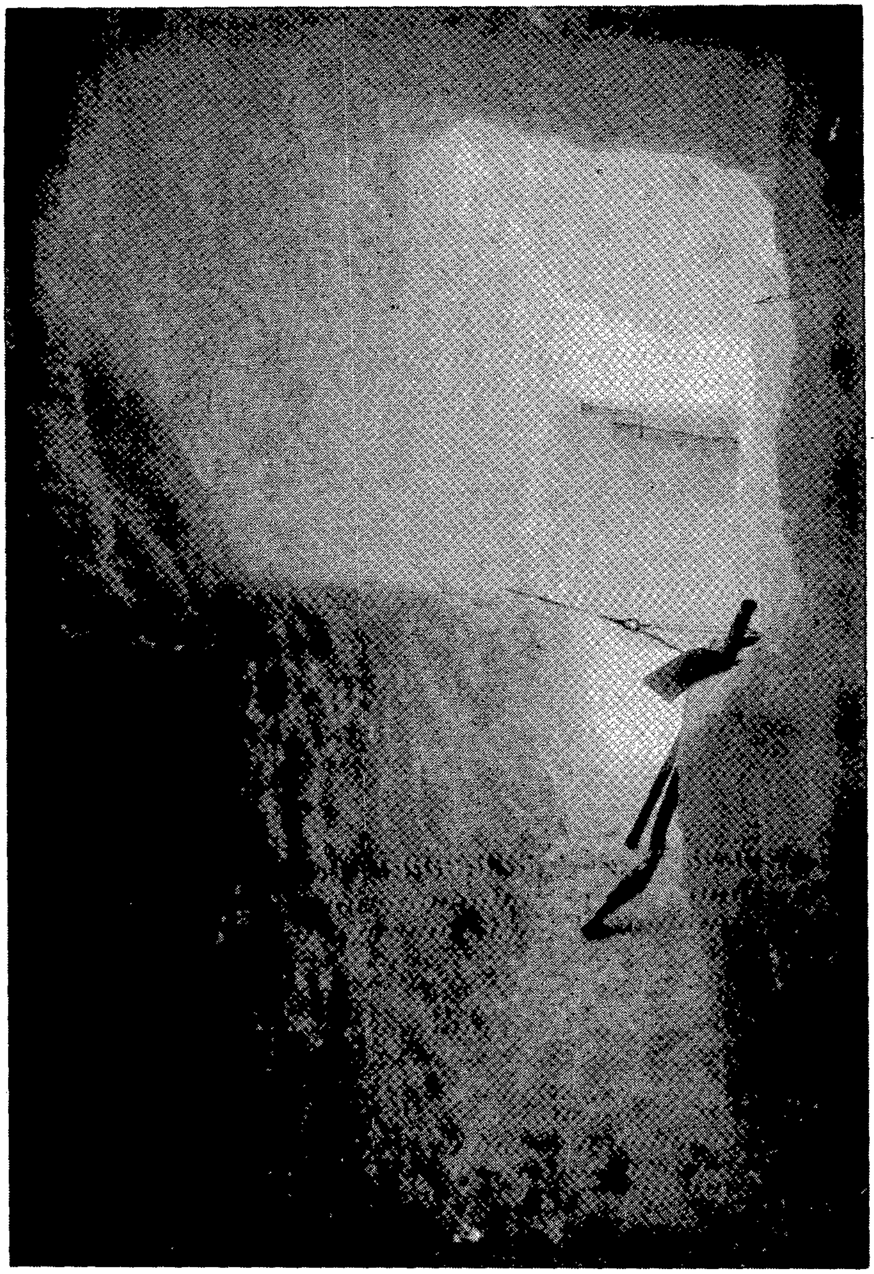

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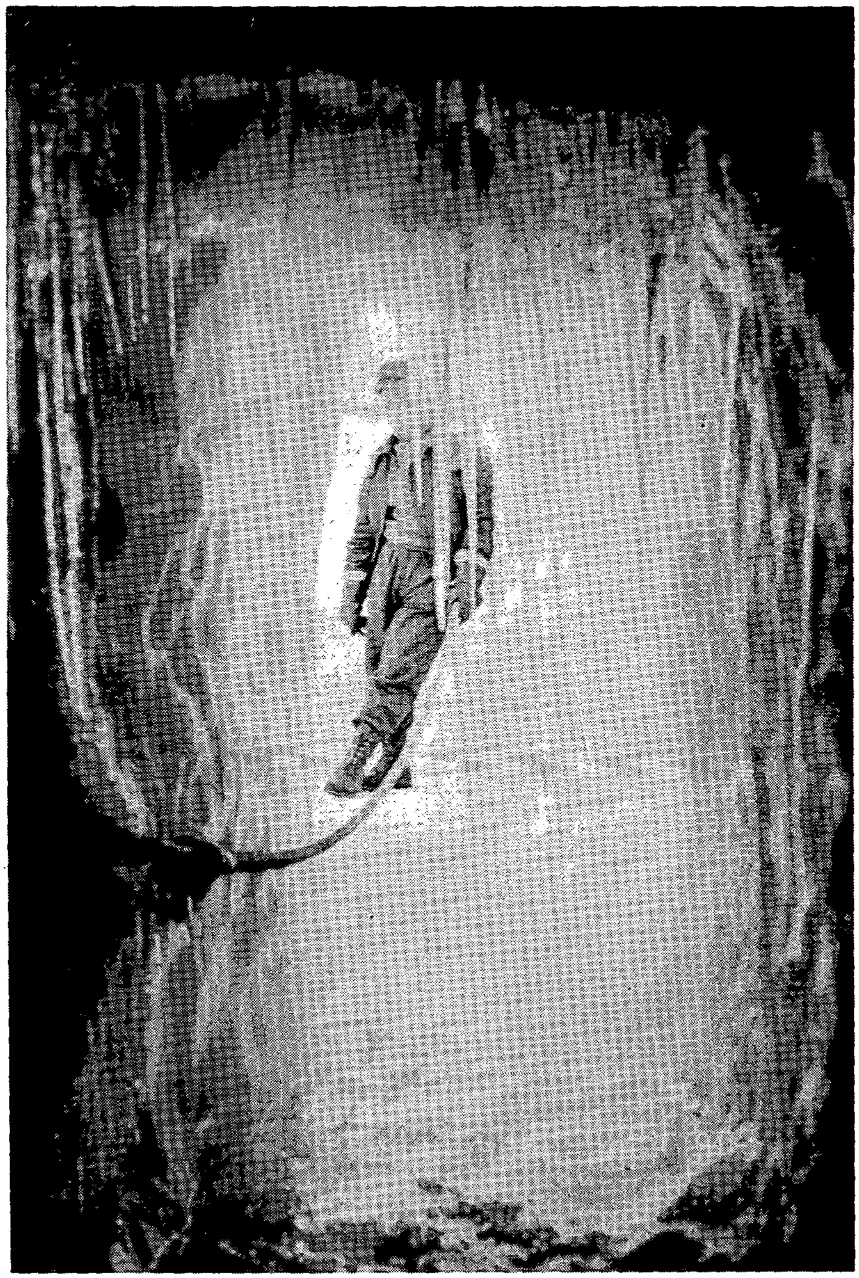

Photo 19

AUSTRALIAN EXPERIENCE WITH CLOTHING IN ANTARCTICA

N. Linton-Smith*

Abstract

Australian National Antarctic Research Expeditions (ANARE) use clothing for feet and hands selected from manufactures of countries with much colder climates than Australia; other types of clothing are generally manufactured locally, either to normal commercial design, or especially to ANARE design. The factors which influence selection and design are discussed, and the clothing ensemble presently used for extreme cold is described. The complete ANARE clothing issue list is included.

1. History of Development

In the early days of ANARE, just after World War II, when stations were operated on subantarctic islands only, nearly all clothing was purchased from war surplus stores which were being disposed of by the RN, the USN, the RAN, and the RAAF. For some years, the Antarctic Division continued to purchase a high proportion of armed service clothing, both new and through disposals, with help from the armed services of Britain, the USA, and Australia.

The Korean war caused a sharp acceleration in the development of service clothing and again ANARE benefited by being able to obtain better boots from both the USA and Britain. (The US army insulated boot (cold/dry) and the British army boot (cold/wet) were both used in Korea and subsequently adopted by ANARE.) We still depend on the sources of supply of the Canadian, the US, and British armies for most of our foot and hand wear.

As the Division diverted more effort into the design of clothing, our dependence on the services became less, and the Scott Polar Research Institute was particularly helpful with advice.

At present, except for the army foot and hand wear, most of our clothing is especially made to our design or is obtained from normal trade sources.

2. Sources of Supply

The provision of clothing to the Australian expeditions is a demanding but interesting task in a country with temperature to tropical climate. There is no large-scale cold-weather clothing manufacture in Australia, and the industry is not generally interested in turning out special garments in the small numbers required for our expeditions. Approximately one half of our

