

REMARKS ON THE MACHINE GROUP

Work to be done by S.B. and Administration and the section for assistance to the nuclear physical teams has not been taken into account here.

A. Preface.

In the following draft are some thoughts collected about work to be done, later on, in the Machine Group and a suitable organisation of it. During the time this paper was written some of these thoughts were already mentioned from other sides and became generally known. Nevertheless, as they come within the framework of this paper they are mentioned again.

The purpose of this draft is to contribute to a basis of discussion inside the Machine Group and perhaps to give one means of information about this group to people outside it.

After some general remarks about the conditions to start with, an enumeration has been made of jobs to be done. It is shown that all these jobs belong to one of three different kinds looked at from the machine point of view.

In the last part of this paper, discussing a suitable form of organisation, it is shown that these three different types of jobs call for a complex organisation. Two of them are covered by the formation of the sections foreseen. The third type, the real operation work, requires a centralized scheme of operation or duty groups crossing the sections and including all the personnel in the sections.

B. General Conditions.

The Machine Group should ensure maintenance and operation of the P.S. and has to see to it that the machine will be and will remain in future a reliable and efficient tool for the nuclear physics research. This aim should be reached in the most economical way. The invested capital for which the Machine Group assumes responsibility amounts to about Sw.Fr. 100,000,000.- The separate parts of this machine do not constitute a visible compact unit, but are distributed over various parts of the P.S. building. The parts of this machine come from various very different technical branches and some have been developed up to the limit of the present possibilities. It is the first machine of this size and principle. The maintenance costs which are foreseen are such that a breakdown of the machine for one hour (i.e. repairs or technical or organisational errors) would almost equal a month's salary of a good technician.

C. Specification of Work to be done.

The work to be done can be divided into three different types according to their dependence on the state of the machine. In order to explain this, some of these jobs will be mentioned hereafter and their characteristics shown.

1. Jobs independent of the state of the machine.

a) Further development: already the fact that this machine is the first of its kind makes further development necessary to render it more reliable and efficient, and to facilitate maintenance, survey and repairs. A minimum of 15 o/o of the initial development capacity needed for the construction of the machine will be necessary for a long time. Let us assume that the development work still to be done only to render the machine reliable and efficient and also to maintain it **efficient amounts, in the average**, to more than 15 o/o of the development work for the construction of the machine. That means, even without special developments for experiments, that more than five years will be needed to arrive at the state aimed at. The estimated 15 o/o further development effort may be right for the average, that means it may easily become twice as high for some sections, i.e. Controls, Linac or R.F.

b) Development and construction of test and measuring equipment for maintenance, survey and safety precautions.

c) Construction of spare units.

d) Repairs on spare units and general preparation of repairs.

e) Detailed schemes and instructions for maintenance and survey of each separate part must be drawn up. Circuit diagrams and lists of components must be made and kept up to date. Spare parts and expendable stores must be ordered and kept in stock. A continuous registration of all maintenance and repair work must be ensured. Regular reports on the behaviour and operation of the machine are to be written.

f) Initiation and further education of personnel: the personnel for the machine should be instructed about the functioning of the machine and about the experiments envisaged and the special adjustments which have to be made for these experiments. Furthermore, engineers and assistants of the Machine Group should have the opportunity of attending important lectures and of keeping up with the literature on the development of this subject. Finally, the reading and studying of the various CERN reports and memoranda also requires some time.

Up till now this special and general education has been understood. In principle everybody has been allowed to reserve the time necessary for this. The future work in the Machine Group, however, must and will be divided much more strictly and everybody will have a smaller amount of time of which he can dispose as he wishes. The points mentioned above should therefore not be forgotten. Ten percent of the working time - corresponding to half a day per week - is certainly the minimum which has to be taken up for this purpose.

g) General work of organisational and administrative character: operation costs of repairs and modifications, questions concerning personnel.

2. Machine not operating.

This situation is in principle undesirable. On the average, as little time as possible should be lost due to the machine not working. Therefore the Machine Group should concentrate all available effort on the jobs which can be done only during this period. During this time also, at least one of the experimental groups should concentrate on the preparation of special experiments with the machine. These are the decisive factors in deciding when the machine should be switched off for maintenance. This must at all costs be done on working days, as during this period intensified help of the Stores and Workshops will be required.

