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CERN - PS DIVISION

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TASK FORCE ON CONSOLIDATION OF THE PS COMPLEX

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Each year, of course, a certain amount of consolidation work is funded through the exploitation budgets allocated to the Divisions. In the case of PS Division, this amounts to slightly over 1 MCHF. The figures for the other Divisions involved in items mentioned in this report are not known, but certainly some money each year flows into jobs noted here (e.g. road and building maintenance). If we consider purely the PS part, however, the total money available from the normal PS exploitation budgets for consolidation work over a 20-year time period amounts to somewhat less than 50% of the 48 MCHF found in our analysis for purely PS items. The missing 50% has to come as additional funding, which means at least 1 MCHF per year extra to the normal exploitation budget.

As far as manpower is concerned, some of the separate reports made preliminary estimates of what would be needed, but not all did so; it was felt premature to insist on this more detailed analysis at this stage, so the manpower is included only in those cases where it was estimated by the groups concerned.

2. The Consolidation areas

Small groups analyzed the situation in each of the areas, and their findings are presented as annexes to this report. Table 1a provides a summary of the requests in each of the areas considered, and table 1b separates out the purely PS machine part from the "buildings" infrastructure in ST Division. All the details are presented in table 2. Table 2 also includes some "additional items" which were extracted to avoid counting items twice, and which are either options or covered in principle by other, already-funded projects.

2.1 Beam Instrumentation

The consolidation required in the different beam diagnostic domains is presented in annex 1; however, LEAR items have been omitted. One important job is the gradual replacement of the TV cameras viewing the scintillator screens at numerous places around the machines. This visualization of the beams is essential for accelerator operation because, when all else fails, the beam can be observed on a screen. However the images are often of poor quality as cameras degrade due to the radiation, and a gradual replacement programme should be implemented. Another major item is the replacement of SEM grids at the Booster, together with various slit and target mechanisms.

2.2 Beam transfer

Internal dump targets for the PS proton beam require attention in the short term, since the existing assemblies are no longer sure, and their repair is problematic. Certain magnets and septa in the transfer lines and main PS ring also need consolidation. Annex 2 gives further details. Some items are taken under "magnets" or "experimental areas", as noted in the table.

2.3 Buildings and infrastructure

The value of the 71 buildings concerning the PS complex is 186 MCHF at today's prices, and they cover a surface area of nearly 55,000 m^2. The cost of maintaining these buildings takes account of the age of the building (almost half of which are more than 25 years old), and includes waterproofing, façades, windows and blinds, painting, etc. Electricity distribution for lighting and power outlets, heating, ventilation, and domestic water supply are also included, using the formulae applied normally in the construction industry. In addition to the buildings themselves, lifts, cranes and service tunnels, as well as the roads serving the area must be maintained. The total estimated for the PS complex is over half the total value of the PS complex consolidation needed; a summary is given in annex 3, reference being made to previous ST documents (ref. 2 and ref. 3).

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by B.W. Allardyce (Chairman), O. Bayard (ST), J. Boillot, J. Buttkus, P. Chevret (ST), V. Chohan, D. Cornuet (SL), G. Daems, G. Gelato, J. Gruber, C. Hill, A. Krusche, A. Lecomte (ST), S. Maury, C. Metzger, H. Mulder, P. Noverraz, J-P. Potier, J-P. Quesnel (EST), J-P. Riunaud, M. Sassowsky (SL), P. Strubin (LHC), H. Ullrich, W. van Cauter (ST), B. Williams.

1. Introduction

During 1996, SL Division produced a report (ref. 1) by a task force on SPS consolidation work which will eventually become necessary around the SPS if it is to continue to run at its present performance for another 20 years. Even though the SPS runs reliably at the moment, there will certainly be systems or areas which will sooner or later need consolidation, and the report aimed to provide an inventory of these jobs.

The SPS report divided the various jobs into three time bins: fairly immediate action needed (0 to 5 years), medium-term (5 to 10 years) and long-term jobs (10 to 15 years, or more). Improvements to the SPS for the LHC era were not included because they are the subject of an already-funded project. The SPS was defined as being not only the machine itself but all of its infrastructure as well, including buildings, roads, tunnels, etc. The report identified jobs to the value of 58.8 MCHF, 55.6 MCHF and 75.8 MCHF respectively for the work in each of the three time bins, adding up to a grand total of 190 MCHF. Buildings and the site electrical distribution accounted for over half the total amount. However it is not clear from the report how much could be found from within the normal exploitation budgets of SL and ST Divisions.

A report along the same lines was requested from the PS. This was achieved by establishing small working groups which looked into the consolidation needed in the various areas, chosen to be the same as in the SPS report, and using the same time bins. An extra area for the AD project was added, however. This report is the synthesis of the separate group reports, with the requests summarized in tables 1a and 1b, and detailed in table 2.

The official CERN physics programme was assumed. Thus, electrons were assumed to continue until the year 2000, and ions and protons were assumed in LHC from 2005 onwards. Since the AD project is now accepted for low energy antiprotons, some infrastructure consolidation is needed in the short term concerning antiprotons, because the externally-funded AD project only covers modifications to the machines and does not include any consolidation work to existing antiproton systems. As in the SPS report, the CERN infrastructure around the PS complex was included, but improvements to the machines specifically for LHC were excluded since they are the subject of an already-funded project. The result obtained was 55 MCHF, 53 MCHF and 42 MCHF respectively in the three time bins, making a grand total of almost 150 MCHF, or about 10 MCHF per year. The part concerning purely the buildings, their infrastructure and the site electrical distribution (102 MCHF) represents two-thirds of the total; an already-funded project ST-33 covers considerable work on electrical distribution. The purely PS "machines and areas" jobs amount to 48 MCHF.

The figures obtained are smaller than those for the SPS, but are of a similar magnitude. We have included only consolidation work which is not included elsewhere as a feature of another approved project (e.g. the East Hall New Look, or the improvements to the PS and Booster for LHC), in order to avoid "double counting".

2.4 Controls

Annex 4 gives details of the various items identified in controls and the MCR. The biggest item is the gradual replacement of front-end computers and the workstations of the control system as they become out-dated with time.

2.5 Cooling and Ventilation

A number of consolidation jobs concerning cooling water and its distribution, and air conditioning/ventilation units must be undertaken if today's performance levels are to be maintained over the next 15 years. The most important job concerns the gradual replacement of the piping for industrial water and chilled water, which is closely linked to the need to separate the domestic water supply from industrial water on the CERN site. Compressed air piping also needs replacement. Details are to be found in annex 5. One item, that of ventilation in the PS tunnel, has been taken under "safety".

2.6 Electrical Distribution

Renovation work on the PS sector of the CERN electrical distribution network, as well as work on the Booster substation and the TCR are covered by other, already-funded projects, notably the project ST-33. Equally, a project is already under way to repair cable trays and remove old cables from the tunnels around the PS. These items are therefore removed from the summary tables 1 and 2, and appear under "additional items". The ST electrical work remaining refers to replacement of irradiated cables, and to replacing the PS main generator on a longer time-scale, for which the ST part is the provision of new transformers. Details are given in annex 6.

2.7 Experimental Areas

The East Hall is the subject of a reconstruction programme foreseen for 1997, for which there is an existing project. However, it is likely that the target stations and the gas system for the experiments will need renovation, for which estimates have been made of the cost; neither of these items is covered by other projects. In the South hall, the LEAR experiments have stopped, and little needs to be done to the hall. In the case of ISOLDE, the area is quite new, and nothing more is foreseen for the moment.

2.8 Magnets and Survey

A number of jobs are necessary, as detailed in Annex 7, consisting of the replacement of certain magnets to improve serviceability, replacing old cables and water manifolds, construction of spare coils for certain magnets, and a general revision of all magnets. One job, the possible replacement of several PS auxiliary magnets is considered as an option and has been included in Table 2 under "additional items".

2.9 Power Converters

There are at present some 1200 power converters in the PS, including those needed for the AD project. Many of these have been renovated in recent years, as spare parts became unobtainable due to changing techniques and products in industry, but there remain many which still need renovation. These are the jobs listed in annex 8, most of which are situated in the 0-5 and 5-10 year time bins. However, there may be a slippage in time due to competition from other already-planned or approved work. In the long term there may also be the problem that, unless there is adequate recruitment, there may be insufficient people with in-house expertise in the domain of power converters.

The replacement of the PS main generator is foreseen in the long term as one important item, and part of the cost is included under the ST provision for "electrical distribution". Annex 8 gives the details of the various jobs envisaged for the different machines or areas:

Linac 2, the Booster, the PS, the transfer lines, the East hall and ISOLDE. The machines LIL, EPA, CTF and LEAR are not included in the estimates.

2.10 Radiofrequency

Certain of the PS radiofrequency systems need no further consolidation because they have recently been or will soon be renewed, or concern machines which will be phased out. Annex 9 give details of those systems which do need renovating.

2.11 Safety

There are consolidation items in several areas to do with safety around the PS complex (see annex 10); these include radiation monitors, access and interlock systems, and intercom/public address systems, fire detection, etc. However, the largest item is the ventilation system of the PS machine. The PS is now nearly 40 years old and does not have a sealed ventilation system, unlike the more recent accelerators at CERN. Instead, air is drawn in from outside through ventilation shafts into the PS ring, and escapes through undefined apertures to the atmosphere or to adjacent buildings. Thus the activated air from the ring (mostly short-lived radio-nuclides) escapes in an uncontrolled manner. However, such a situation is not in conflict with Swiss legislation and there are no problems with radioactivity measurements made at the site boundary. Nevertheless, in view of increased public awareness in this area, and the fact that more recent machines such as SPS, LEP, and ISOLDE have ventilation systems which control the release of radioactivity into the atmosphere, it is probably judicious to consider equipping CERN' s oldest accelerator in this way. Annex 10 gives further details.

Another item mentioned in annex 10 is radioactive storage. Formally the PS has no permanent storage area for slightly radioactive components, and ideally a building of 800 m^2 is needed. This item has not been included in the summary tables since it is likely this subject will be treated CERN-wide at a later date, so the amount concerned of 1.6 MCHF has been placed under "additional items" in Table 2.

2.12 Vacuum

Vacuum equipment generally has a rather long lifetime of around 15 years, but there is a large volume of such equipment around the PS, so there is always a need for renewal. One important item is the replacement of radiation-damaged cables and connectors, but by far the biggest item is the gradual replacement of vacuum pumps of all sorts. Annex 11 presents the details.

2.13 AD project

Although the removal of the AA machine and the modification of AC to become the Antiproton Decelerator is externally funded, the approval of the AD project will cause some additional consolidation work in the short term (0 to 5 years), which would otherwise not have been required if there were no further antiprotons in CERN.. The work involves the preparation of spare elements for the highly-radioactive antiproton production zone, power supplies for certain AD magnets, a new kicker for ejection, and a spare quadrupole for the line towards the new AD experimental zone. Details are given in annex 12.

Conclusions

The items identified in this report require considerable sums to be spent if the consolidation work is to go ahead. In the spartan times ahead, however, it is likely that little money will become available for so un-glamorous a subject as consolidation. Nevertheless, this report and that of the SPS serve to identify areas which are not included in other renovation programmes, and which will eventually lead to loss of performance if the jobs are put off indefinitely. This report therefore serves as an inventory of items which will one day need attention.

