EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
ORGANISATION EUROPÉENE POUR LA RECHERCHE NUCLÉAIRE

CERN - ST Division

CERN-ST-2000-031
February, 2000

PERFORMANCE REPORT AND IMPROVEMENTS IN CV MACHINE AREAS

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Abstract

The performance of cooling and ventilation (CV) equipment is defined as its availability to the PS, SPS and LEP accelerators. Three teams for the accelerators plus a Utilities team, which receives performance information from the physics and technical control room, carry out the operation of this equipment. Collected performance statistics as well as data from the Computer Aided Maintenance Management system (CAMM) and supervision system provide information on the exact state of the CV equipment. This is used to more effectively schedule preventive maintenance which, by reducing system failures, results in improved equipment performance. This paper will present performance data and discuss the prospects for improving it through the use of an updated version of CAMM and a new supervision system.

Presented at the 3rd ST Workshop
Chamonix, France, January 25 - 28, 2000

1 INTRODUCTION

This paper will describe how the Cooling and Ventilation (CV) group is evaluating the performance of equipment belonging to the group. The functioning of a major part of the CV equipment is important for the accelerators and a breakdown in a small piece of equipment can cause an interruption of the experiment. Therefore the availability of the CV equipment for physics is the most crucial factor for the CV performance. The performance statistics are compiled by the control rooms, and include the number of hours of experiment running, interruptions of the experiment, and which piece of the group's equipment is causing the downtime. The Prévessin control room within the SL division is responsible for the experimental machine operation of the LEP and SPS accelerators. The PS accelerator is operated by the main control room in Meyrin within the PS division. These data are used to calculate the CV equipment performance. The Technical Control Room is responsible for the surveillance of the equipment belonging to the CV group in the accelerators, and on the basis of the daily reports the equipment causing the stop can be determined.

To avoid equipment breaking down the preventive maintenance is of the utmost importance. For this purpose the new Computer Aided Maintenance Management system (CAMM), that is going to be put into service in 2000, will be a greatly improved tool for the operation teams and the maintenance contractor. Another important step is the upgrade and standardization of the supervision system.

2 PERFORMANCE STATISTICS

2.1 Data presented

The following four sets of data are used to define the performance of the CV equipment:

- number of times during the year when a failure in the CV equipment has caused an interruption of the experiment;
- total number of hours of downtime registered by the physics control rooms caused by CV equipment;
- CV equipment downtime compared with the total hours of downtime for all the services registered;
- number of hours of interruption caused by CV equipment compared with the total number of hours of experimental runtime; this is equal to the availability of the CV equipment.

2.2 PS statistics

The statistics from the lepton and proton periods constitute the PS data, Fig. 1 [1]. These statistics also include linac data.

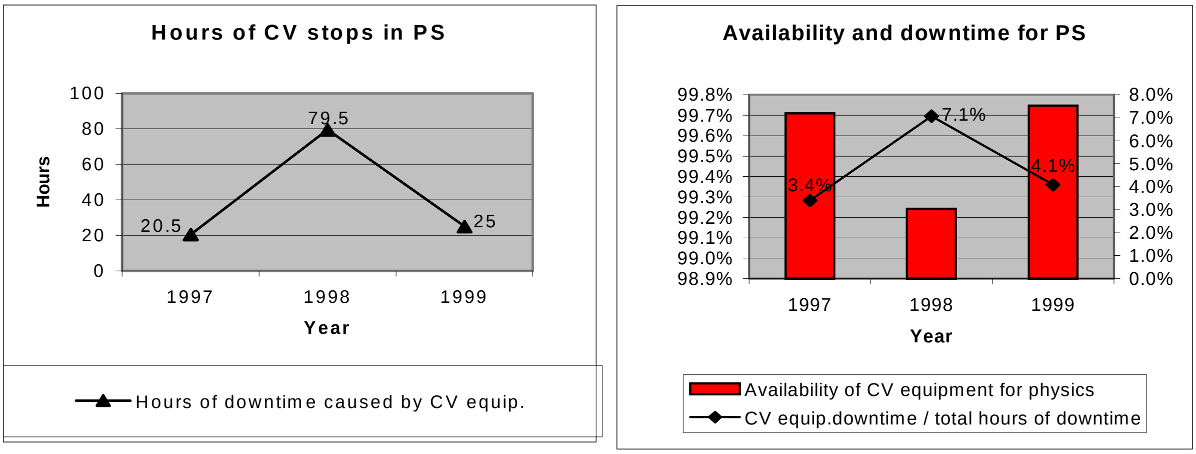

Figure 1: PS statistics.

