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MAINTENANCE MANAGEMENT IN THE ST DIVISION

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Abstract

The Maintenance Manager Working Group was established in order to revise existing maintenance contracts and to provide comprehensive and applicable tools for the execution of maintenance activities in the ST Division. This was necessary mainly due to the fact that the maintenance plans in the Division have often evolved rather than being consciously set up and in respect to the change towards result orientated contracts. Also, because the decrease of CERN staff and the trend towards outsourcing, a tighter and well-organised maintenance management has to be established. In order to achieve the most realistic and applicable results the technical and commercial aspects must be considered by following the industrial approach. This document will outline the objectives of the working group and will show the progress that has been made by the implementation of already achieved results. Furthermore this paper will show a possible structure of future maintenance management.

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1 INTRODUCTION

The proper running of the CERN accelerators and various other technical facilities is one of the main tasks of the ST Division. About 47 staff members of the ST Division are working directly in the field of maintenance. Due to outsourcing over the last two decades the biggest part of maintenance activities is now done by contractors. Last year the ST Division held 31 maintenance contracts. Approximately 22 MCHF, which corresponds to about 50% of the ST operation Budget, was spent in year 2000[1] for the maintenance.

2 MAINTENANCE MANAGER WORKING GROUP

2.1 Mandate

The Maintenance Manager Working Group was established in order to revise existing maintenance contracts and to provide comprehensive and applicable tools for the execution of maintenance activities in the ST Division. In order to achieve the most realistic and applicable results the technical and commercial aspects must be considered.

2.2 Participants

All ST groups involved in maintenance are represented in the maintenance manager working group. Isabel Bejar Alonso (LHC Naming Convention), Enrico Cennini and Rui Nunes for ST/AA, Rosario Principe for ST/CV, Claude Jacot (INB Regulations) and Björn Jenssen for ST/DI, Paolo Ciriani (Senior Manager), Grzegorz Kowalik and Serge Oliger (MP5) for ST/EL, Bernd Langer and Ingo Ruehl (Chairman) for ST/HM, Bruno Vercoutter (MP5) for ST/MO, Paul Pepinster for ST/TFM and Alexander Kurz (Industrial Service Contracts) for SPL/IS.

3 STANDARDISATION

Due to the decrease of CERN staff and the trend towards outsourcing, a tighter and well-organised maintenance management has to be established. Part of an well-organised maintenance management is to standardise the maintenance activities and procedures throughout the ST Division in order to create more effective and transparent results.

3.1 Computerized Maintenance Management System [CMMS]

One of the main tasks over the last year was the migration from the old CMMS RAPIER to the new system MP5. This was necessary due to the fact that the old CMMS was obsolete and that there was no possibility to create a common database for the entire ST Division. The biggest part of the migration is done but some challenges, as for example the stock management, is still to meet.

3.2 Maintenance Terminology

With the migration to the new CMMS MP5, the ‘European Standard for Maintenance Terminology’ was adopted in order to obtain the maximum congruence for all groups regarding planning sheets, routines, frequencies, activity codes, reports etc. Big efforts have been made over the past few years in Europe in order to establish an ISO standard for maintenance including the maintenance terminology that might be published in 2001.

3.3 Equipment Coding

The equipment coding was, is, and will still be one of the future challenges. By accepting the LHC naming convention and in order to meet the requirements of the new CMMS MP5 the equipment codes had to be extended to five letters as it can be seen in table 1.

[1] ST Operation Budget 2000: 37.9 MCHF
ST Personal Budget 2000: 35.3 MCHF (for 261 staff members)

Table 1
Example for Equipment Coding for ST/HM

Letter	Significance	RAPIER	MP5
1	System Code	Non Existent	**H**
2	Family Code	Non Existent	**H**
3	Sub-Family Code	Non Existent	**L**
3	Equipment Code	**P** (Pont)	**P**
5	Equipment Code	**R** (Roulant)	**R**

The coding for new equipment shall follow the new requirements but it is up to the different groups, if and how they want to change the old labels on their equipment.

Another major aspect in the future will be the tracability of equipment due to requirements of the INB regulations. The new CMMS MP5 allows the allocating of 'Barcodes' to the equipment but it is not decided yet if this will be necessary.