Annexes

Annex 1, Beam diagnostics consolidation, by G.Gelato
Annex 2, Beam transfer consolidation, by J-P.Riunaud
Annex 3, Consolidation of buildings, by P.Noverraz and A.Lecomte.
Annex 4, Controls and MCR consolidation, by G.Daems and H.Mulder
Annex 5, Consolidation du complexe PS, by W. van Cauter, CERN/ST-CV/96155/WVC/bm
Annex 6, Programme de renovation a long terme du reseau électrique du CERN, by O.Bayard, CERN-ST-IE/96-138
Annex 7, Consolidation of PS magnets, by D.Cornuet and J.P.Quesnel, CERN-PS/DI/Note 97-08.
Annex 8, Long-term renovation program for the PS complex magnet power supplies, by J.Gruber, CERN-PS/PO/Note 96-22 (Tech).
Annex 9, Consolidation of the PS complex RF systems, by A.Krusche, CERN-PS/RF/Note 96-25.
Annex 10, Safety consolidation for the PS complex, by V.Chohan, CERN-PS/Safety 96-16.
Annex 11, Vacuum consolidation, by J-P.Bertuzzi, M.Brouet, P.Strubin
Annex 12, Consolidation work as a result of AD acceptance, by S.Maury and J.Gruber.

References

1. Report of the Task Force on SPS Consolidation, by A.Beuret, T.Bohl, P.Collier, K.Elsener, A.Faugier, A.Heikkila, V.Mertens, P.Ribeiro, H.Schmickler, and A.Spinks, SL-Note 96-32 DI.
2. Conservation du patrimoine: état des façades et ouvrages de surface en béton armé; J.Baldy, C.Girard, L.Symons, CERN ST/94-03 (CE), 2nd edition November 1994 and CERN-ST-CE/LS/94-166/mv.
3. Conservation du patrimoine: état des surfaces recouvertes de béton bitumineux, partie 1, routes; J.Baldy, J.Garcin, C.Girard, L.Symons, CERN-ST-CE/LS/94-250/mv.

Table 1a. Summary of consolidation requests for the PS complex

Areas needing consolidation	Category 1 (< 5 years)		Category 2 (5-10 years)		Category 3 (10-15 years)	
	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)
Beam diagnostics	805	2.0	350	2.0	300	1.0
Beam transfer	300	1.0	700	0.0	0	0.0
Buildings and infrastructure	31'400	0.0	29'400	0.0	29'900	0.0
Controls	4'895	27.0	3'900	31.0	4'850	31.0
Cooling and ventilation	4'415	0.0	4'980	0.0	265	0.0
Electrical distribution	750	0.0	700	0.0	0	0.0
Experimental areas	50	0.0	200	0.0	0	0.0
Magnets and survey	395	0.0	530	0.0	120	2.0
Power Converters	5'340	16.0	7'000	15.5	3'760	6.0
Radiofrequency	250	0.0	880	0.0	0	0.0
Safety	3'740	0.0	3'600	0.0	200	0.0
Vacuum	1'817	1.0	1'315	0.3	2'638	0.3
AD project	700	0	0	0	0	0
TOTALS	**54'857**	**47.0**	**53'555**	**48.8**	**42'033**	**40.3**

GRAND TOTAL 150'445

Additional items	Category 1 (< 5 years)	Category 2 (5-10 years)	Category 3 (10-15 years)
Electrical distribution	**7'775**		
Magnets and survey	**120**		
Safety	**1'600**		

Table 1b. Summary of consolidation requests, separating PS machines from ST infrastructure

Areas needing consolidation	Category 1 (< 5 years)		Category 2 (5-10 years)		Category 3 (10-15 years)		
	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)	
Buildings and infrastructure	31'400	0.0	29'400	0.0	29'900	0.0	
Cooling and ventilation	4'415	0.0	4'980	0.0	265	0.0	
Electrical distribution	750	0.0	700	0.0	0	0.0	
TOTAL for ST infrastructure	**36'565**	**0.0**	**35'080**	**0.0**	**30'165**	**0.0**	**101'810**
Beam diagnostics	805	2.0	350	2.0	300	1.0	
Beam transfer	300	1.0	700	0.0	0	0.0	
Controls	4'895	27.0	3'900	31.0	4'850	31.0	
Experimental areas	50	0.0	200	0.0	0	0.0	
Magnets and survey	395	0.0	530	0.0	120	2.0	
Power Converters	5'340	16.0	7'000	15.5	3'760	6.0	
Radiofrequency	250	0.0	880	0.0	0	0.0	
Safety	3'740	0.0	3'600	0.0	200	0.0	
Vacuum	1'817	1.0	1'315	0.3	2'638	0.3	
AD project	700	0.0	0	0.0	0	0.0	
TOTAL for machines and areas	**18'292**	**47.0**	**18'475**	**48.8**	**11'868**	**40.3**	**48'635**
TOTALS	**54'857**	**47.0**	**53'555**	**48.8**	**42'033**	**40.3**	**150'445**

Table 2. Details of the consolidation requests in each of the areas considered.

Areas needing consolidation	Category 1 (< 5 years)		Category 2 (5-10 years)		Category 3 (10-15 years)	
	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)
Beam diagnostics						
Pickup replacement in injection lines	100		50	1.0		
SEM grids for the Booster	300					
Slit drives and fast target mechanics	105	1.0				
Video cameras for beam visualisation	300	1.0	300	1.0	300	1.0
Beam transfer						
Spare magnets MHB3, MHB5, and quadrupoles, see under "magnets"						
Electrostatic septa renovation			700			
Internal dump targets for PS	300	1.0				
Bump 16 auxiliary magnets renewal, see under "magnets"						
PS ring transport system repair, see under "magnets"						
East area gas system renewal, see under "experimental areas"						
East area targets renewal, see under "experimental areas"						
Buildings and infrastructure						
Waterproofing, facades, painting, etc	13,543		9,429		5,370	
Electricity distribution	4,840		5,886		4,417	
Heating, ventilation and domestic water	6,617		6,685		12,213	
Roads	400		400		400	
Underground	2,000		2,000		1,500	
Lifts and cranes	4,000		5,000		6,000	
Controls						
Timing system, repacement of CAMAC	300					
CATV screens and distribution of signals	100		100		100	
MCR instrumentation	100					
Generic and applications software	250	21.0	250	21.0	250	21.0
MCR consoles and infrastructure	200					
Network	820		500			
Structure cabling completion	120					
Front end computers	1,000	6.0	0	10.0	1,000	10.0
Workstations and licences	500		2,500		2,500	
Interface	525				300	
Analogue observation	780		250		500	
Laboratory evolution, instruments, etc	200		300		200	
Cooling and ventilation						
Water distribution in PS ring central building	70		90			
Replace water system in equipment test hall (building 174)	450					
Water treatment plant	350					
South and East halls water distribution system	160		1,090			
Replacement of refrigerants in LPI system			110			
Industrial water, cooled water, compressed air distribution network	2,500		3,000			
TT2 air conditioning	250					
Booster air conditioning in BHP room	160					
PS control room air conditioning			140			
Linac 2 ventilation			50			
PS central building air conditioning	275					
Ventilation system for PS ring, see under "safety"						
Renovation of ventilation units in East hall, building "Y" and hall ERB3			500		265	
Replacement of water pipes in the East hall	200					
Electrical distribution						
Renovation of PS sector electrical distribution, see "additional items"						
New Booster substation and TCR, see "additional items"						
PS cabling renovation, see "additional items"						
Follow-up of cabling renovation, and replacement of irradiated cables	750					
Replacement of main PS generator			700			
Experimental areas						
East hall gas distribution			200			
East hall taget stations	50					

Areas needing consolidation (continued)	Category 1 (< 5 years)		Category 2 (5-10 years)		Category 3 (10-15 years)	
	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)
Magnets and survey						
PS main magnet (transport device and back leg windings)	35				10	
General revision of auxiliary magnets						2.0
PS auxiliary magnets (H and V correctors)	10				10	
PS auxiliary magnets (cables for doublets and low energy magnets)			40		70	
PS auxiliary magnets (5 dipoles for BSW16), see "additional items"						
New magnets (1 quadrupole, 1 dipole) for ejection 58	300					
Renovation of manifolds for 50 magnets			70			
Transfer line (TT2) hoses	20					
Booster (interlock cables)			120			
Booster drawings	30		30		30	
Spare coils for Linac dipoles			70			
New alignment jigs and targets			200			
Power Converters						
Linac 2 (pulsed dipoles and other supplies)	460	1.5	760	2.0	550	1.5
Booster (diverse supplies)	660	2.5	2,480	4.5		
PS, main power supply and auxiliary and corrector supplies	1,480	5.5	1,860	4.5	2,250	2.0
Transfer Lines	1,460	3.5	500	1.5	0	0.0
East Area	1,200	3.0	1,200	2.0	800	2.0
ISOLDE	80		200	1.0	160	0.5
Radiofrequency						
PS 10 MHz RF systems (spare ferrite rings)	50					
PS 10 MHz RF systems (replacement of obsolete electronics)			220			
PS 10 MHz RF systems (replacement of tuner transistor banks)			350			
PS 200 MHz RF systems (revision of rf power amplifiers)	90					
PS 200 MHz RF systems (modernisation of electronics)			200			
PS beam control electronics replacement and modernisation	110		110			
Safety						
Induced activity monitors and infrastructure	290					
Beam loss monitors	240					
Ventilation system for PS ring	2,560					
Radioactive storage area for PS, see "additional items"						
Beam interlock			1,200			
Access system			2,000			
Intercom and public address system	500					
Fire detection, gas detection, level 3 alarms, emergency evacuation	150		400		200	
Vacuum						
Vacuum chambers	145		75		75	
Valves	192		220		143	
Pumps and pump groups	580		525		1,660	
Gauges					185	
Pump and gauge supplies	400		310		350	
Control and interlock equipment			50		75	
Cables and connectors, radiation-damaged	400		85		100	
Documentation	100	1.0	50	0.3	50	0.3
AD project						
Antiproton production zone magnets	390					
Ejection kicker	150					
Spare quadrupole for transfer line to AD experiments	100					
Power converters for AD	60					
TOTALS	**54,857**	**47.0**	**53,555**	**48.8**	**42,033**	**40.3**

Additional items not included above because they are optional, or already funded.

Electrical distribution						
Renovation of PS sector electrical distribution, should be in ST-33.	4,675					
New Booster substation and TCR, should be covered by ST-33	1,900					
PS cabling, removal of old cables, already under way, project PS-9515	1,200					
Magnets and survey						
Ejection 16: 5 new dipoles or 1 new power supply, optional	120					
Safety						
Radioactive storage area for PS, may be treated later CERN-wide	1,600					

Table 2. Details of the consolidation requests in each of the areas considered.