It is normal practice in the physics control rooms for all downtime hours due to cooling problems to be registered in the account of the CV group. However, some of these cooling problems, such as water leaks in the magnets or in electrical cabinets, are the responsibility of other groups. In such cases, the number of downtime hours not caused by CV equipment should be transferred to the group responsible. This is done in the SL control room for the LEP and the SPS, but has not been the practice in the PS control room. This results in the number of interruptions attributed to the CV group being too high: In 1999 the PS operation team attributed only 25 hours of downtime to CV equipment, equalling only 23% of the hours in the account.

2.3 SPS statistics

The statistics from the lepton, proton and ion periods constitute the SPS data, Fig. 2 [2].

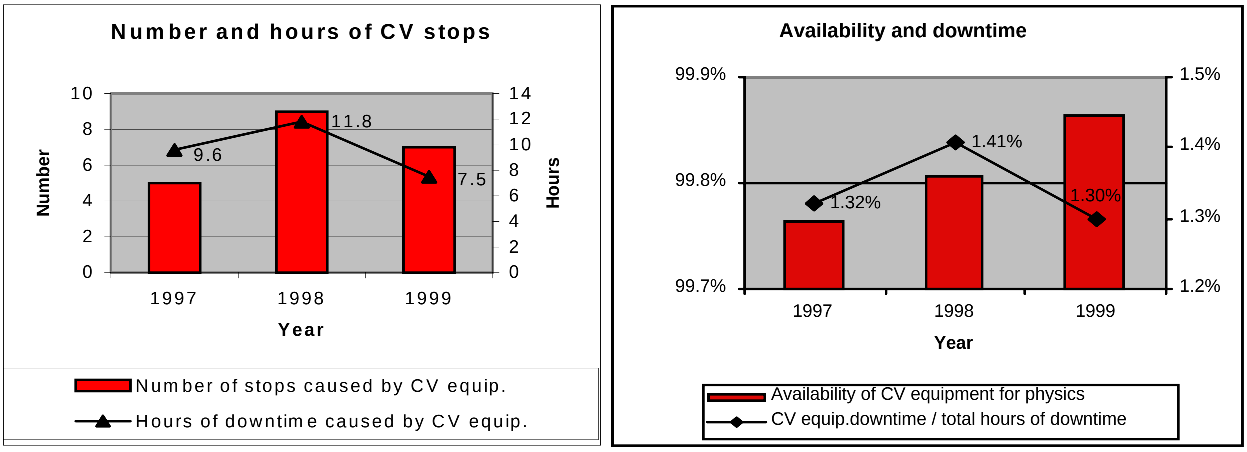

Figure 2: SPS statistics.

The downtime in 1999 can be divided into four types.

- Equipment failures caused four incidents, 44% of the total hours. After each incident the cause was examined and improvements made ensure more reliable operation of the equipment and to prevent similar incidents.
- Failures by the maintenance personnel caused one incident, 12% of the total hours. This incident and two similar ones at the LEP have led to a change in working practice. Now only maintenance which can be done with zero risk of stopping the experiment is carried out during the run.
- Start-up problems after electricity saving days (EJPs) caused two incidents, 44% of the total hours. There were several EJPs during the ion period. After each EJP the CV equipment is started up immediately before the start-up of the experiment. This means that even small problems in the starting phase immediately cause downtime for the experiment. This procedure has now been changed: The equipment is now started up from 1800 to 2200 hours and possible problems can be solved before the start of the run at 0100.

2.4 LEP statistics

The LEP is the last stage in the chain of accelerators delivering a beam. Downtime for the PS and SPS will immediately affect the LEP. However the amount of downtime registered for the CV group is only for failures caused by LEP equipment, Fig. 3 [2].