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clothing funds for both cloth and made-up clothing is spent overseas in countries such as Britain, Canada, the USA, and Norway.

3. Styles and Colour

Clothing must first of all be functional. Fashion or appearance must always be secondary considerations after the functional nature of the clothing has been established. This makes it difficult to achieve an attractive appearance, but we try hard to do so, because brightly coloured, well styled clothing adds significantly to the psychological well-being of an expedition. Bright colours show up well outside and can also be a means of identifying a person at a distance. It is potentially hazardous, of course, for expeditions in Antarctica to wear clothing of colours which tend to blend with the surroundings. We supply as many colours as we can obtain, and shades as bright as possible consistent with dye-fastness in laundering.

This year our expeditioners are wearing bright orange or yellow windproofs trimmed with natural wolverine fur; white insulated boots or mukluks (US and Canadian army issues); five different types of socks in perhaps ten different colours; woolen shirts in bright red and black, or green and black, checks; woollen sweaters in red, green, blue or orange; down parkas in black, blue, wine and green; and underwear/pyjamas in red, blue, green and fawn. Some garments have red or yellow delrin zip - fasteners which add a brilliant finish to them. Some of the colours seem garish when seen in normal urban surroundings, but in Antarctica they are appropriate and preferred, whether indoors, in the glare of sunshine and dazzling reflected light,or in the pale gloom of white-out.

For formal occasions, such as going away ceremonies etc., we have a dress uniform of dark reefer jacket and grey trousers. The jacket pocket bears the ANARE emblem in gold embroidery.

The Division supplies every man with all his clothing "from skin out", except the reefer jacket. The issue of indoor and summer wear is usually augmented by individuals' own clothing which they choose to take with them, but the issue is adequate if care is taken. Attached may be found lists of clothing pertaining to 1968 expeditions.