Areas needing consolidation	Category 1 (< 5 years)		Category 2 (5-10 years)		Category 3 (10-15 years)	
	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)
Beam diagnostics						
Pickup replacement in injection lines	100		50	1.0		
SEM grids for the Booster	300					
Slit drives and fast target mechanics	105	1.0				
Video cameras for beam visualisation	300	1.0	300	1.0	300	1.0
Beam transfer						
Spare magnets MHB3, MHB5, and quadrupoles, see under "magnets"						
Electrostatic septa renovation			700			
Internal dump targets for PS	300	1.0				
Bump 16 auxiliary magnets renewal, see under "magnets"						
PS ring transport system repair, see under "magnets"						
East area gas system renewal, see under "experimental areas"						
East area targets renewal, see under "experimental areas"						
Buildings and infrastructure						
Waterproofing, facades, painting, etc	13'543		9'429		5'370	
Electricity distribution	4'840		5'886		4'417	
Heating, ventilation and domestic water	6'617		6'685		12'213	
Roads	400		400		400	
Underground	2'000		2'000		1'500	
Lifts and cranes	4'000		5'000		6'000	
Controls						
Timing system, repacement of CAMAC	300					
CATV screens and distribution of signals	100		100		100	
MCR instrumentation	100					
Generic and applications software	250	21.0	250	21.0	250	21.0
MCR consoles and infrastructure	200					
Network	820		500			
Structured cabling completion	120					
Front end computers	1'000	6.0	0	10.0	1'000	10.0
Workstations and licences	500		2'500		2'500	
Interface	525				300	
Analogue observation	780		250		500	
Laboratory evolution, instruments, etc	200		300		200	
Cooling and ventilation						
Water distribution in PS ring central building	70		90			
Replace water system in equipment test hall (building 174)	450					
Water treatment plant	350					
South and East halls water distribution system	160		1'090			
Replacement of refrigerants in LPI system			110			
Industrial water, cooled water, compressed air distribution network	2'500		3'000			
TT2 air conditioning	250					
Booster air conditioning in BHP room	160					
PS control room air conditioning			140			
Linac 2 ventilation			50			
PS central building air conditioning	275					
Ventilation system for PS ring, see under "safety"						
Renovation of ventilation units in East hall, building "Y" and hall ERB3			500		265	
Replacement of water pipes in the East hall	200					
Electrical distribution						
Renovation of PS sector electrical distribution, see "additional items"						
New Booster substation and TCR, see "additional items"						
PS cabling renovation, see "additional items"						
Follow-up of cabling renovation, and replacement of irradiated cables	750					
Replacement of main PS generator			700			
Experimental areas						
East hall gas distribution			200			
East hall taget stations	50					

Table 2. Details of the consolidation requests in each of the areas considered (cont.)

Areas needing consolidation (continued)	Category 1 (< 5 years)		Category 2 (5-10 years)		Category 3 (10-15 years)	
	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)	Total price (kCHF)	Manpower (m-y)
Magnets and survey						
PS main magnet (transport device and back leg windings)	35				10	
General revision of auxiliary magnets						2.0
PS auxiliary magnets (H and V correctors)	10				10	
PS auxiliary magnets (cables for doublets and low energy magnets)			40		70	
PS auxiliary magnets (5 dipoles for BSW16), see "additional items"						
Spare magnets (1 quadrupole, 1 dipole) for ejection 58	300					
Renovation of manifolds for 50 magnets			70			
Transfer line (TT2) hoses	20					
Booster (interlock cables)			120			
Booster drawings	30		30		30	
Spare coils for Linac dipoles			70			
New alignment jigs and targets			200			
Power Converters						
Linac 2 (pulsed dipoles and other supplies)	460	1.5	760	2.0	550	1.5
Booster (divers supplies)	660	2.5	2'480	4.5		
PS, main power supply and auxiliary and corrector supplies	1'480	5.5	1'860	4.5	2'250	2.0
Transfer Lines	1'460	3.5	500	1.5	0	0.0
East Area	1'200	3.0	1'200	2.0	800	2.0
ISOLDE	80		200	1.0	160	0.5
Radiofrequency						
PS 10 MHz RF systems (spare ferrite rings)	50					
PS 10 MHz RF systems (replacement of obsolete electronics)			220			
PS 10 MHz RF systems (replacement of tuner transistor banks)			350			
PS 200 MHz RF systems (revision of rf power amplifiers)	90		-			
PS 200 MHz RF systems (modernisation of electronics)			200			
PS beam control electronics replacement and modernisation	110		110			
Safety						
Induced activity monitors and infrastructure	290					
Beam loss monitors	240					
Ventilation system for PS ring	2'560					
Radioactive storage area for PS, see "additional items"						
Beam interlock			1'200			
Access system			2'000			
Intercom and public address system	500					
Fire detection, gas detection, level 3 alarms, emergency evacuation	150		400		200	
Vacuum						
Vacuum chambers	145		75		75	
Valves	192		220		143	
Pumps and pump groups	580		525		1'660	
Gauges					185	
Pump and gauge supplies	400		310		350	
Control and interlock equipment			50		75	
Cables and connectors, radiation-damaged	400		85		100	
Documentation	100	1.0	50	0.3	50	0.3
AD project						
Antiproton production zone magnets	390					
Ejection kicker	150					
Spare quadrupole for transfer line to AD experiments	100					
Power converters for AD	60					
TOTALS	**54'857**	**47.0**	**53'533**	**48.8**	**42'023**	**40.3**

Additional items not included above because they are optional, or already funded.

Electrical distribution						
Renovation of PS sector electrical distribution, should be in ST-33.	4'675					
New Booster substation and TCR, should be covered by ST-33	1'900					
PS cabling, removal of old cables, already under way, project PS-9515	1'200					
Magnets and survey						
Ejection 16: 5 new dipoles or 1 new power supply, optional	120					
Safety						
Radioactive storage area for PS, may be treated later CERN-wide	1'600					

ANNEX 1:

13 September 1996

Expected financial requirements for the consolidation of the PS complex (beam diagnostics)

G. Gelato

Protons programme:

1) The electronics for the position monitors of the LINAC2 and of the PSB rings is obsolescent (more than 20 years old). It will need replacement.

2) There are no spares for the position monitors in the PSB injection line, of which 24 are in use. Recently, one failed due to irradiation (the ceramic became brittle and sprang a vacuum leak).

   Of course, they may go on forever without problems. After all, radiation doses are not very high everywhere. However, should one or more monitors spring leaks, we would be in serious trouble: procurement times may be very long (in fact, the firm that made the original pieces may no longer be in business). Also, a substantial part of the cost is due to tooling. Ordering just one or two monitors, and go on ordering as the need arises, would be very expensive and it is doubtful whether we could find a firm ready to do it.

3) Cables to the transformers near the Isolde targets are likely to be damaged by radiation sooner or later. Some money should be put aside for their replacement, should the need arise.

4) The motors for the slits of LINAC2 need to be replaced.

5) The movement of the internal fast targets of the PS should be replaced (mechanics plus electronics).

6) The SEM grids at septum 42 should be replaced.

Ions programme:

1) The shielding and the front end electronics of the LEAR d.c. transformer need improvement. It may be wise to wait for the outcome of the development under way for LHC, which is expected to lead to improvements applicable, partially or totally, to the existing transformers.

2) The position monitoring system of LEAR is based on a commercial network analyzer. It works fine, but the analyzer is obsolete and can no longer be maintained. A modern one should be bought as soon as possible.

Antiprotons programme:

1) If AD is going to operate for a long time, the cables to the transformers close to the production target are likely to fail again due to radiation. Some of them have been replaced already: when will the next replacement be needed? The same considerations as for the ISOLDE transformers apply here.

Leptons programme:

1) The WBS of LIL must be upgraded (replacement control electronics plus software for 5 units).

Protons and ions programmes:

1) 4 SEM grids are required in the PSB injection line.

All programmes:

1) The video cameras in several machines and lines should be replaced by upgraded versions, including digitalization of video signals.
   The SOS also needs modernisation (replacement of obsolete equipment, addition of extra channels).

		Position monitoring PROTONS								
		(1997-2001)			(2002-2006)			(from 2007 onwards)		
		Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)
Machines	LIN2				Renew electronics for magnetic P.U.	10				
	PSB				Renew electronics for P.U. (development, construction, testing)	40	12			
Lines	PSB INJ	24 P.U. *)	>100 (?)							

*) One has failed, possibly due to radiation, others may. How many? When? Difficult to foresee, but expect trouble.

		Position monitoring IONS								
		(1997-2001)			(2002-2006)			(from 2007 onwards)		
		Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)
Machines	LEAR	Replacement of network analyzer (old model, not maintainable)	48			10				

		Position monitoring PROTONS + ANTIPROTONS + IONS + LEPTONS								
		(1997-2001)			(2002-2006)			(from 2007 onwards)		
		Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)
Machines	LIN2	Replace motors for slits (protons)	20	2						
	CPS	Internal fast targets: mechanics + electronics (protons)	55	6						
	CPS	SEM grids at septum 42 (protons)								
	Several machines and lines	Video cameras: digitalization & SOS (protons + antiprotons + ions + leptons) **)	300	12	Video cameras: digitalization & SOS (protons + antiprotons + ions + leptons) **)	-276	-564	Video cameras: digitalization & SOS (protons + antiprotons + ions + leptons) **)	-852	-1140
	LIL	Internal dumps: electronics (protons + antiprotons + leptons) *)	?	?						
Lines	PSB INJ	4 SEM grids (protons + ions)	300	3						

*) Urgent: not BD responsibilty (PA? Contact M. Zanolli)

*)) BD estimate: may differ from Ciriani's

		Current Measurement ANTIPROTONS								
		(1997-2001)			(2002-2006)			(from 2007 onwards)		
		Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)
Machines	AD				Cables for transformers close to production target *)	5	1			

*) Very hypothetical. Cables have been replaced because of radiation damage: how long will the present ones last?

		Current Measurement PROTONS								
		(1997-2001)			(2002-2006)			(from 2007 onwards)		
		Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)
Experimental areas	ISOLDE				Cables for BTY-TRA213 and BTY-TRA325 *)	5	1			

*) It may or may not be needed. The area is highly radioactive: cables don't last indefinitely.

		Current Measurement ANTIPROTONS								
		(1997-2001)			(2002-2006)			(from 2007 onwards)		
		Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)	Job	Cost (kCHF)	Manpower (man*month)
Machines	LEAR				Front end electronics obsolescent. Will need replacement.	10	3			

ANNEX 2:

PS Beam Transfer Consolidation

J-P. Riunaud

	Cost in kCHF			Observations	
Period	0 - 5 yrs	5 - 10 yrs	10 - 15 yrs		
PS Ring					
Main Magnet					
Cranes - Finished 1997	0				
Repair of transport system	50			ST/MH	*
Auxiliary Magnets					
Bump 16	100				*
Internal Dump	300				
Kickers - Covered by FPP project	0				
Septa - electro-static		700			
Transfer Channels					
Tunnels (civil engineering)		500			*
Equipment:-					
Spare Magnets MHB3: MHB5: Quad.	300				*
Experimental Areas					
East - EHNL - Project	0				*
Gas	?	200			*
Targets	50				*
South - no work foreseen	0				
ISOLDE - no work foreseen	0				

* Included elsewhere

ANNEX 3:

CONSOLIDATION INFRASTRUCTURE COMPLEXE PS

P. Noverraz, A. Lecomte

La situation des Bâtiments PS est la suivante:

Nbre de Bâtiments recensés: 71

Valeur actualisée: 186.2 MCHF

Surface nette: 54'743 m^2

Les coûts de maintenance pour les 15 années à venir tiennent compte de l'âge de chaque Bâtiment, ainsi que d'une répartition en % pour chaque oeuvre.

La plupart des chiffres ont été communiqués par la Divsion ST.

Les estimations concernant les souterrains, les ascenseurs et les ponts roulants sont, quant à elles beaucoup moins précises.

Patrimoine PS (=24% du site du Meyrin et 15% du CERN)

Age (ans)	Nombre	Valeur actualisée (kCHF)	Surface M2
1 à 10	11	9'180	2'907
11 à 15	11	12'992	4'246
16 à 20	3	22'272	5'040
21 à 25	12	17'194	7'263
> de 26	34	124'574	35'287
	71	186'212	54'743

Eléments d'estimation

	Répartition	Durée de vie (années)
Gros oeuvre	40%	99
Second oeuvre		
Etanchéité	3%	21
Facades (stores, vitrages, portes, etc.)	11%	26
Peinture et sols	6%	16
Autre second oeuvre	11%	21
Corps d'état technique		
Electricité	17%	36
Chauffage, eau, ventilation	12%	26
	100%	

Investissement théorique nécessaire (en kCHF)

	de 1997 à 2001	de 2002 à 2006	de 2007 à 2011
Gros oeuvre	---	---	---
Second oeuvre (étanchéité, façades			
peintures et sols, etc.)	13'543	9'429	5'370
Electricité	4'840	5'886	4'417
Chauffage, eau, ventilation	6'617	6'685	12'213
	25'000	22'000	22'000
Routes	400	400	400
Génie civil dans souterrains	2'000	2'000	1'500
Ponts roulants, ascenseurs	4'000	5'000	6'000
Totaux:	31'400	29'400	29'900
soit par an:	6'280	5'880	5'980

ANNEX 4:
Controls Group: some comments on the consolidation project

G. Daems

Networks

At short term the existing network must be upgraded to the new cable technology approach. This means the replacement of some 400 cables.
At long term higher traffic rate can be expected on certain parts of the network. Fibre optic technology between the various control zones (buildings) would be the answer to this problem.