3.4 Statistics

Also the step towards common statistics that shall be applied for all groups will help to get more comparable results and more transparency in the maintenance activities. The new CMMS MP5 will be able to provide the following statistics:

- The Top Ten of non-disposable equipment
- Maintenance cost par equipment or family
- Number of on-failure (corrective) maintenance per month
- Costs of Spare Parts per month
- Mean Time Between Failure (MTBF)
- Mean Time To Repair per equipment (MTTR)
- …

The major reason to establish this statistics is to create applicable performance indicators and in order to have a kind of benchmarking within the ST Division and towards the industry.

3.5 Overall Maintenance Costs

In order to compare the maintenance activities at CERN with those in the industry each group in the ST Division was asked to establish the overall maintenance costs.

The benchmarking parameter in this case is the percentage [R] of equipment value that is spent for the maintenance on the equipment.

For calculating this benchmarking parameter the following numbers were needed:

- [E] Equipment value based on the renewal price,
- [M] Maintenance costs (contracts, spare parts etc.),
- [O] CERN Staff and overhead costs[2].

The table 2 below lists the major maintenance contracts held by CERN and give an example how the benchmarking parameter was calculated.

[2] The average salary and overhead costs for one CERN staff member is estimated to 156 KCHF/year.

Table 2
Overall Maintenance Costs

Group ST	*Equipment*	*Maint. Contracts n°*	*Value of [M]aint. Contracts CHF*	*[E]quipment Value CHF*	*CERN Staff n°*	*CERN [O]verh. Costs CHF*	*Ratio (M+O)/E %*
AA	SUSI	1	644'000	10'000'000	1	156'000	8.00%
	ZORA	2	200'000	35'000'000	6	936'000	3.25%
	Fire Detection	1	1'100'000	20'000'000	3	468'000	7.84%
	TOTAL	**4**	**1'944'000**	**65'000'000**	**10**	**1'560'000**	**5.39%**
CV	Cooling & Vent.	1	3'500'000	350'000'000			
	Water Treatment	1	120'000	200'000			
	TOTAL	**2**	**3'620'000**	**350'200'000**	**17**	2'652'000	**1.79%**
EL	Contractor	1	1'270'000				
	Manufacturers	1	900'000				
	TOTAL	**2**	**2'170'000**	**280'000'000**	**6**	**936'000**	**1.11%**
HM	Lifts	8	309'050	11'500'000	1	156'000	4.04%
	Cranes etc.	1	1'750'000	90'000'000	2.5	390'000	2.38%
	Vehicles	3	428'000	12'500'000	1.5	234'000	5.30%
	TOTAL	**12**	**2'487'050**	**114'000'000**	**5**	**780'000**	**2.87%**
TFM	HVAC		1'790'000	76'000'000	2.33	363'480	2.83%
	Electricity		1'390'000	50'000'000	3.33	519'480	3.82%
	Civil Engineering	11	3'100'000	1'260'000'000	3.34	521'040	0.29%
	TOTAL	**11**	**6'280'000**	**1'386'000'000**	**9**	**1'404'000**	**0.55%**
ST	**TOTAL**	**31**	**14'331'050**	**2'195'200'000**	**47**	**7'332'000**	**0.99%**

In industry a percentage of 2% of equipment value that is spent on maintenance is applied as a benchmarking factor. The percentage spent on the maintenance of ST equipment is about 1.9% if only the technical equipment is considered and not the facility maintenance (Civil Engineering) as in the above table 2. This shows that in general the maintenance contracts within the ST Division are well prepared and only small adjustments might be necessary. It is obvious that the various technical equipment need partly specific maintenance as, for example, the lifts that need by law an obligatory maintenance and security check every month. Therefore the percentage of equipment value spent on maintenance will be above 2%. But as in industry, the 2% benchmark is considered as a crossover result for the various technical equipment.

4 A WORLD CLASS MAINTENANCE MANAGEMENT SYSTEM

The flowchart below (Figure 1) shows the major steps in maintenance management.