4. Description of Clothing for Cold/Wet Climate
(for temperatures of -10°C to + 10°C, with strong wind, rain, sleet and snow)

ANARE expeditions began when the Heard and Macquarie Island stations were established in 1948, and many experiements have been carried out with clothing there. The rainy and windy climate at those stations is quite a challenge to the designer of clothing for people whose only means of travel is walking, carrying a pack. The three types of outer clothing which are most popular on Macquarie at present are as follows:

No.	Garment	Cloth used	Comments
1	Pullover parka and trousers lightweight	Hypalon coated nylon single layer	Durable and waterproof. Too hot for much walking. Ideal for biological work at waterside. Supplied at present to M.I. but not to Continent.
2	Zip-up parka and trousers	English L19 Ventile fully lined with L34 Ventile	Durable and acceptably waterproof. Can be reproofed. Supplied at present to all stations including Continental ones.
3	Zip-up parka and trousers	Canadian Quarpel-proofed nylon/cotton combat cloth, fully lined with the same	Under trial for the first time by four men at M.I.

At present, every man going to Macquarie Island receives No.2. This suit is waterproof, vapour-permeable and elaborately ventilated. It is easily the most popular outer suit used on the island.

5. Description of Clothing for Cold/Dry Climate

(for temperatures of -50°C to +5°C, with winds to 240 k.p.h., and driving snow).

Since our first base on the Antarctic continent was established in 1954, the clothing used has undergone considerable development. As on Macquarie Island, our clothing has to be suitable for walkers, because dog teams are still used on the coastal runs to the penguin rookeries and in heavily crevassed areas.

5.1 Outer Wear

We have always had this manufactured locally from imported cloth. At first the cloth used was English L28 (8 oz.) Ventile in a single layer. We then changed to L19 ($6\frac{1}{2}$ oz.) Ventile with a 4 oz. japara lining. Nylon/cotton, in the form of Wyncol, then had a few years use, and other cloths from other countries were tried from time to time. For some years now we have used L19 Ventile with a lining of L34 (4 3/4 oz.) Ventile. This year we are using the same cloths and are also trying six suits at each station made from Quarpel-proofed Canadian combat cloth of nylon/

cotton, and approximately 5 oz. per square yard. As with the cold/wet clothing, the cloth used in cold/dry clothing must be water-resistant, vapour permeable and windproof. It is desirable that it be flameproof but it must also be durable and resist accumulation of static electricity. At present the Ventiles have most of these attributes, and it is a considerable advantage to be able to use the same cloth at all stations, (wet or dry). It has been our aim to use the same parkas and trousers at all stations too. Further trials are being carried out, because a mixed response came from our first year of trial of Macquarie Island outer clothing at Mawson and Wilkes.

5.2 Face Protection

The blizzard visor described earlier(1) has not been adopted, owing to changes in design of our parka and other factors which have relieved the problem of face protection in most circumstances. In common with parkas of some other nations, our parka now has a tunnel-like extension on the hood which is rimmed with wolverine fur on a malleable wire edge. A double-layer knitted balaclava and large ventilated goggles complete the official issue, but individuals have gone further and made sheepskin nose-protectors held by a band around the head to the top of the nose. This has left only the nostrils exposed.

5.3 Electrically Heated Gloves and Socks

Gloves and socks knitted from terylene, with heating wires knitted in, operating from the 12-volt supplies in vehicles, were tried for two successive years at both stations. While they were working they were popular with over-snow vehicle drivers. Trouble arose when they failed because they caught fire. Fortunately, no one was seriously burned, but the overall experience has prejudiced any future use of these garments, and remaining serviceable units have been withdrawn. It proved to be too difficult to foresee or prevent damage to the garments while they were being worn.

5.4 Vapour-Barrier Clothing

Coated nylon cloth was tried out in the early days in the following ways; this was, of course, prompted by the idea of keeping the insulation dry, and therefore effective, and experience on the very wet Heard and Macquarie Islands would have had a strong influence:

1. Sleeping bag liners of this cloth were provided. They were not popular.

2. Ventilated clothing of the same cloth was tried. It, too, was not popular and experiments were discontinued.

3. The US army insulated boots, as developed for Korea and subsequently

improved, were tried and have remained in use for quite a few years. They are popular with perhaps half the expeditioners, the other half finding them uncomfortable and much preferring vapour-permeable footwear such as mukluks.

In any clothing the insulating layers of the clothing must be kept dry. Hence, in vapour-barrier clothing, unventilated vapour-barrier underwear or ventilated vapour-barrier outerwear must be worn to maintain this dryness. The first requires the person to be wet all over, which is usually unacceptable and the second involves, through ventilation, the continuous loss of warm air which should remain trapped in the insulating layers of clothing.

Experience has led to rejection of vapour-barrier clothing, and good vapour permeability is considered essential.

5.5 Typical Ensemble for Extreme Cold

A typical expeditioner, in the field, in wind at -50°C, would probably be wearing the following:

cotton string single and shorts, under a long-sleeved pure wool singlet and flannel pyjama pants;

coloured flannel shirt and pure wool venetian working trousers;

two woollen sweaters or a Canadian down-filled nylon ski parka;

one pair of nylon socks and one pair of long Norwegian ragsocks;

one pair sheepskin inners for mukluks, or one pair of double duffle socks;

one pair felt insoles resting on one pair saran mesh insoles;

one pair Canadian army nylon mukluks;

one pair double-silk instrument gloves;

one pair woollen mittens;

one pair Canadian army outer mittens;

one woollen balaclava, or fur-lined cap;

one pair goggles;

one wolverine fur-trimmed outer parka;

one pair outer trousers.