Front End Computers

Most of the 120 installed CPU's in the VME crates at the equipment level are already obsolete technology today. Particularly their memory capacity and execution speed are insufficient. Migration to a new CPU, probably POWER PC, is mandatory over the next 5 years. A new update can be predicted five to ten years later.
Those changes and other software evolution will ask for some extra manpower.

Workstations

Due to fast computer technology changes workstations and Xterminals need to be changed every 5 years. As the last change has be done in 1996, the next two changes can be expected in the 5-10 years period and in the 10-15 years period.
Software evolution will introduce the need of new licences.

Application SW evolution

This field covers 3 categories of activities.

1) The evolution of the generic software and the SW development environment for applications .
   The costs are mainly generated by the licences of the new SW products (included in the rubric "new licences" of the workstations) and the missing manpower, which reflects the minimum amount of external manpower (Fellows, etc.) currently working on consolidation work.
2) The manpower generated by the evolution of the specific applications programs used mainly by the operation in the control room.
3) The price to pay for the evolution of SW packages realised in the context of collaboration projects with Russian Institutes.

Timing System

This part shows the costs of the timing not yet renewed during the D067 project. New consolidation is not expected during the next 10 to 15 years.

Interface

The project cots of this part is mainly the continuation of the replacement of the CAMAC by VME modules and 1553-bus. It does not include the G64 interfaces for the upgrade of the power supply interfaces. After ten years of operation of the actual 1553 field bus it becomes probably necessary to replace it by a new cheap industrial bus (~200,- CHF/power converter)

Analogue Observation Systems

The replacement of the old Signal Observation System (SOS) by the New Analogue Observation System (NAOS) must be completed for the LPI next year. At longer term the used VXI technology will probably evolve towards a level where hardware changes become necessary.
The old SOS-Video system should be replaced as soon as possible by some new, preferably industrial, system This may have an influence on the controls architecture and accelerate the Network evolution.

Office Network

The 350 PC's and 40 printers distributed over the PS division should statistically be replaced every 5 years but this is paid from normal exploitation and so does not figure here.

Structured Cabling of the Office Network

This has already been implemented in some PS buildings, but there remain outlying buildings which will cost 120kCHF to complete.

Maintenance and development laboratories

Both items need regularly technological upgrades in order to follow the evolution of the controls hardware and instruments in the division

CONTROLS GROUP: Consolidation project Costs split by activity

G. Daems

		<5 years			5 - 10 years			10 - 15 years		
		Project costs (KCHF)	Manpower required (Man-year)	Manpower missing (Man-year)	Project costs (KCHF)	Manpower required (Man-year)	Manpower missing (Man-year)	Project costs (KCHF)	Manpower required (Man-year)	Manpower missing (Man-year)
1	**Network**									
	Replacement coax cables by RJ45	320								
	Interbuilding Fiber optics cables	500			500			0		
2	**Front End Computers**									
	Replacement of CPU's	1000			0			1000		
	Front End SW Evolution	0	6	2	0	8	2	0	10	
3	**Workstations**									
	Replacement	0			2000			2000		
	New Licences	500			500			500		
4	**Aplication SW evolution**									
	generic software		15	8		15	8		15	
	specific applications		6			6			6	
	outsourcing SW maintenance	250			250			?		
5	**Timing System**									
	Replacement Camac	300			0			0		
6	**Interface**									
	Replacement Camac	525								
	Replacement Mil 1553							300		
7	**Analog observation System**									
	Replacement old SOS	30			0			0		
	Replacement old SOS-Video	500			0			0		
	NAOS evolution	250			250			500		
8	**Office Network**	2000			2000			2000		
9	**Structured cabling completion**	120								
10	**Maintenance and development lab evolution**	200			300			300		

Consolidation PS: MCR

H. Mülder

Item	Costs in kCHF		
	< 5 years	< 10 years	< 15 years
PS ring warning messages:			
CATV distribution	35	35	35
CATV screens, 89 TV's	63	63	63
MCR instrumentation	100		
PC application software	1 man-year	1 man-year	1 man-year
New consoles to match present & future requirements	100		
Flooring & ceiling following new air-con & consoles	100		

ANNEX 5:

CONSOLIDATION DU COMPLEXE PS

ST-CV

W. Van Cauter

REFROIDISSEMENT - RESEAUX - PRODUCTION FROID VENTILATION - CLIMATISATION

1. Refroidissement

Installation	Bât.	Travaux	Estimation CHF	Prévisions années
Centre anneau	359	Remplacement des pompes eau déminéralisée + modif. partielle du réseau	70'000	< 5
Hall de test	174	Remplacement de l'installation actuelle	450'000	2
Traitement d'eau	358	Remplacement de l'installation de production d'eau déminéralisée	350'000	< 5
Zones experimentales Lear + Est	255	Remplacement du réseau primaire	160'000	< 5
		Sous total	**1'030'000**	**< 5**
Lear + Est	355	Remplacement des circuits secondaires, échangeurs, régulation, pompes, etc...	900'000	< 10
Lear + Est	255	Remplacement des virolles des ventilateurs réfrigérants	100'000	< 10
Centre anneau	359	Remplacement des réfrigérants atmosphériques	90'000	10
Hall exp. Est	157	Remplacement du réseau acier ébonite	200'000	10
Lear	234	Remplacement des réfrigérants atmosphériques	90'000	10
LPI	2004	Remplacement des réfrigérants atmosphériques	110'000	10
		SOUS-TOTAL	**1'490'000**	**10**

2. Réseaux

Installation	Travaux	Estimation CHF	Prévisions années
Eau potable Eau industrielle Air comprimé Incendie Eau glacée	Remise en état des réseaux	5'500'000	1/2 < 5 1/2 < 10
	TOTAL	**5'500'000**	

3. Ventilation - climatisation

Installation	Bât.	Travaux	Estimation CHF	Prévisions années
TT2	269	Remplacement clim Tunnel (monoblocs)	250'000	5
Centre anneau	359	F1 08.09 adjonction de deux climatiseurs et installation d'un nouveau groupe frigo.	250'000	< 5
Centre anneau	365	Remplacement condenseur à air	25'000	< 5
Anneau PS	350	Remplacement clim. tunnel	2'560'000	> 5
Booster	361	Climatisation salle BHP à revoir	160'000	< 5
Linac 2	363	Remplacement des batteries	50'000	> 5
Salle contrôle PS	354	Remplacement régulation	140'000	> 5
Générateur EST	251	Remplacement monoblocs	325'000	< 5
Bâtiment Y	269	Rénovation stations	180'000	> 5
ERB3	263	Remplacement monoblocs	260'000	> 5
		TOTAL	**4'200'000**	
		TOTAL GENERAL	**12'220'000**	

4. Projets non financés par PS

Projet	Bât.	Travaux	Estimation CHF	Prévisions années
AD	193	Adaptation de la station	100'000	< 5
Booster/LHC	361	Nouvelle station de refroidissement	1'750'000	< 5
Booster/LHC	361	Nouveau circuit primaire (réfrigérants)	350'000	< 5
Booster/LHC	361	Nouvelle centrale frigorifique	900'000	< 5
Centrale frigo/PS	355	Nouvelle centrale frigorifique	1'000'000	< 5
Isolde	170	Augmentation de la capacité de refroidissement et climat.	400'000	< 5
Centre de calcul	513	Rénovation des groupes frigo. et réfrigérants	400'000	5
		TOTAL	**4'900'000**	**5**

ANNEX 6:

ST-IE/96-138 3.06.96

PROGRAMME DE RENOVATION A LONG TERME DU RESEAU ELECTRIQUE DU CERN - 1996 à 2010 -

O. Bayard

1. Préliminaire

Suite à la demande de la Direction générale d'établir rapidement le coût de la consolidation des machines constituant la chaîne des injecteurs du LHC et des services associés, j'ai établi le coût de la rénovation de l'ensemble du réseau électrique du CERN desservant ces machines sous la forme de la table 1 ci-après. Ce bilan, associé à ceux des autres groupes ST, a été présenté par A. Lecomte aux DPO des autres divisions.

Cette note accompagnant ce bilan est essentiellement destinée à servir d'aide-mémoire à ceux qui après moi auront à traiter des problèmes de rénovation du réseau électrique.

Les chiffres doivent être considérés comme des ordres de grandeur; leur validité est suffisante pour une approche statistique. Ils sont basés en premier lieu sur un inventaire des équipements qui devraient être normalement remplacés après une période d'exploitation de 35 à 40 ans (remplacement un pour un); dans d'autres cas le remplacement a plutôt été guidé par des pronostics de dégénérescence fondés sur l'accroissement des défaillances ou sur des calculs d'irradiation. Seuls les projets déjà approuvés ont été l'objet d'une analyse technique approfondie conduisant à un optimum technico-économique, le tout documenté dans un rapport.

Ce bilan ne prend pas en compte la consolidation du réseau électrique du secteur tertiaire sous responsabilité ST/TFM.

2. Présentation du bilan

La table 1 donnant le bilan du programme de rénovation sur les 15 prochaines années (1996 à 2010) est présentée de la façon suivante :

- Inventaire des systèmes à rénover

  Chaque ligne numérotée représente un système à rénover. Les systèmes ont été classés en 4 grandes familles :

  lignes 10 à 19 Réseau général de Meyrin hors PS

lignes 20 à 29	Réseau desservant le complexe du PS
lignes 30 à 49	Réseau desservant le complexe du SPS
lignes 50 à 59	Réseau desservant le LEP puis le LHC. La rénovation porte sur les parties du réseau non couvertes par le projet LHC proprement dit.

- Projets déjà autorisés

  Les systèmes dont la rénovation est déjà couverte par des projets autorisés sont reconnaissables par la référence du projet remplaçant le n° de ligne. Dans ce cas la colonne "Past" donne les dépenses déjà effectuées sur ce projet et la dernière colonne "Total projet" le montant total déclaré pour ce projet. Les montants indiqués pour 1996 et 1997 sont ceux autorisés.

- Ventilation par année

  Les dépenses ont été classées en 3 catégories :

  - *Catégorie 1 : 1996 à 2000.*
    Celles antérieures à la période de construction du LHC.

  - *Catégorie 2 : 2001 à 2005.*
    Celles tombant dans la période de construction du LHC.

  - *Catégorie 3 : 2006 à 2010.*
    Celles postérieures à la construction du LHC.
    La date de 2010 est purement une limite comptable.
    La catégorie 3 peut évidemment s'étendre au-delà.

  La colonne "Total général" donne le bilan de l'argent nécessaire par système de 1996 à 2010, quelque soit la division responsable du budget.

  La colonne "Total ST" donne la part du "Total général" tombant explicitement dans le budget ST, soit pour des systèmes généraux clairement sous responsabilité budgétaire ST (réseau général Meyrin), soit pour des systèmes déjà couverts par des projets ST.

3. Stratégie de rénovation

Les systèmes à rénover ont été classés en catégorie 1, 2 ou 3 à partir des règles suivantes :

- Ceux atteignant 35 ans d'âge dans la période antérieure au LHC sont classés en catégorie 1 (Réseau Meyrin et PS) et ceux présentant un grand risque de longues pannes (compensateurs du SPS - projets ST100 et 32).