Some examples of jobs during these periods are:

- a) Direct repairs.
- b) Exchange of units and modifications.
- c) Periodical exchange of components (tubes, etc.)
- d) Testing, measuring and adjusting of the different parts.

3. Operation of the machine.

Taking into account the large number of physicists interested in the machine, the demand for operational time will always exceed the time available. We will be happy to get the machine running during 40 hours per week after the running-in period, that is after the official take-over. The possible maximum operational hours per week is difficult to assess. Probably it will not be possible to reach more than 120 hours per week. This aim can only be reached if a continuous and complete survey of the machine can be ensured and errors in the operation are excluded. This survey does not only involve the adjustments that have become necessary, and the registration of the operation and failures, but also the recognition of those parts of the equipment that

need to be revised during the following maintenance period. This in order to avoid additional unforeseen failures of the machine.

Of course, the survey and registration should be mechanized as far as possible. A development period of many years will however still be necessary to reach this aim.

When estimating the personnel requirements for the operation, this establishment can be compared to establishments of similar technical variety, similar capital and operational costs. One also has to take into account the spatial expansion and the amount of documentation. After extensive mechanization, one responsible engineer, who represents the leader of the machine group during the time of operation and at least three assistants for continuous adjustments and survey of the machine will be needed for the operation of the machine. In the beginning, after taking-over, at least the double will be needed.

This supervising job requires great attention and therefore means a rather one-sided employment of the personnel. It is therefore advisable not to let the persons on this job, work on it for too long a period: on no account for longer than 4 hours at a time.

4. Comparison and summary of the different jobs.

Summarizing the requirements in personnel for the jobs mentioned above, the following figures can be given as a minimum.

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a) <u>For the beginning with 40 hours/week:</u>	<u>persons</u>
Operation: 7 men x 40 hours/week	7
Repairs, modifications and service: 40 men x 20 hours/week	20
Further developm. and automatisation: 15 o/o of the PS div.cap.	15
Work on spare units and test apparatus: 5 o/o " " "	5
Documentation and adm.	5
	<hr/>
	52
+ 17 o/o for sickness and holidays	9
	<hr/>
	61
+ 10 o/o for education	6
	<hr/>
	67

b) <u>For final operation with 120 hours/week.</u>	<u>persons</u>
Operation: 4 men x 120 hours/week	12
Repairs, modification and service: 32 men x 12 hours/week	10
Further developm. and automatisisation: 10 o/o of the PS dev.cap.	10
Work on spare units and test apparatus: 5 o/o of the PS dev.cap.	5
Documentation and administration	<u>10</u>
	47
+ 17 o/o for sickness and holidays	<u>8</u>
	55
+ 10 o/o for education	<u>6</u>
	61

c) Relative effort of personnel.

From the figures in paragraphs a) and b) the relative efforts for the whole Machine Group are calculated . For this comparison the times for sickness and holidays are excluded.

	<u>Beginning</u>	<u>Later</u>
Operation	12 o/o	23 o/o
Repairs, modification and service	35 o/o	19 o/o
Further development and automatisisation	26 o/o	19 o/o
Work on spare units and test apparatus	9 o/o	19 o/o
Documentation and Administration	8 o/o	19 o/o
Education	10 o/o	11 o/o *
	<u>100 o/o</u>	<u>100 o/o</u>
*) included change of personnel	58 Persons	53 Persons

It is improbable that there will be a steady progress from the initial to the final stage, since there will be lapses as well as progress.

D. Organisation of the Machine Group.

1. Character of the Personnel.

The conditions mentioned above show the requirements of the personnel needed: intelligent people with a pronounced sense of responsibility, reliability and thoroughness, and who are also capable of understanding the machine as a whole. In addition they should make the maintenance of the machine a matter of personal interest.

The personnel available at this moment has been employed on the design and development of the machine and shows high qualities for this type of work. However, for the operation of the machine a different kind of work is required. For this reason the employment of new people specially qualified for the operation of the machine can probably not entirely be avoided. That is why, for instance, in industry special personnel is kept for development, production and commerce, etc.