The complete ensemble weight about 10 kg. This could vary a few kg, either way, according to sizes chosen and to whether the light-weight ski parka is chosen instead of the heavy sweaters.

Reference

(1) Black, H. P. A blizzard visor for improved vision. Symposium on Antarc- Logistics, Boulder, Colorado, 1962, pages 520-523. National Academy of Sciences, Washington, USA.

DEPARTMENT OF SUPPLY
ANTARCTIC DIVISION
OFFICIAL CLOTHING ISSUES, 1968 EXPEDITIONS

EXPLANATIONS.

Personal issue: Issued in Melbourne.

Group stock: This comprises:

(A) special clothing for field work or work at the station;
(B) replacements for worn-out clothing on personal issue;
(C) bed clothes and towels.

Issues made from group stock constitute loans and items issued should be returned to the station OIC when they are no longer required.

According to their condition on their return, the station OIC should do the following:

(1) return them to the station store for use in the future;
(2) return them to Australia for cleaning or repair;
(3) dispose of them as he thinks fit.

e.g. The group stock establishment (at the beginning of the year) of, say, trousers working, 2 pairs per man, does not automatically entitle every man on the station to 2 pairs of trousers. The trousers are there in case of accident to, or wearing out of, those issued in Melbourne. Also, garments which are normally used only on field work, such as parkas and trousers Ventile, parkas and trousers down-filled, parka furs, mukluks, big mittens, Rod goggles etc., must be issued for field work only. The fact that sufficient field clothing is provided to outfit every man on the station, does not entitle anyone who is not doing field work to any of such special clothing.

Emergency reserve

This stock should be used only in the even of loss of the normal clothing stocks, e.g., by fire. The emergency reserve clothing should be stored in an isolated fire-proof building having neither heating, lighting nor electricity. All this stock must be returned to Australia at the end of the year as it is completely replaced every year.

Reordering procedures

Re-orders should be completed by 15th June. Page 73 of Operations Manual November 1964, as amended October 1965, explains the method. Estimated quantities remaining at change-over, of each item on the current clothing list (the list must be identified), must be stated in sizes where applicable. The sizes are most important. Identification should be by the list numbers with every tenth item named in full. Any errors discovered in the re-order later in the year should be reported so that rectification can be done at Head Office. Emergency reserve clothing is not to be included in the re-order.

Items usually returned to Australia for cleaning are:

blankets;
down-filled parkas and trousers;
down-filled sleeping bags;
mattress covers.

Other items which could be added to this list are:

parkas and trousers, Ventile;
jackets, fur-lined;
parkas and trousers, windproof;
furs for parkas, Ventile;
mittens, US Arctic.

Antarctic Continent Personnel (Mawson and Wilkes)
1968 Expeditions

Members are to be offered two optional combinations* as follows:

(1) parka windproof, camouflage or green;
trousers do. do. ;
sweater roll neck;
sweater shawl neck;
sweater, crew or vee neck;

(2) ski parka, down-filled;
trousers, windproof, camouflage or green;
sweater, crew or vee neck.

Both combinations of clothing have been proved in practice to have exactly the same thermal insulation for any given temperature and wind conditions. Both parkas are adjustable for ventilation by means of a full-length frontal zip.

The important differences between the two combinations are as follows:

Property	Combination 1	Combination 2
Weight	About 8 lbs.	About 4½ lbs.
Adjustability	For top, four separate layers available as required.	For top, two separate layers available but, in addition, the thick parka is adjustable for warmth in the front by means of the long zip. Occasionally there could be situations when the back would be too warm.

Should members have difficulty deciding, the personal recommendation of the Senior Technical Officer (Field Equipment and Clothing) is offered.

Combination 2 is preferred because it is:

(1) much easier to adjust for varying conditions;

(2) much lighter;

(3) less complicated.

Item No.	Description	Personal Issue	Group Stock Establishment at Beginning of Year	Emergency Reserve Establishment at Beginning of Year
1.	Jacket, fur-lined	-	1 per man (M. only)	-
2.*	Parka, windproof, comouflage or green	1	12	1 per man

Item No.	Description	Personal Issue	Group Stock Establishment at Beginning of Year	Emergency Reserve Establishment at Beginning of Year
3.	Trousers windproof, camouflage or green	1 pr	12 prs	1 pr per man
4.*	Sweater, shawl neck	1	12	-
5.*	Sweater, roll neck	1	-	-
6.*	Sweater, crew or vee neck	1	-	1 per man
7.*	Ski parka, down-filled	1	-	-
8.	Parka windproof, Ventile	-	1 per man less 5	-
8A.	Parka windproof, Quarpel	-	5	-
9.	Parka waterproof, Ventile	-	6	-
10.	Trousers windproof, Ventile	-	1 per man less 5 prs	-
10A.	Trousers windproof, Quarpel	-	5 prs.	-
11.	Fur for parka, Ventile	-	1 per man	-
12.	Parka, down-filled	-	12	-
13.	Trousers, down-filled	-	12	-
14.	Trousers, working, Venetian green, grey or RAAF, WSD	1 pr	2 prs per man	1 pr per man
15.	Trousers, dress	1 pr	-	-
16.	Jacket, reefer (on repayment)	1	-	-