- Ceux atteignant 35 ans d'âge dans la période postérieure au LHC sont classés en catégorie 3. Il s'agit essentiellement des systèmes du SPS.

- Les systèmes entrant en catégorie 2 ont été limités au minimum puisque les ressources humaines et financières dans la période de construction du LHC devraient être entièrement dévolues à cette tâche. On trouve dans cette catégorie les programmes directement induits par le LHC, mais non couverts par le projet proprement dit (systèmes 50 à 55), les suites de la catégorie 1 (prolongation de travaux ou utilisation de contrats cadre) et des urgences ne pouvant attendre 2006.

4. Brève analyse système par système

L'ensemble des systèmes ou programmes inventoriés dans la table 1 ci-après sont individuellement analysés dans l'annexe 1 pour ne pas rallonger cette note.

5. Conclusion

Le budget total de consolidation du réseau électrique s'élève à 108.6 MCHF répartis sur 15 ans, soit de l'ordre de 7,2 MCHF/an. Le capital représenté par l'ensemble de ce réseau est estimé à 250 MCHF. Cette consolidation est de l'ordre de 2,9% par an et correspond à un cycle de renouvellement de 35 ans. Les distributeurs d'énergie considèrent qu'un cycle de 30 à 35 ans maximum doit être envisagé pour les équipements du réseau pour lesquels une bonne fiabilité est exigée; un cycle de 35 à 40 ans maximum peut être envisagé pour des équipements de moindre importance stratégique.

En associant le budget exploitation ordinaire du groupe ST-IE de 3 MCHF/an, le CERN devrait consacrer de l'ordre de 10 MCHF par an (4% du capital) au maintien de son réseau électrique.

REF:	EQUIPEMENT	*Past kCHF*	CATEGORIE 1 :kCHF					CATEGORIE 2: kCHF					CATEGORIE 3 :kCHF					TOTAL :kCHF		TOTAL
			96	97	98	99	2000	2001	2	3	4	5	2006	7	8	9	2010	général	ST	Projet
10	**RESEAU GENERAL MEYRIN**																			
ST-69	**Rénovation JURA et hors PS**	***1130***	**750**	**800**	**820**													**2370**	**2370**	**3500**
12	ZONE OUEST ,cadre LHC				500													500	500	
13	Groupes electrogenes										1000	2000						3000	3000	
14	Superviseur central			300	300	300												900	900	
	SOUS TOTAL GENERAL MEYRIN	***1130***	**750**	**1100**	**1620**	**300**	**0**	**0**	**0**	**0**	**1000**	**2000**	**0**	**0**	**0**	**0**	**0**	**6770**	**6770**	**3500**
20	**RESEAU COMPLEXE PS**																			
ST-33	**Rénovation SECTEUR PS**	***2775***	**1100**	**600**	**1350**	**1350**	**275**											**4675**	**4675**	**7450**
22	Nouveau booster et TCR			950	950													1900		
23:PS-	**Mise en ordre cablage PS**		**300**	**400**	**350**	**300**	**150**											**1500**		**1500**
24	Suite 23 et cables irradiés					250	500											750		
25	Remplacement génératrice										350	350						700		
	SOUS TOTAL COMPLEXE PS	***2775***	**1400**	**1950**	**2650**	**1900**	**925**	**0**	**0**	**0**	**350**	**350**	**0**	**0**	**0**	**0**	**0**	**9525**	**4675**	**8950**
30 à 49	**RESEAU SPS**																			
ST-100	**3e compensateur,SE1**	***1385***	**2200**	**3600**	**3600**	**3600**	**2115**											**15115**	**15115**	**16500**
32	Rénov.transfo 400kV & réactances						1000	2000	2000	1000								6000	6000	
ST-34	**80Mvar condensat. série au PCB**			**600**														**600**		**600**
ST-31	**Consolid. SPS:30 UPS & controle**	***870***	**100**	**300**	**440**	**440**	**450**											**1730**	**1730**	**2600**
35	50 km Cables HT enterrées												700	700	700	700	700	3500		
36	80km Cables refroidi (9500kF)20%												400	400	400	400	400	2000		
37	240 cellules MT							800	800				1600	1600	1600	1600	1600	9600		
38	Protections et controle							200	200				400	400	400	400	400	2400		
39	66 transfo 2.5 MVA												600	600	600	600	600	3000		
40	155 Tableaux 400v												1120	1120	1120	1120	1120	5600		
41	Serv. gén.machine(irradiés) et exper.												800	800	800	800	800	4000		
42	TCR au BB3										1200							1200		
43	Réseau ascenseur sur diesels locaux											1000						1000		
44	Rénovation BB81 et diesel											1500						1500		
45	40 Auxiliaires 48V & 110V												400	400	400	400	400	2000		
46	Processeurs de controle												180	180	180	180	180	900		
	SOUS TOTAL SPS	***2255***	**2300**	**4500**	**4040**	**4040**	**3565**	**3000**	**3000**	**1000**	**1200**	**2500**	**6200**	**6200**	**6200**	**6200**	**6200**	**60145**	**22845**	**19700**
50	**RESEAU LEP,LHC hors projet**																			
51	Reprise BT tunnel irradiée							5000	5000	5000								15000		
52	Démontage tunnel.LEP							4000	4000									8000		
53	Démontage reste LEP							2000	2000									4000		
54	Processeurs de controle							1250	1250	1250	1250							5000		
55	Travaux SM18			200														200		
	SOUS TOTAL LEP,LHC	***0***	**0**	**200**	**0**	**0**	**0**	**12250**	**12250**	**6250**	**1250**	**0**	**0**	**0**	**0**	**0**	**0**	**32200**	**0**	**0**
	TOTAL ANNUEL	***6160***	**4450**	**7750**	**8310**	**6240**	**4490**	**15250**	**15250**	**7250**	**3800**	**4850**	**6200**	**6200**	**6200**	**6200**	**6200**	**108640**	**34290**	**32150**

Reseau electrique PS

Ref	Equipment		Qty	Price	Priority 1 (< 5 yrs)		Priority 2 (5-10yrs)		Priority 3 (10-15yrs)	
					Total Price	Man Power	Total Price	Man Power	Total Price	Man Power
					kCHF	Man-year	kCHF	Man-year	kCHF	Man-year
20	RESEAU COMPLEXE PS				4675					
ST-33	Rénovation SECTEUR PS	1)			1900					
22	Nouveau Booster et TCR				1200					
23:PS	Mise en ordre câblage PS	2)			750					
24	Suite 23 et câbles irradiés									
25	Remplacement génératrice						700			
					8525	**0**	**700**	**0**	**0**	**0**

N.B.: 1) => Projet ST autorisé 2) => Projet FPP

ANNEXE 1

Brève analyse système par système des programmes de rénovation du réseau électrique

Référence [1]	Analyse technique du programme de rénovation
10	**Réseau général Meyrin**
• ST-69	Ce projet à moitié achevé porte maintenant sur la rénovation des sous-stations principales JURA et SW (cf. ST-IE/95-85 - Rénovation de la station 18 kV JURA - G. Cumer / M. Delidais).
• 12	Concerne l'aménagement probable de la zone Ouest (tout ou partie) comme zone de montage et test pour le LHC.
• 13	Les groupes électrogènes de JURA auront 45 ans à cette époque, et devraient être remplacés par 3 groupes de 1500 kVA (type secours LEP). Ce programme est associé aux programmes 33 et 44 qui permettent de réduire par 2 la puissance unitaire de chaque groupe, tout en bénéficiant de l'intérêt d'une commande globale pour les groupes de type similaire inclus dans ces programmes, avec l'avantage d'une maintenance dans le cadre d'un seul contrat.
• 14	Ce projet concerne un superviseur central du réseau électrique. Il est lié aux projets 46 et 54 incluant des superviseurs régionaux. L'ensemble vise à une rénovation progressive et globale du contrôle du réseau électrique par l'installation d'unités de traitement et d'acquisition industrielles, avec des interfaces homme-machine accessibles aux techniciens électriciens (ce qui est aujourd'hui la tâche d'ingénieurs-coopérants, avec le manque de continuité que cela comporte), et totalement intégrés dans le système de contrôle des accélérateurs. Une note définissant cette stratégie est en préparation. L'évolution rapide dans ce domaine conduit à un cycle de remplacement de 15 à 20 ans.
	Réseau du complexe du PS
20 • ST-33	Ce projet vise à remplacer les composants datant de 35 à 40 ans du réseau du PS. Commencé par la sous-station PS principale (ME6) en 95-96, il continuera en 96-97 par les générateurs Est (ME11), puis le Booster, Centre anneau, générateur Sud, réseaux BT des machines (cf. ST-IE-ER/94-164 - Modernization of the electrical distribution network in the PS complex - M. Delidais / G. Kowalik).
• 22	<u>Nouveau booster et TCR.</u> Ce projet PS complète ST-33 en incluant le changement de la partie machine de la sous-station booster et un nouveau compensateur (TCR) pour l'injection dans le LHC. Le nouveau TCR devrait être couvert par une contribution canadienne.

[1] Références utilisées dans la table 1 - Budget rénovation réseau ST/IE

Référence	Analyse technique du programme de rénovation
• 23.PS	Mise en ordre câblage PS. Ce projet PS lancé en 1995 doit continuer jusqu'en 2000 (cf. : ST-IE/95-142 - Projet de mise en ordre du câblage PS - M. Dujardin, JC. Guillaume, J. Pedersen).
• 24	Suite programme 23 et câbles irradiés. Un complément au programme 23 ci-dessus est nécessaire et couvre une remise en état des services généraux du PS et annexes, spécialement dans les zones à forte irradiation.
• 25	Remplacement de la génératrice principale La génératrice principale du PS aura 38 ans d'opération en 2005. Même si son état d'entretien est excellent et les pièces de réserve adéquates, ce sera néanmoins une vieille machine nécessitant un entretien coûteux et des spécialistes pour l'opération. Le programme 25 vise à arrêter cette machine en pulsant directement le PS sur EDF via le 3e compensateur en cours d'installation dans le cadre du projet ST-100 après l'achèvement du programme supplémentaire 32. Le coût de l'opération porte sur l'installation de 2 transformateurs d'adaptation 18/6.6 kV de 20 MVA, de 2 tableaux inverseurs de source (alternateur - nouveau transfo), d'un banc de condensateurs d'une vingtaine de MVar pour la compensation locale, et du renforcement à 40 MVA de la ligne JURA - PS (la ligne actuelle MP6 étant réutilisée à cette fin pour la liaison Prévessin - JURA).
30	**Réseau SPS**
• ST-100	Cet important projet, dont l'installation a débuté lors du shut-down 95/96, vise à utiliser la tranche 2 (400 kV/18 kV) du poste d'arrivée EDF, en lui associant un 3e compensateur permettant de secourir soit la tranche 1 et son compensateur, ou la tranche 3 et son compensateur, pour assurer en toute hypothèse un fonctionnement à 450 GeV du SPS comme injecteur du LHC. Une liaison 66 kV alimentant le point 1 du LHC complète ce dispositif et permet les échanges d'énergie EDF - EOS au niveau élevé souhaité (cf : CERN ST/93-02(IE) The CERN 400 kV/66 kV/ 18 kV main substation and its associated compensators and filters - O. Bayard - J. Pedersen).
• 32	Le rebobinage et reconditionnement des 3 transformateurs et 2 réactances des tranches 1, 2, 3 ci-dessus que la réalisation du projet ST-100 permettra d'entreprendre est le complément indispensable de ce projet.
• ST-34	Fin du remplacement des condensateurs des tranches 1 et 3 ci-dessus dans le cadre du programme "élimination du PCB" géré par TIS.
• ST-31	Ce petit projet a servi à reprendre par des MICENE le contrôle du réseau du SPS, après l'arrêt des ordinateurs NORD. Le solde du programme sert à couvrir le remplacement d'UPS.
• 35	Les câbles 18 kV des boucles stables et pulsées du SPS et les câbles 18 kV alimentant les stations de conversion sont enterrés dans une zone marécageuse et présentent des défauts d'étanchéité en nombre croissant. La tension standard d'essai ne peut plus être appliquée. Il faut donc envisager leur remplacement à terme.