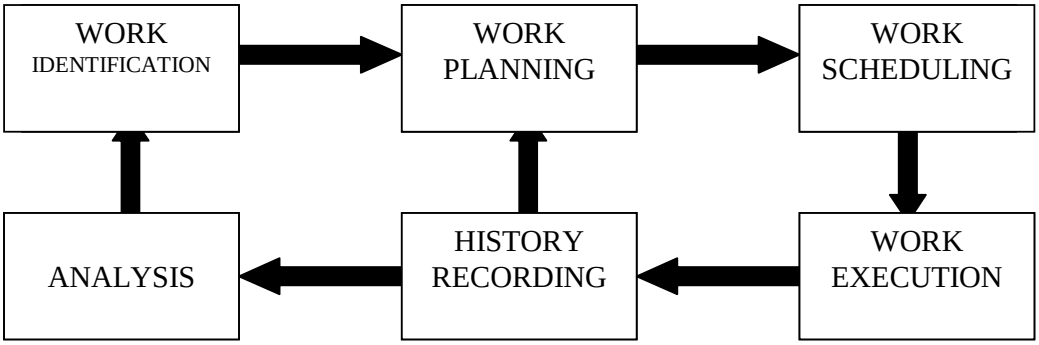

Figure 1: Maintenance Flowchart

In the first instance, organisations might choose simply to outsource the work execution step. This is often done on a limited basis as a supplement to in-house work force during times of high workload as for example major shutdowns.

An alternative approach is to outsource all of the above activities with the exception of the analysis and work identification steps. In this approach, the contractor is permitted to plan and schedule his own work, and decide how and when work is to be done, but the outsourcing organisation retains control over what is to be done.

A third approach is to outsource all of the above steps, thus giving control over the development of equipment maintenance strategies to the contractor. In this instance, the contract must be structured around the achievement of desired outcomes in terms of equipment performance, with the contractor given latitude to achieve this to the best of his ability.

The current situation at CERN corresponds to the second approach with tendencies to the third approach. The major steps missing to apply the third approach is firstly to structure the contracts around the achievement of desired outcomes in terms of equipment performance and secondly the ability of CERN staff to adopt this new approach by restricting the maintenance to a purely analytical activity.

Furthermore it must be realised that a contractor is purely profit orientated and each contract should be carried out in such a way to motivate the contractor to deliver a better product regarding maintenance performance and a profound analysis of the history recording.

The only way to establish this kind of maintenance contract is a close collaboration between the divisions ST and SPL.

4.1 Maintenance Strategies

The four key maintenance strategies are:

4.1.1 On-Failure Maintenance (Corrective Maintenance)

The maintenance is done when the equipment has failed to fulfil its function.

4.1.2 Fixed Time Maintenance (Preventive Maintenance)

The equipment maintenance is based upon fixed time – either calendar based, actual hours in operation, or the number of equipment cycles carried out.

4.1.3 Condition Based Maintenance

The equipment maintenance is based upon its known condition.

Maintenance on inspection or monitoring is an attractive concept, in that the maintenance action will only be performed when knowledge of the equipment indicates that failure to fulfil its function is imminent.

Condition based maintenance can generally be applied if the time between the first point of measurable deterioration and the point of unacceptable deterioration is at least about six months (see Figure 2). In this case the frequency of measurements has to be done according the equation:

$$F = T / (4..6)^{3}$$

[3] This factor depends on the type of equipment (according to the existing ISO recommendation).

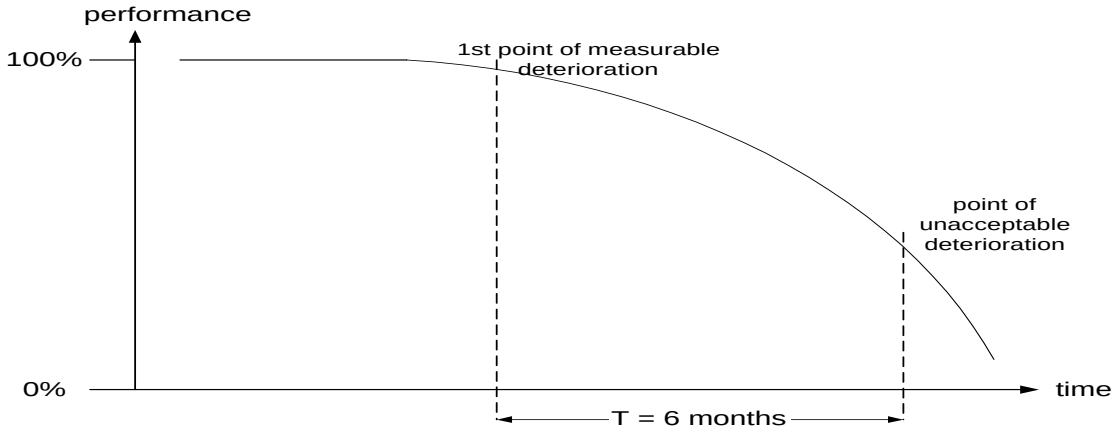

Figure 2: Equipment Performance Diagram

4.1.4 Design Out Maintenance

Design, or redesign, equipment to eliminate the root cause of failure and resulting failure modes so as to eliminate or minimise the need for maintenance.