Item No.	Description	Personal Issue	Group Stock Establishment at Beginning of Year	Emergency Reserve Establishment of Beginning of Year
17.	Suit overall, top level etc.	1	2 per mechanic mech.-driver electrician plumber carpenter storeman	-
18.	Suit overall, NZ	-	1 per man	-
19.	Cap, ski, peaked	1	10	-
20.	Cap, balaclava, Jaeger	1	10	-
21.	Cap, balaclava, Australian or Canadian	1	10	1 per man
22.	Boots, British army, C/W.	1 pr	1 pr per man	-
22A.	Insoles, mesh for C/W boots	1 pr	2 prs per man	-
23.	Boots, Aust. army H.H. or non slip	1 pr per mechanic mech.-driver electrician	-	-
24.	Boots, rubber knee	-	8 prs	-
25.	Boots, thermal	-	16 prs	-
26.	Boots, mukluk outer	-	2 prs per man	1 pr per man
27.	Boots, mukluk inner	-	3 prs per man	1 pr per man
28.	Boots, mukluk insoles	-	3 prs per man	1 pr per man
29.	Boots, tent, Australian	-	1 pr per man	-
30.	Boots, hunting	-	5 prs	-

Item No.	Description	Personal Issue	Group Stock Establishment at Beginning of Year	Emergency Reserve Establishment at Beginning of Year
31.	Slippers, Chester, Grosby or Clark, or desert boots	1 pr (2 prs to cooks)	8 prs	-
32.	Bootlaces, cotton	-	4 prs per man	2 prs per man
33.	Bootlaces, leather	2 prs	2 prs per man	2 prs per man
34.	Gaiters, long, size 6	-	1 pr per man	-
35.	Socks woollen, Australian army	4 prs	4 prs per man	-
36.	Socks ski, Norwegian short	2 prs	2 prs per man	4 prs per man
37.	Socks, Hebridian	1 pr	1 pr per man	-
38.	Socks ski, Norwegian long	-	4 prs per man	-
39.	Socks, wool/nylon, Holeproof	-	2 prs per man	-
40.	Socks, nylon stretch	2 prs	-	-
41.	Mask, blizzard	-	16	-
42.	Scarf	-	10	-
43.	Mittens, woollen, Norwegian	1 pr	2 prs per man	2 prs per man
44.	Mittens, woollen, Hebridian	1 pr	-	-
45.	Mittens, leather Australian	-	1 pr per man	-
46.	Mittens, trigger finger, outer	1 pr	2 prs per man	-
47.	Mittens, trigger finger, inner	1 pr	2 prs per man	-

Item No.	Description	Personal Issue	Group Stock Establishment at Beginning of Year	Emergency Reserve Establishment at Beginning of Year
48.	Mittens, Canadian, outer	-	8 prs	-
49.	Mittens, Canadian, inner	-	8 prs	-
50.	Mittens, US Arctic	-	14 prs	-
51.	Gloves, Australian, soft leather	1 pr	1 pr per man	-
52.	Gloves, Tuf-Duk vinyl	1 pr	1 pr per man	-
53.	Gloves, cotton working	1 pr	-	1 pr per man
54.	Gloves, instrument, silk or cotton	-	1 pr per man	-
55.	Gloves, instrument, cape leather	-	1 pr per man	-
56.	Mittens, half finger	-	1 pr per man	-
57.	Wristlets, woollen	-	2 prs per man	-
58.	Gloves, rubber household, Ansell	-	2 prs per man	-
59.	Gloves, rubber, heavy duty, Kenta	-	1 pr per man	-
60.	Shirt, coloured flannel	1	1 per man	1 per man
61.	Shirt, khaki, cotton or polyester	1	1 per man	1 per man
62.	Shirt, cotton, white	1	-	-
63.	Singlet, cotton, athletic or tee shirt	3	-	-
64.	Single, string, Sutex	2	-	-

Item No.	Description	Personal Issue	Group Stock Establishment at Beginning of Year	Emergency Reserve Establishment at Beginning of Year
65.	Singlet, long sleeves, buttoned neck	2	2 per man	1 per man
66.	Drawers, P.T.U's	3 prs	-	-
67.	Drawers, pyjama	2 prs	2 prs per man	-
68.	Drawers, woollen, long	-	-	1 pr per man
69.	Pyjama suit	2	-	-
70.	Blanket	-	6 per man	4 per man
71.	Sheet	-	3 per man	-
72.	Pillow slip	-	2 per man	-
73.	Mattress cover	-	1 per man	-
74.	Towel	-	4 per man	-
75.	Kitbag	2	-	-
76.	Braces	-	6 prs	-
77.	Belt	1	1 per man	-
78.	Sungoggles, Meiss	1 pr	10 prs	-
79.	Sungoggles, Rod	-	10 prs	-
80.	Housewife	1	-	-
81.	Toilet bag	1	-	-
82.	Comb	1	2 per man	-
83.	Razor blades, packet of 5, stainless	1	6 per man	-
84.	Nail brush	1	10	-