Référence	Analyse technique du programme de rénovation
• 36	Les câbles haute intensité refroidis à l'eau du SPS sont toujours en bon état. On devrait néanmoins s'attendre statistiquement à des détériorations sur une longue durée. Un remplacement de 20% a été envisagé arbitrairement.
• 37	Les 240 disjoncteurs 18 kV des BA du SPS sont du type à minimum d'huile et seront totalement obsolètes en 2010. Il en est de même des cellules 18 kV du BE à coupure dans l'air. Pour ces dernières cellules, on pourrait envisager de les remplacer en 2001, 2002 par les cellules à coupure sous vide du programme ST-100 dans le cadre de la rénovation des tranches T1, T2, T3.
• 38	Le même diagnostic que ci-dessus s'applique aux relais de protections équipant ces cellules.
• 39	Les 65 transformateurs du SPS seront proches de leur limite d'âge. Il faudra envisager de les remettre en état, après décuvage, et pour certains d'entre eux de les remplacer.
• 40	Les 155 tableaux débrochables du SPS peuvent être affectés par le vieillissement comme un récent incident du BA2 l'a démontré. L'état des tableaux de Meyrin après 35 ans confirme cette analyse, la situation s'aggravant par le manque progressif de pièces de réserve. Un remplacement au moins partiel devra s'imposer.
• 41	Les services généraux du SPS et partiellement de la zone Nord seront en fin de vie et les installations de sécurité ne répondront plus du tout aux exigences. Les installations dans les zones à forte irradiation devront être totalement changées; seuls les câbles de contrôle le sont aujourd'hui.
• 42	Le compensateur auxiliaire du BB3 (première génération de TCR) aura une électronique de puissance totalement obsolète. Il devra peut-être être renforcé pour compenser la pulsation des tunnels de transfert vers le LHC.
• 43	Le réseau 3 kV de sécurité (dit "réseau ascenseur") est pour sa partie enterrée dans un état pire que celui du réseau 18 kV (programme 35). La proposition consiste à le supprimer et à le remplacer par de petits groupes Diesel de 250 kVA type LEP aux BA1, BA2, BA4, BA5 et par un groupe de 1500 kVA au BE pour le reste du site de Prévessin, en association avec le programme 13. Ceci conduirait en plus aux avantages suivants : - Un véritable réseau de sécurité, répondant à l'exigence d'une autonomie de source, de puissance suffisante pour alimenter l'ensemble des auxiliaires de sécurité dont les UPS, dont l'autonomie pourra être faible. Les onduleurs et redresseurs 110 V pour l'éclairage de sécurité seront supprimés. - Une puissance réduite d'autant pour le remplacement des groupes de JURA qui passeraient de 3 MVA à 1,5 MVA pièce. Le groupe de 1500 kVA pour la cryogénie au BB81 pourra être remplacé dans le cadre du programme ci-dessus.
• 44	
• 45	Les auxiliaires 48 V et 110 V des sous-stations seront largement atteints par la limite d'âge et seront remplacés par des ensembles type LEP. Le remplacement des cellules 18 kV du programme 37 permettra d'éliminer les auxiliaires 110 V.

Référence	Analyse technique du programme de rénovation
• 46	Ce programme concerne le remplacement des 29 MICENE du SPS et l'adjonction de superviseurs régionaux selon la stratégie définie au programme 14.
50	**Réseau LEP et LHC (hors projet LHC)**
• 51	Le groupe Radioprotection a calculé qu'en l'an 1999 les installations en partie supérieure du tunnel du LEP auront reçu une dose de 5 10^4 Gy, et entre 3 et 10 fois plus dans les zones entre les aimants. La distribution AC et l'éclairage risquent de ne plus être en état pour couvrir la durée du LHC. Une décision devra être prise en fonction de l'état en 1999. Le prix du remplacement est établi au mètre (cf. : TIS-CFM/IR/96-02 - Dose measurements in LEP and estimate of radiation damage for LEP200).
• 52, 53	Des échelles et des services généraux du tunnel du LEP et de certains US et les câbles correspondants devront être démontés et en partie remplacés. Cette activité n'est pas prise en compte dans le projet LHC. Le coût total de 12 MFS est estimé au prorata du coût du montage des mêmes équipements dans le LEP. Seules des études précises permettront d'affiner ces valeurs.
• 54	Concerne le remplacement des 150 MICENE du LEP. Mêmes remarques que pour le programme 46. De plus, la cohabitation de nouveaux équipements modernes à contrôle intégré avec les MICENE sera très difficile à traiter dans le cadre de la stratégie du contrôle de l'an 2000.
• 55	Concerne l'adaptation du SM18 aux besoins du LHC. Il faudra approfondir les études pour mieux cerner les coûts.

ANNEX 7:

PS Magnet System Consolidation Programme

D. Cornuet, J.P. Quesnel

1. INTRODUCTION

For the time being each of the 10 accelerators (except the LEAR and the LINACs which are directly under the responsibility of the engineers in charge) have technicians (6 for the whole PS Complex) who are responsible for the machines. The technicians are able to make quick repairs, they update the lists of spare equipment and alignment jigs, they maintain and store them, they follow up the ageing of the magnets and propose improvements and replacements if necessary. Those local specialists are necessary due to the fact that the equipment has been manufactured over a period of 40 years and are therefore disparate despite constant effort for many years towards a certain standardisation. Of course they take part, thanks to their local knowledge of the equipment, in the design and implementation of the permanent changes necessitated by the operation.

2. PS MAIN MAGNETS

A consolidation programme has been fulfilled in the past years. A yearly inspection (HV test, earth currents, etc...) is carried out each year and no weak points are detected except for the crimps of the pole face windings for which we expect to have enough spares of complete sets for the next 20 years.

However, the cables of the back-leg windings which are submitted to radiation should be replaced within 10 to 15 years.

Cost: 10 k CHF

3. TRANSPORT OF THE MAIN MAGNETS

Although there exists 1 spare magnet of each of the 4 types installed in the machine, a replacement of one complete unit cannot be done for the moment. A complete revision of one of the 2 "locomotives" has to be undertaken within the next 5 years.

Cost: 35 k CHF

4. PS AUXILIARY MAGNETS

- Some vertical and horizontal corrector magnets which operate during injection should be manufactured as spares.
- The cables powering the low energy magnets where installed at the origin of the PS machine, they should be replaced within 10 to 15 years.
- A consolidation programme is being proceeded with the existing budget and manpower for the high energy magnets. It will last over a period of 5 years. But a revision of those magnets including their spares should be resumed within 10 to 15 years, which will need 2 man-years over that period.

- The situation of the bumpers for ejection 16 is not satisfactory. They are the only auxiliary magnets which are not openable and which need to break the vacuum to be replaced. Moreover, they are old, radioactive and no spare is available. The best solution would be to replace very soon the 4 bumpers by 4 dipoles type 406 where we have enough spares, and to modify the common power supply (action PS/PO). The option of manufacturing 5 new openable bumpers with the same inductivities as the old one would be much more expensive (+120 k CHF at least).
- Two spare magnets have to be manufactured for ejection 58 (1 quadrupole and 1 dipole MHB3).
- The cables powering the high energy magnets are in good repair. The only ones which would need replacement are the ones which cross radioactive zones, i.e. the doublet lines.
- The manifolds of the demineralized water distribution should be renewed within 5 to 10 years.

Cost: 510 k CHF or 630 k CHF according to option
Manpower: 2 man-years

5. INTERLOCKS OF THE PS MACHINE

The interlock system of the main magnets is recent. When the technician who has designed the system retires, the maintenance of the electronic chassis should be transferred to the PS/PO group.

The interlock system of the auxiliary magnets is robust and reliable and will not need any overhaul for the next 20 years.

Cost: none
Man-power: partial transfer of responsibility

6. TRANSFER LINES AND EST EXPERIMENTAL AREA

- A consolidation programme is being carried out with the existing budget and manpower for the magnets of the Est experimental area where the physicists calibrate their detectors. This activity has to be pursued all year long.
- The demineralized water hoses between the magnets of the TT2 transfer lines have to be replaced in the next five years.

Cost: 20 k CHF

7. BOOSTER

- The interlock cables of the machine are old and not halogen free, they should be replaced within the next 10 years.
- The drawings of the magnets and their installation should be updated for the past and the future, this represents a regular and permanent job over the years.
- The status of the main magnets is being investigated and no weak points have been detected yet; spare elements exist.

Cost: 210 k CHF

8. LINACS

- Any breakdown of a magnet in a LINAC is a major breakdown. In order to be safe, a complete spare LINAC should be available, which is out of the question.
- Spare coils have to be manufactured for dipole magnets of transfer lines.

Cost: 70 k CHF

9. ALIGNMENT

The PS Complex presents a big disparity of the alignment systems. Some magnets have to be equipped with modern alignment targets. Some alignment jigs which are no longer within their specified accuracy have to be replaced, others which have disappeared have to be manufactured. This work should be done within the next 5 to 10 years.

Cost: 200 k CHF

10. CONCLUSION

The above estimates suppose that the existing exploitation budgets are maintained and that the technicians involved who will retire within the next few years are replaced. We are at the minimum limit of what may be reasonably admissible. Any reduction of exploitation budget or of personnel would need to reopen new budgets and new posts if we want to guarantee the same level of reliability of the machines as today.

Total consolidation costs: 1'045'000 CHF

or 1'165'000 CHF

according to option (§4)

PS MAGNET CONSOLIDATION PROGRAMME

ITEM	PRICE IN k CHF		
	Cat. 1 (0 to 5 years)	Cat. 2 (5 to 10 years)	Cat. 3 (10 to 15 years)
1. PS MAIN MAGNETS			
1.1 Back leg windings			10
1.2 Transport device	35		
2. PS AUXILIARY MAGNETS			
2.1 Vertical correctors	10		
2.2 Horizontal correctors			10
2.3 Cables of low energy magnets			70
2.4 5 dipoles for BSW 16	120 or 0 (either option)		
2.5 Cables for doublets		40	
2.6 1 quad. & 1 dip. for ejection 58	300		
2.7 Water distr. (50 manifolds)		70	
2.8 General revision			2 manyear
3. TRANSFER LINES & EXP. AREA			
Water distr. (hoses) for TT2	20		
4. BOOSTER			
4.1 Interlock cables		120	
4.2 Drawings	30	30	30
5. LINACS			
Spare coils of dipoles		70	
6. ALIGNMENT			
Jigs, targets		200	
TOTAL	515 or 395 (according to option)	530	120 + 2 manyear

ANNEX 8:

PS/PO/JG/ed 20 September 1996

Long Term Renovation Program for the PS Complex Magnet Power Supplies

PS-PO Group

Introduction

The greater part of the PS Complex Magnet Power Converters has been designed between 25 and 30 years ago. Ever since, many consolidation programs have been carried out in order to improve the reliability and to cope with the increased requirements, necessary to operate different PS accelerators. Globally, the present performance of the power converters is very high, and the reliability is good. However ageing signs appear more and more, and in order to maintain this good reliability, it is important to define the necessary renovation program for the power converters of the PS Complex accelerators, and to carry out this work during the next 5, 10 and 15 year phases.