2. Starting conditions.

In looking for a form of organisation that will meet the needs outlined above, two aspects must be taken into account:

a) The biggest part of the personnel is engaged in the present organisation of P.S. and in jobs which will overlap with the preparatory work of the machine group for about one year.

b) Too frequent and too rigorous changes in the form of organisation unsettle the personnel and cause both technical and administrative difficulties. Therefore it is important to find a form of organisation which will cover, if possible, all the future jobs of the Machine Group in their different states, also bearing in mind that even after years the machine may have to be modified and therefore not operate for weeks.

3. Form of organisation.

The three different types of work which should be covered by one consistent form of organisation make the problem a complex one. We have to find therefore a complex form of organisation. Such a form of organisation is not new but has developed over centuries throughout the world for technical plants with similar working conditions.

a) For the jobs listed in paragraphs C.1 and C.2, it is useful to make as many members of the Machine Group as possible responsible for special parts of the equipment and to charge them with the necessary development. The resulting specialisation assures the best efficiency for repairs, adjustments and maintenance, Also the store keeping and correct exchange of spares, tubes etc. will be assured in the best way. The care of the special parts of the equipment becomes then a matter of personal concern to the staff members.

For these jobs in paragraphs C.1 and C.2, the personnel can also be divided into sections which correspond to the present development groups. The leadership and carrying out of the necessary development work can best be arranged in these sections. This is also of value in the establishment and supervision of maintenance and servicing schedules and in keeping up to date circuit diagrams and lists of components. These sections ensure also education in operation of the special parts of the equipment.

b) The jobs listed in paragraph C.3, dealing with the operation of the machine must be led centrally for the whole machine in any case. The duty groups (or operation groups) for these jobs, which have to be built, will represent a cross section of the whole Machine Group, that means through the development and maintenance sections mentioned above. They should only be formed for the time of their duty during operation of the machine. It is surely inevitable that during the whole time the machine is running one responsible engineer in charge must be present. During his period of duty he should represent the leader of the Machine Group in all questions concerning the machine and be informed about the intentions of the interested experimental teams and all other events. He should also be responsible for protection against radiation and general safety measures, and should supervise the records of operation and breakdowns of the machine. This engineer in charge would be selected from the section leaders and from other engineers in the sections. The assistants working under him for the duty period are the technicians who at other times are doing jobs listed in paragraphs C.1 and C.2. For the jobs in C.2 this is self-evident, since these cannot be done while the machine is operating. With the fact that there may be still longer breaks in operation it is necessary for nearly all members of the Machine Group to work alternatively on jobs of the three different types. This is also obvious from the comparison of jobs in paragraph C.4.c. The assistants could, to a great extent, supervise the equipment of their sections and would gain from this operation work ideas about maintenance, service and further development.

4. Set-up of the proposed organisation.

For the P.S. Machine Group the following sections are foreseen:

- 1) Power
- 2) Linac
- 3) R.F.
- 4) Vacuum + Magnet
- 5) Controls and Safety
- 6) Experimental team assistance

The number of operation groups (duty groups) which will relieve one another for the operation of the machine can be reduced or increased at any time. For the purposes of the table below, which shows the complex organisation of the machine, this number is taken as five.

Radiation Theory Secretaries Operation plan		Sections						Section leaders
		S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	
E ₁								Duty groups
E ₂								
E ₃		Power	Linac,	R.F.	Vacuum + Magnet	Controls + Safety	Exp. team ass.	
E ₄								
E ₅								

Engineers
in charge

The engineers in charge (E_1, E_2, \dots) would be selected from the section leaders (S_1, S_2, \dots) and other engineers of the sections.

Each section should contribute for operation at least as many assistants as are necessary for the supervision of their equipment. Which members of the sections these will be, depends on the repairs, service and development work, which has to be done urgently in the sections. The leader of the Machine Group M_1 needs, beside the section leaders, responsible engineers or physicists for radiation, machine theory, operation plane, etc. and secretaries.

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