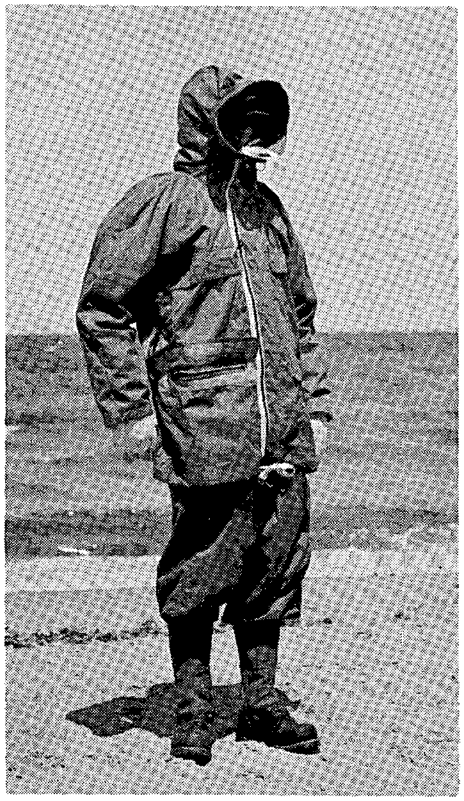


Fig. 1. ANARE cold/wet clothing, waterproof and vapour permeable.

Fig. 2. ANARE cold/dry clothing.

Item No.	Description	Personal Issue	Group Stock Establishment at Beginning of Year	Emergency Reserve Establishment at Beginning of Year
85.	Shaving brush	1	-	-
86.	Tooth brush	2	4 per man	-
87.	Clasp knife	1	10	-
88.	Shoulder flash	1	10 (for visitors)	-
89.	Lapel badge	1	-	-
90.	Pennant	-	10 (for visitors)	-
91.	Chef's jacket	2	-	-
92.	Chef's trousers	2 prs	-	-
93.	Chef's hat, tall	2	-	-

USE OF SYNTHETIC-FIBERS IN PERSONAL EQUIPMENT, ESPECIALLY IN SNOW BOOTS FOR J.A.R.E.

Testuya Torii

Summary

Since Japan's participation in the Antarctic Research Expedition in the IGY, the Japanese teams have consistently used synthetic-fiber products in most of their members' antarctic outfits. Sleeping bags and cold weather clothing, in particular, are fine examples of synthetic-fiber products which have effectively proved their real worth during frequent field-study expeditions carried out there by the members.

As regards the recently-developed antarctic boots, mainly made from low-moisture polyvinyl chloride ("Teviron") felt, it has been observed that, at temperatures down to 50 degrees C. below zero, these boots clearly have greater advantages over conventional snowboots from the standpoint of both perspiration and warmth.

Our experience from a year-long use of these boots in the Antarctic last year indicates that they indeed possess adequate capitalities in cold-protection, warmth, comfortable easiness of action and durability.

1. General

As was stated at the Logistics Symposium, 6th SCAR meeting, Boulder, U.S.A., 1962, a large quantity of synthetic-fiber products have been, and are, used in the antarctic outfits of the Japanese team. For instance, polyester staple, in place of eiderdown, has been used successfully in sleeping bags (double-layered) and cold weather clothing; polypropylene working gloves have proved to be excellent in workability as well as in heat insulating abilities when used under leather gloves. It is true that natural fibers are preferred in some items: e.g. all the cutter shirts, sweaters and skiing socks used in JARE (Japanese Antarctic Research Expedition) are woollen; some underwears and gloves are of natural fibers and others are of synthetic fibers. However, the general predominance of synthetic-fiber products in the JARE equipment is believed to be worthy of special mention.

Synthetic-fiber cold weather outfits are not expensive, and are easy to wash. The washability is highly appreciated by the JARE office because it is customary with the JARE to accomodate the personnel with the personal equipment including a sleeping bag and some cold weather outfits, and collect them for repeated use after the expedition is over.

Two trips were made in JARE 1967 - 68: to Molodezhnaya Station in August, 1967, and to Plateau Station during the period from November, 1967, and January 1968. All the synthetic-fiber gear used in these trips (Table 1) proved to be perfectly serviceable at temperatures down to -50°C.

2. Snow Boots

Antarctic boots of various materials, such as natural leather, woollen felt, seal skin, etc., have been tried by the JARE teams since 1956. With all of them the trouble was that the condensation of water on the inside of the boots due to perspiration substantially deteriorated the heat insulation in cold weather. If the boots were made of a material through which neither water nor water vapour can penetrate at all the inside could be kept warm, but this would mean that the wearer's feet become dripping wet. This we did not like. So we started a study to solve the problem by adopting synthetic-fiber materials through which the water vapour can penetrate at an adequate rate.

At present five groups of boots (Table 2), all of synthetic-fibers, are employed in JARE: rubber boots and working boots for the summer season, snow boots and indoor boots for the winter season, and Mukluks for the field work. Among these, the snow boots mentioned in the third place that have proved especially good for use at lowest temperatures are described below in some detail.

The construction of the boots is illustrated in Fig. 1.

They are essentially made of polyvinylchloride fiber (TEVIRON). This material was chosen after a systematic test at the Institute of Low Temperature Science, Hokkaido University, Sapporo. Test boots of the same type and size were made of nylon, polyester, polyvinylchloride and polyacrylic fibers, and of natural felts. Test wearers put on these boots and stayed in a large low temperature room. The changes in the skin temperatures of the wearers' feet were observed as functions of time. Polyester and polyvinylchloride boots were found to be the best in heat insulating properties at temperatures down to -60°C. The latter was chosen finally because it absorbs less water (Table 3) and can be felted by heating to 60-70°C --- a convenient property for making boots. Even the hard insteps can be prepared by further heating. This kind of boots have been tested since 1964 by Japanese scientists dispatched to the Arctic Drifting Station ARLIS - 2 and the American and New Zealand Stations in the Antarctic as well as by wintering members there. The results were satisfactory.