4.2 Maintenance Plan

Each of these strategies has a place within an optimised maintenance plan, but the distribution of the mix will depend upon many factors including:

- the equipment to be maintained,
- the operational context- both in terms of production and the prevailing environmental conditions,
- the maintenance resources available,
- health and safety compliance,
- general practicalities,
- cost.

Each maintenance strategy has advantages when implemented correctly, but conversely, disadvantages when implemented incorrectly.

The optimum maintenance plan in general for the industry (figure 3) is considered to be a mix of.

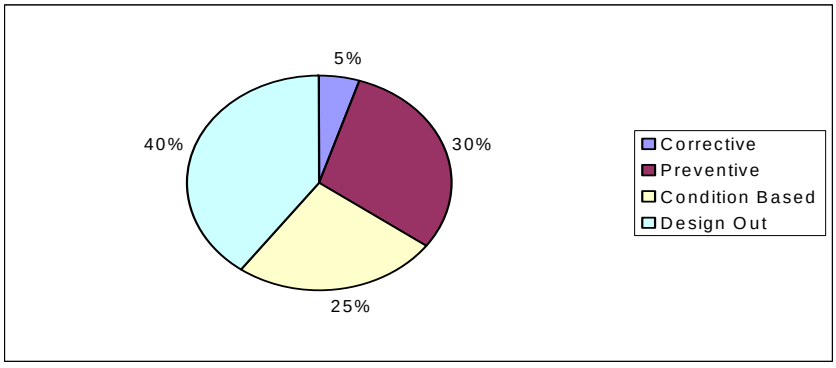

Figure 3: Maintenance Plan

At CERN the maintenance strategy for the most contracts is biased towards costly preventive maintenance. In contrast the condition based maintenance and the designing out of equipment that demands an expandable maintenance is hardly applied.

It will be one of the main tasks for the maintenance manager in the future to exploit the new CMMS MP5 in order to apply condition-based maintenance and to justify the design out and purchase of new equipment.

4.3 Result Oriented Maintenance Contracts

Many of the result orientated maintenance contracts are based on a cost and fee basis according to the following arithmetic technique:

$$R = F + C + [0.5 * (E - C) + f(Q)]$$

- F - Fixed Costs (Contract Management, Assurances, Office costs etc.)
- E - Estimated Maintenance Costs
- C - Real (Executed) Maintenance Costs
- f(Q) - Bonus-Malus Factor as a result of applied performance indicators

The main idea behind this approach is to motivate the contractor to provide a better, faster and more professional equipment maintenance product by sharing the profit resulting from a lower executed maintenance [C] than estimated [E] between the contractor and CERN.

This approach has of course also limitations due to the fact that by constantly reducing the maintenance the breakdowns of equipment will increase. Therefore the application of the performance indicators is of big importance in order to get the right balance between a sensible maintenance reduction and an acceptable equipment performance.

4.4 Maintenance Management

The organisation of the maintenance management applied within the ST division corresponds to the standard structure in the industry. The main importance in lean maintenance management is the clear definition of roles and responsibilities.

The structure consists mainly of 3 parts:

1. The Overhead Group represented by the 'Senior Managers' of the ST and SPL division responsible for the main contract strategy and as control organ.
2. The Maintenance Managers that are directly responsible for the correct application of the maintenance contract.
3. The Maintenance Technician for the correct execution of the maintenance activities. The number of maintenance technician depends mainly on the number and variety of equipment.

5 CONCLUSION

In general terms the maintenance contracts held by the ST division are well executed and correctly implemented. Only small adjustments are necessary, as for example, the implementing of performance indicators in order to realise the step towards result orientated contracts. In order to facilitate the implementation of performance indicators, the forthcoming maintenance contracts shall be clearly structured around the achievement of desired outcomes in terms of equipment performance.

In industry the maintenance is nowadays an important part of the production process and hence subject to an ongoing evolution. Stagnation in maintenance progress often means loss in profit and market share. The maintenance managers are requested, in order to align themselves more closely

with industry, to follow up the latest developments, as for example the trend towards facility maintenance contracts.

The results and analysis that can be obtained by evaluating the data collected in the CMMS are not only beneficial for improving maintenance strategies but should also be used by the project leaders in order to consider the life time costs (acquisition, maintenance, energy consumption) of equipment as adjudication criteria. This could be an important tool in order to obtain better equipment that might have higher initial costs but will be absorbed within a short time due to the more favourable life time costs.

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