This list is a first approach, with 1996 costs and today's techniques.

1. Presentation of the different power converters renovations

10. Linac 2

11. Pulsed dipoles and quadrupoles: classical renovation of the complete series. 12. Other Linac power supplies: see detailled sheet.

20. Booster

21. Main PSB power supply: independently of the LHC renovation which is underway, the 5 rectifiers must be replaced : second priority.
22. Ring dipoles and multipole power supplies : must be replaced, first priority.
23. Pulsed dipoles : second priority.
24. Distributor : electronics of the 6 power supplies will be replaced, first priority.
25. Bdl, QCD, QCD : replacement of the electronics, in second priority.

30. PS

31. Main PS power supply:
    - the old electronics of the rectifiers must be replaced: first priority
    - to suppress the generator, 2 main transformers must be bought and installed, and connected directly with the new foreseen 18 kV mains : second priority. (also foreseen on the ST/IE Consolidation Program)
    - after the phases 1 & 2, the Siemens rectifiers will be replaced : third priority.
32. Septa 16 and 58: complete renovation of the power supplies, first priority; (part of this point (PC reserve, strip lines, etc.) could be second priority).
33. Low energy power supplies : due to the number of power converters, the project is divided between the first and second priority.
34. Tekelecs and PFW's power supplies:
    Tekelecs : new installation in the building 365: first priority

PFW's power supplies consolidation: second priority.

35. New power supplies to replace the SPG2 power supply : first priority
the SPG1 power supply : second priority.

40. FT 16 Transfer Line
    41. These modulated power converters have been specifically designed for the TT2-magnets. No spares exist for ppm-mode. First and second priority.
    42. Steering power supplies. Industrial product, but no longer available. First priority.

50. FA 58 Transfer line
    51. Dipoles and quadrupole power converters for the TT70 line. Transformers are very old. Can be replaced by smaller units, if this line is only used for <3.5 GeV/c. First priority.
    52. New steering power supplies. Second priority.

60 East Area
    61. Apart from converters R2G, which is second priority, all other types are first priority.
    62. A program to replace the Experimental power converters equipped with PCB-cooled transformers has been started and will be completed at the end of this year. The remainder first or second priority.
    63. Recuperated thyristor modules from Booster main power supply and old transformers. First priority.

70. Isolde
    71. Many recuperated SC-power supplies. First priority.
    72. New controls electronics G64. First priority.
    73. New controls electronics G64. First priority.

Conclusions

The consolidation period is planned and scheduled over the next 15 years, with the major part of the work during the first two phases (5 and 5-10 years). The renovations have been split up according to the age of equipment, but also the possibilities of improving the operation and reliability of the machines.

The first 5 year phase is overloaded as we still have different projects running during the next 2 years:

- PSB consolidation for LHC.
- New power supplies for the Savers and Beamscope of the Booster.
- Modifications to the East Area.
- AD Project.

To fulfill these various tasks, the number of man-years has been estimated: it is high, and therefore we have to ensure a sufficient engineering staff level for the next 5 years, but also after that period in order to be able to undertake the second phase.

	Equipment		Qty	Total price kCHF	Man Power Man-year		Total price kCHF	Man Power Man-year		Total price kCHF	Man power Man-year	
10	**LINAC 2**											
11	Pulsed Dipoles and quadrupoles	1)	65	110	0.5		370	1		300	1	
12	Other equipment			350	1		390	1		250	0.5	
20	**Booster**											
21	Main power supply (Not in LHC project)	1)	5		0.5		1000	1.5				
22	Dipoles pulsed	1)	50				620	1.5				
	Ring Dipoles	1)	40				400	1				
23	Multipoles (Groups A, B, C, D)	1)	100	600	2			300				
24	Distributor	2)	6	60								
25	*Bdl, QCD, QCF*	*2)*	*16*				*160*	*0.5*				
30	**PS**											
31	Main power supply : power part			90	0.5			1.5		2250	2	
	electronics			180	1.5							
32	Septa 16, 58 power supplies	1)	3		1		180					
33	*Low correction energy power supplies*	*1)*	*154*	*690*	*2*		*540*	*1*				
34	*Tekelecs & PFWs power supplies*	*2) & 1)*	*14*	*220*	*0.5*		*600*	*1*				
36	*Septa 57 and 61 power supplies*	*1)*	*2*				*420*	*1*				
37	*Gamma Transition power supplies (Included in FPP List)*											
40	**FT 16**											
41	Modulated power supplies	1)	21	1000	2		400	1				
42	Steering power supplies	1)	4	100	0.5							
50	**FA 58**											
51	R2B power supplies	1)	6	360	1							
52	Steering power supplies	1)	4				100	0.5				
60	**East Area**											
61	Power supplies R1, R2, R2A, R2B, R2G	1)	50	1000	2		600	1.5		800	2	
62	Power supplies R10, R31,T1B	1)	16				380	1.5				
63	Power suppiles R6	1)	2	200	1		220					
70	**Isolde**											
71	Old SC power supplies	2)	5	40								
72	Electronics renovation	2)	20							160	0.5	
73	Dipoles BTY, Dipoles transfer dc	2)	30	40	1		200					
	AD (estimation : 6 - 03- 1997)			60								
			617	**5100**	**17**		**6580**	**15**		**3760**	**6**	

N.B. : 1)= Power part + Electronics 2) = Electronics

LEAR, LPI, CTF and AD project are not included in this list. **The projects which are on the FPP list are mentionned in italic**

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ANNEX 9:

PS/RF/Note 96-28
2 October 1996

CONSOLIDATION OF THE PS COMPLEX RF SYSTEMS (PS-RF GROUP)

A. Krusche

The following estimation of future consolidation needs is based on the assumption that the present RF Group exploitation budget is kept constant and that sufficient manpower is available to maintain the rf equipment in a healthy working state.

With the official boundary conditions for the present and future PS operation in mind, one can identify a number of rf systems which will not require a substantial consolidation in the foreseeable future:

1. PS Complex RF Systems Without Consolidation Needs

- *AA/AC rf systems, LEAR rf systems, PS antiproton transverse dampers:*

  Their operation will stop in 97 and all future activities in these systems are then supposed to be covered by project budgets.

- *PS 114 MHz systems:*

  They are used exclusively for lepton acceleration and their operation will stop with the lepton programme (2000). Beyond year 2000 their function can be taken over by new 80 MHz cavities that are presently under construction.

- *EPA/LIL rf systems:*

  The equipment can be operated with normal maintenance until the lepton programme stops (2000) and beyond that date.

- *Linacs I/II rf systems:*

  The systems are fairly new and normal maintenance should suffice in the forthcoming years.

- *PSB 8 MHz and 16 MHz rf systems:*

  The systems will be modified or replaced in 1998 within the framework of the LHC project.

2. PS Complex RF Equipment that Needs Further Consolidation

	0 ... 5 years	5 ... 10 years
- PS 10 MHz rf systems		
• purchase of spare ferrite rings	50 kF	
• replacement of obsolete electronics		220 kF
• replacement of tuning amplifier transistor banks		350 kF
- PS 200 MHz rf systems		
• revision of rf power amplifiers	90 kF	
• modernisation of electronics and electrics		200 kF
- PS beam control electronics		
• replacement, upgrading and standardisation	110 kF	110 kF
- Air conditioning in the PS Centre Building (Bldg 359/353)		
• renovation and upgrading of these aging systems are indicated. The budget is assumed to be included in the cooling and ventilation consolidation estimate	-	-
Total kF	**250**	**880**

ANNEX 10:

PS/VC/lmg

PS/Safety 96-16
6.9.1996

SAFETY CONSOLIDATION FOR THE PS COMPLEX

V. Chohan

INTRODUCTION

This note has been written in response to a divisional request to analyse and enumerate the possible costs of consolidating the PS Complex in the next 15 years from the Safety point view. The cost scenarios have been defined by 3 categories namely, Category I meaning in the immediate future (<= 5 years), Category II meaning the medium-term future (5-10 years) and Category III implying long-term future (10-15 years hence). The note attempts to list the overall safety considerations; it does not include particular project related improvements, modifications and additions already in progress such as the PS Complex conversion to LHC or the new East Hall Experimental Area.

RADIATION MONITORS AND ANCILLARY SYSTEMS

Area Monitors (PAX): There are 44 Area monitors at present in the PS Complex; their distribution is as follows:

East Hall:	11
LPI:	6
AAC:	5
PS & PSB:	15
ISOLDE:	7

It is not envisaged to increase this number because to a large extent they satisfy all current requirements. However, on the Induced Activity Monitors side, we need to install additional ones, particularly in light of new roles of East Hall for test beams in the future as well as continued and increased physics beams in ISOLDE and for facilities such as the CTF2 in the LPI region.

Induced Activity Monitors(PMI):

	Current (22)	Additional(14)
AAC:	4	-
EAST Hall:	-	8
PS & PSB:	10	-
ISOLDE:	8	2
LPI-CTF2:	-	4

The cost of these 14 additional Induced Activity Monitors is estimated to be in the order of **140 kCHF in Category I.**

The Infrastructure (Chassis, power supplies with standby batteries and cabling) of the present PS Radiation Monitoring System dates from 1970. Many of the component parts, in particular the batteries, need replacing. For homogeneity and long-term upkeep, the PS Radiation Monitoring System Infrastructure should be changed completely to the recent CERN standards used in LEP.

The cost of this major upgrade is estimated to be **150 kCHF in Category I,** broken down to approximately 100 kCHF for components and 50 kCHF for cabling.

BEAM LOSS MONITORING SYSTEM

The Beam Loss Monitoring System as it is today, needs major refurbishing to be able to visualise as well as to store and retrieve losses at a given location. The current hardware for loss detection provides all the required information in a volatile manner; the problem therefore is to do the necessary by software to follow losses in the PS, PSB Rings as well as transfer lines (e.g. TT2, ISOLDE etc.). Proposals are in progress to define a powerful software facility to visualise, store and retrieve data in a 3-Dimensional, user-friendly manner.

The cost estimate for this significant software upgrade is estimated to be 240 kCHF in Category I.

AIR ACTIVATION AND VENTILATION

When beam is lost in the PS Ring, the secondary high energy particles which are produced interact with nuclei in the tunnel air, causing them to become radioactive. For the PS Ring enclosure, the air based induced radioactivity is released through many undefined openings into the adjoining buildings or to the atmosphere. This is because unlike more recent accelerators and areas in CERN, the PS Ring and its enclosure does not have a ventilation system which extracts the air from the Ring enclosure in a controlled manner. The PS Ring was built over 35 years ago and does not have a sealed system for ventilation. There are 8 ventilation shafts through which air is pumped into the ring. The air based release mainly consists of short-lived radio-nuclides, and does not infringe the host states' site boundary limitations. However, given that the more recent CERN accelerators and areas conform to better control of such released activity (ISOLDE, SPS and LEP) a serious thought has to be applied to the oldest accelerator at CERN and its releases of short-lived

radioactivity to adjoining buildings and atmosphere. Recent changes in Swiss legislation impose on CERN an evaluation of environmental impact of its radioactive releases. Similar considerations should also be applied to the East Hall, considering its role in the future for test beams or special experiments like PS211. In the AAC Target Area, a sealed system exists but with controlled release into the adjoining AAC Hall (Bldg. 193) which needs to be reconsidered appropriately if the AD project becomes a reality.

The cost estimates for the new PS ventilation system alone (with controlled extraction) are in the order of 320 kCHF per pumping station, hence a total of **2560 kCHF for the 8 stations**, classified in Category I. For the AD or East Hall projects, some extra contingencies must be catered for through the project budgets.