Our own experience in JARE 1967 - 68 also proved the excellence of these snow boots. No one complained of cold toes during the wintering period including those days that were spent in the fields. Two insoles were used: a SARAN insole on top of polyvinylchloride felt insole. It would be worthy of note that even in the field surveys it was not necessary to change the insoles every day.

This is most probably due to the fact that polyvinylchloride fiber absorbes practically no water, whereas the felt texture allows the water to diffuse through the boot pretty freely. The polyvinylchloride felt insoles dry faster than the woollen ones when taken out of the boots after a long use.

These boots weight only 2 kg/pair and can conveniently be used in rocky areas as well. They are inevitably less durable than leather boots, but JARE members who stayed in and around Syowa Station, including those engaged in the heavy construction work, did not require more than a pair per person throughout the year. It seems desirable, however, to supply two pairs per year to a field worker.

In conclusion we would like to express our sincere thanks to all the people, including those in foreign antarctic parties, who tried the new boots and gave us valuable advices.

Table 1. Clothing and Sleeping Outfit

	Article	Material	Quantity	
			Summer	Winter
1.	Headgear			
	Cap, ski	Cloth; Wool serge; Teviron boa	1	1
	Balaclava, long neck	Wool	-	1
	Cold weather cap	Leather with Teviron quilting	-	1
2.	Hand Wear			
	Working gloves	Vinylon, Polypropylen	6	6
	Gloves, shell	Leather	4	8
	Gloves, insert	Teviron, Exlan, Wool	2	6
	Mittens	Nylon with Teviron boa	-	1
3.	Foot Wear			
	Socks, thin	Nylon, Wool	5	12
	Socks, heavier	Kanekalon pile, Wool	3	6
4.	Body Wear			
	Anorak, JARE	Nylon, Vinylon	1	3
	Windproof trouser	Nylon, Vinylon	1	3
	Parka coat	Cloth: Nylon; Filling: Polyester staple	-	1
	Trousers, field	" "	-	1
	Cold weather vest	" "	-	1
	Quilting undershirt & underdrawers	" "	1	1
	Cutter shirt, flannel	Wool	1	2
	Trousers	Wool serge	1	2

Article	Material	Quantity	
		Summer	Winter
Sweater, pull-over	Wool	1	2
Working wear	Vinylon 50%, Cotton 50%	1	2
Underwear, shirt & long pants	Polyacrylonitrile 75%, Wool 25%	2	5
Underwear, heavier	Polyacrylonitrile	1	2
T-shirt	Cotton	4	6
Air-net shirt	Vinylon 50%, Cotton 50%	1	2
5. Field Outfit			
Sleeping bag, double-layered	Cloth: Nylon; Filling: Polyester staple	1	1

Vinylon: Polyvinyl alcohol

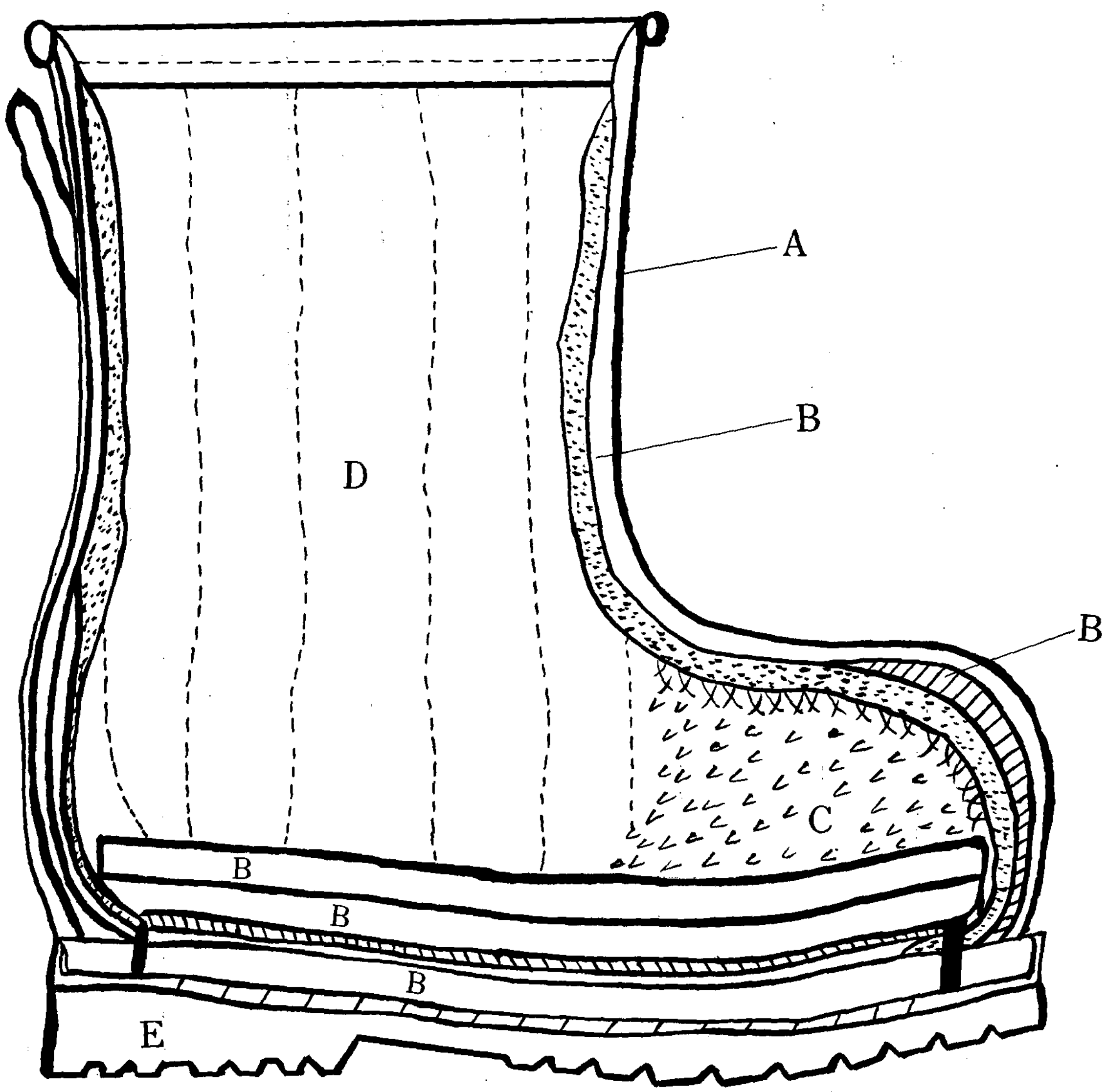
Teviron: Polyvinyl chloride

Kanekalon, Exlan: Polyacrylonitrile

Table 2. Boots used in JARE 1966-67.

Article	Material	Quantity	
		Summer	Winter
Rubber boots, long, insulated	Cloth: Nylon Filling: Teviron staple	1	2
Working boots	Cloth: Nylon canvas Teviron boa	1	1
Snow boots, D-type	Cloth: Polyester 50%, Cotton 50% Filling: Teviron	-	2
Mukluks	Cloth: Ployester 50%, Cotton 50%	1	1
Inner socks for Mukluks	Cloth: Nylon Filling: Teviron staple quilting	-	2
Indoor boots	Leather with Teviron boa	-	1

Fig. 1. Crass section of snow boots D-Type.



A : Synthetic fiber (Canvas)
B : Polyvinyl chloride felt
C : Synthetic fiber boa
D : Polyvinyl chloride staple filling
E : Moulded rubber sole

Table 3. Property Chart (Staple).

		Nylon	Polyester (Tetoron)	Polyvinyl alcohol (Vinylon)	Polyvinyl chloride (Teviron)
Tensile Strength	Std.	4.7 - 6.7	4.4 - 5.5	3.8 - 6.2	2.0 - 2.6
(grams per den.)	Wet	3.9 - 5.7	4.4 - 5.5	3.2 - 5.0	2.0 - 2.6
Wet tenacity / Dry tenacity (%)		83 - 90	100	77 - 85	100
Elongation (%)	Std.	38 - 50	40 - 50	15 - 26	15 - 23
	Wet	40 - 53	40 - 50	16 - 27	15 - 23
Specific gravity		1.14	1.38	1.26 - 1.30	1.39
Moisture regain at 20°C 65% RH		4.5	0.4	5.0	0

A REVIEW OF NEW ZEALAND ANTARCTIC CLOTHING

A.J. Heine*

Summary

The climate experienced by New Zealand personnel is described and the clothing issue to these men is reviewed in detail. Clothing fabrics and their characteristics are also described.

Climate of Scott Base

Scott Base is established on Pram Point which lies towards the Southern end of Hut Point Peninsula, Ross Island. The co-ordinates of the station are 77°51' South, 166°48' East. Each year a new team of men reach Scott Base during October and November, most of whom return to New Zealand in January and February, leaving a wintering-over party of ten men to remain at the Base until October. Scott Base is built on a gentle south-east facing slope of basaltic debris which is snow covered in winter and spring but relatively snow free in mid-summer. Melt water streams usually flow from mid-December to mid-January and conditions around the base can become wet and muddy about that time.

To provide a background to the problems of providing suitable clothing for New Zealand personnel, the monthly mean of the daily maximum and minimum temperatures at Scott Base are given in Table 1. The table covers the period 1957-1964.

MONTH	MEAN OF DAILY MAXIMUM	MEAN OF DAILY MINIMUM
	°C	°C
January	- 1.7	- 9.3
February	- 7.7	-15.7
March	-17.5	-26.6
April	-18.7	-29.5
May	-21.5	-34.4
June	-20.0	-32.2
July	-23.8	-36.8
August	-25.3	-38.6
September	-20.9	-33.2
October	-17.8	-28.8
November	- 7.2	-16.4
December	- 2.1	- 9.3

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a reasonable prototype has been developed. However, there still remain several minor faults such as 'rolling of the foot' within the boot which may be difficult to overcome. The Onitsuka snow boot is satisfactory down to temperatures of -55°C (-67°F), and its very warmth depends on the loose insulated sides and a very thick felt inner sole. Any tight strapping around the sides of the boot would immediately reduce the insulation effect and produce other complaints from the wearer. The snow boot is not waterproof and it must be replaced by leather boots during the peak temperatures of the Scott Base summer.

PART III