STORAGE OF RADIOACTIVE MATERIAL

The PS Complex currently operates 10 accelerators or storage rings and has gone through a significant period of construction, renewal and improvement of its machines in the last 20 years. From the construction of the new proton Linac about twenty years ago to today, we have gone through the construction of the antiproton source facilities in two stages, construction of LEAR and its experimental facilities, construction of LEP injector facilities, construction of ISOLDE facility to use PSB beams and lastly, the newly constructed heavy ion Linac. At the same time, several facilities or areas have been decommissioned such as the SC, the old proton Linac or, had major renewals such as the South Experimental Hall for LEAR physics. We are about to enter a phase where major existing facilities are to be decommissioned (AA, LEAR, South Hall) and/or renewed in a significant manner (East Hall, PS-PSB Conversion for LHC and possibly AC to AD and Experiments) in the near future (Cat. I) and in five years (LEAR to Lead Ion Storage Ring, LPI moth-balling, etc. (Cat. II)). Given these facts, it is clear that a significant quantity of slightly radioactive material has been accumulated in the last 20 years in the form of accelerator components and parts including magnets; this quantity will increase in the coming 5 years. Some of these components have been reusable occasionally as valid spares, depending on the application to a certain degree and knowledge about its existence among the specialist teams concerned, i.e. vacuum components, septum spares etc.

Formally, the PS Complex has no designated storage area for slightly radioactive material; Octant 1 of ISR Tunnel is used for storage of radioactive material as well as parts of North Hall (Bldg. 151) and Bldg. 225 (TIS property) in an ad hoc manner reminiscent of the days when a lot of the mechanical and vacuum services were part of the PS Division itself. As a matter of comparison, the SPS has around 3000 to 4000 sq. metres of storage space of which 1600 sq. metres are designated for storage of radioactive material. It is imperative that the PS Complex organises and designates a storage area in the order of 800 sq. metres for radioactive material with a controlled inventory and upkeep. It should be mentioned that the storage situation as it stands will be further aggravated by the future loss of the ISR area.

The cost estimate for such a depository if constructed new on a given site would be in the order of 2 kCHF per sq. metre, i.e. **1.6 MCHF for 800 sq. metres in Category I,** including the usual supporting equipment like lifting gear, heating etc.

BEAM INTERLOCK, ACCESS AND INTERCOM SYSTEMS

The PS Complex Beam Interlock Systems date several years with various extensions, improvements and modifications that have been introduced during the PS Complex growth period of 1978-91. For the LHC era, major refurbishing will be necessary to achieve continuity and homogeneity with similar systems in other accelerators of CERN. Beam stoppers and interlocking of critical elements to the hardwired Safety chain form the basis of this system. Some of these stoppers may also need refurbishing in the coming future.

The Access Systems are linked to the Interlock System and permit safe access to primary or secondary area belonging to the PS Complex. The Access Systems at CERN are gradually moving to common CERN-wide standards under ST Division. In the medium-term, a major upgrade of these systems is foreseen.

The PS Complex is interconnected to various accelerators, buildings and zones by a bi-directional Voice Intercom System linked to the MCR. Given the evolution of modern communication techniques, it would seem that the existing system is obsolete as well as not being easily maintainable in the very near future. However, serious considerations have to be applied to such a communication medium in the near future if this facility is indispensable to the good functioning of the PS Complex.

To summarise, the expected costs of this consolidation are:

Interlock System:	**1200 kCHF**	**Cat. II**
Access System :	**2000 kCHF**	**Cat. II**
Intercom(or DECT):	**500 kCHF**	**Cat. I**

Fire (Smoke) Detection, Gas Detection and Emergency Evacuation Systems

The buildings which are PS "property" are located in Safety Zones (as defined by TIS) 24, 27, 28, 29 and 30. Since many of the fire detection systems on the Meyrin site were obsolete or obsolescent, a call for tender was sent out in 1994 and a contract was passed with a Spanish firm in 1995 for the renovation of at least 4 zones. Up to now the above-mentioned zones have been renovated except zone 29 (PS ring) which will be refurbished during the 1997 shut-down; Bldg. 193 (AAC) in zone 30 was **not** renovated either, since it was not known last year what was going to happen with the AAC after 1996. For the immediate future, no large expenditure is foreseen except for adjustments to modern existing installations (e.g. there are proposals from CERBERUS to improve the detection in Bldg. 2001 - protection of goods - costing **a few tens of kCHF**; periodically the lead Linac also asks for extensions which also cost a **few tens of kCHF** and are paid for by their budget. If the AC Ring becomes AD in Bldg. 193, it is expected that it will cost **a few tens of kCHF** to upgrade the fire detection systems in Bldgs. 193 and 195.

The newly (1995-97 era) installed systems are expected to last at least 10 years. Similarly, the current fire extinguishers placed in the PS areas are expected to have a lifetime of 10 more years or so.

However, for the detection of flammable gases in the PS Complex, serious considerations have to be given for its upgrading in the near future. Similar considerations need also to be applied to the handling of level 3 Alarms (defined as alarms which indicate danger to human life in a given area or zone) and Emergency Evacuation Systems which are in the PS Complex.

Given the above facts, the consolidation of fire detection, gas detection, Level 3 Alarms and Evacuation Systems can be categorised as follows:

Fire Detection :	**200 kCHF**	**Cat. III**
Gas Detection :	**250 kCHF**	**Cat. II**
Level 3 Alarms:	**150 kCHF**	**Cat. II**
Emergency Evacuation:	**150 kCHF**	**Cat. I**

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The information given in this note has been collected with the help of various persons in other divisions including TIS and ST.

APPENDIX

Summary Table of Safety-related items per category and costs in KCHF

	Category I	Category II	Category III
Radiation: Monitoring : Infrastructure	140 150		
Loss Monitoring	240		
PS Ring Controlled Air Extraction & Ventilation	2560		
Radioactive Storage	1600		
Interlock System		1200	
Access System		2000	
Intercom	500		
Fire Detection			200
Gas Detection		250	
Level 3 Alarms		150	
Evacuation System	150		

ANNEX 11:

PS Vacuum consolidation over the period 1996 to 2011

J.-P. Bertuzzi, M. Brouet and P.Strubin

1) Assumptions

The lifetime for the various Accelerators and Linacs are taken from the long term planning.

The estimated lifetime for the vacuum equipment has been defined as follows:

- Ion pumps : 15 years, with the exception of Lin2 (RFQ): 2 years
- Rough Pumping Stations: 12 years
- Valves (Sector & Roughing): 15 years
- Titanium Sublimation Pumps:
  no limit, but filaments must be changed each year and pump bodies be cleaned every 5 years to remove titanium coatings.
- Gauges and Gas Analysers: 15 years
- Power supplies: 10 years
- Interface to main control system: 5 years

The average cost (in KCHF) used to replace a particular equipment is:

- Ion pumps	(400 l/s)	7 + 2.5 for power supply
	(270 l/s)	6
	(60 l/s)	3
- Rough Pumping Stations	(450 l/s)	15 + 2.5 for control unit
	(200 l/s)	10
	(50 l/s)	7
- Gauges Heads (Pirani+Penning):		2 + 2 for power supply
- Gas Analysers:		15
- Ti Sublimation Pumps Cost is considered as coming from maintenance budget		
- Valves	(Ø150 mm:)	6.5 + 2.5 for control unit
-	(Ø100 mm)	4

Finally, the assumption was made that the replacement of cables and power supplies was an on-going process, prepared outside of shut-down time and installed and commissioned during shut-downs. Therefore, the Excel sheets for "controls" quote a percentage of the installed value which we believe we have to change annually.

PS Complex Consolidation 1996-2011

M. Brouet and J-P. Bertuzzi

1 Machines and time scale considered

PS & BR:	>15 years
LIN 2:	>15 years
LIN3:	1996-2000 and 2002....?
Lines FT16 & Isolde Line:	>15 years
LPI:	1996-2000 (2015....?)

2 Life time of vacuum equipment

- Ion pumps: 15 years: Lin2 (RFQ): 2 years
- Rough Pumping stations: 12 years
- Valves (Sector & roughing): 15 years
- Titanium sublimination pumps: no limit, but filaments must be changed each year and pump bodies cleaned every 5 years to remove titanium coatings.
- Gauges and Gas Analysers: 15 years

3 Cost of equipment (kCHF)

- Ion pumps	400 l/s:	7 + 2.5 for power supply
	270 l/s:	6
	60 l/s:	3
- Rough Pumping stations	450 l/s	15 + 2.5 for control unit
	200 l/s:	10
	50 l/s:	7
- Gauges Heads (Pirani+Penning):	2 + 2 for power supply	
- Gas Analysers:	15	
- Ti Sublimination Pumps Cost is considered as coming from maintenance budget		
- Valves ∅150 mm:	6.5 + 2.5 for control unit	
- Valves ∅100 mm:	4	

4 Planning of consolidation

0 to 5 years:	First priority:	**Lin2** Rough Pumping Stations and ion pumps (96-97)
		Irradiated cables
	Second priority:	**Lines FT16** (1997)
		Rectangular Tanks in the **BR** (1997-98)
		Ion Pumps **LIL** and **EPA** (1998-2000)
5 to 10 years:	Rough Pumping Stations PS and BR and **Isolde Line**	
10 to 15 years:	Ions Pumps **PS** and **BR** and **FT16, LTB, BTP** Lines, and **Isolde Line**	

5 General considerations

This budget does not take into account Manpower and Spares.

PS Vacuum System (LHC-VAC)

	0 to 5 years			5 to 10 years			10 to 15 years		
	Project Cost (KCHF)	Required Manpower (Man Years / Year)	Missing Manpower (Man Years / Year)	Project Cost (KCHF)	Required Manpower (Man Years / Year)	Missing Manpower (Man Years / Year)	Project Cost (KCHF)	Required Manpower (Man Years / Year)	Missing Manpower (Man Years / Year)
Vacuum Chambers	145			75			75		
Valves	192			220			143		
Pumps & Pumping Groups	580			525			1660		
Gauges & RGA							185		
Gauge and Pump supplies	400			310			350		
Control & Interlock Equipment				50			75		
Cables & Connectors	400			85			100		
Documentation	100	1	1	50	0.3	0.3	50	0.3	0.3
	1817	**1**	**1**	**1315**	**0.3**	**0.3**	**2638**	**0.3**	**0.3**

ANNEX 12:

Consolidation work as a result of AD acceptance

S. Maury and J. Gruber

Certain consolidation jobs became necessary following the approval of the AD project, since the antiproton production zone and the various antiproton (as well as proton test beam) transfer lines in building 193 must continue to function for the life of AD. Such work is not contained in the AD project itself, which covers the removal of AA and the cost of transforming AC into AD.

In the target region, the quadrupole QFO 6030, 2 pulsed quadrupoles and a steerer all need spare units, since this is a highly radioactive zone and no spares exist. Two new coils for BHZ 6024/5 are also needed. A spare kicker unit is required for extraction from AD, as well as 2 spare quadrupoles for the 3.5 GeV/c transfer line.

Finally, consolidation of a number of power converters is needed, which would not have been necessary if AD had not been approved. These are the main power converters for AD ring magnets, pulsed supplies for septa (2kV and 4kV) and an upgrade of R2B and T1B supplies.

Target Zone	**Cost (kCHF)**	**Totals (kCHF)**
Spare QFO 6030	100	
2 spare pulsed quadrupoles	150	
Spare steering magnet	80	
2 spare coils for BHZ 6034/5	60	**390**
Extraction kicker	150	**150**
Spare quadrupoles in transfer line	100	**100**
Power converters for AD		
Pulsed supplies, 2kV and 4kV	30	
Main power converters	20	
Upgrade of R2B and T1B	10	**60**
		700