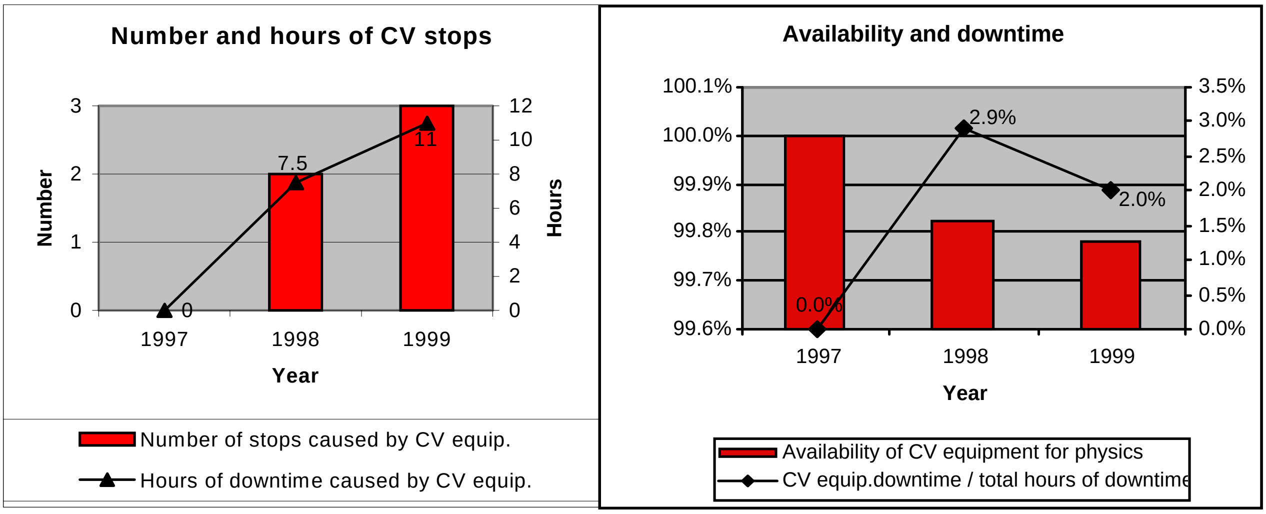

Figure 3: LEP statistics.

In 1999 the high demand for physics and the continued increase of the beam energy pushed all systems to the limits. This caused more downtime for all services, but a record number of 4971 physics hours were achieved.

2.5 Utilities statistics

For the physics control rooms there is no difference between the different teams in the CV group and so the utilities team is not registered separately in the statistics. However it is a very important team because it is responsible for delivering water to the accelerators. In 1999 a stop at Pumping Station 5 caused 10 hours of downtime in the LEP, 10 hours in the SPS and 7 hours for the PS.

3 MAINTENANCE STRATEGIES

3.1 CV equipment conditions

The CV equipment for the LEP, SPS and PS was installed when the accelerators were constructed. Fortunately the equipment installed for the accelerators has proven to be of good quality and has been well-maintained, thus limiting the number of breakdowns. However, when a breakdown does occur spare parts are often no longer available from the supplier. This makes intervention very costly and the delivery of parts can take months. Thus it is important that all crucial equipment has a standby system so interruptions can be avoided.

Each piece of equipment is registered in the CAMM database. The data stored include technical information, time periods between maintenance, and the kind of work which needs to be carried out. This system is an important tool for maintenance work. Unfortunately the structure of the database and the user interface is not kept up-to-date, which currently limits the value of the system.

3.2 Preventive maintenance

From a maintenance point of view the equipment belonging to the CV group can be divided into two major categories. One category can be maintained during operation of the experiment and a second, the crucial equipment, can only be maintained during a shutdown because a failure during maintenance work could cause a stop to the experiment. To categorize the equipment a risk evaluation is carried out for all equipment, defining when maintenance work can be carried out. The shutdown period is being reduced by the growing demand of physics. This factor, along with an increasing amount of critical equipment given by the risk evaluation, is causing a demand for more manpower from the maintenance contractor during the shutdown. This exceeds the number of people necessary during the run. For this reason it is difficult to fulfil all the maintenance work that has to be done during the shutdown.

Some equipment installed today needs no or very little preventive maintenance. An example of this type of equipment is the compressors for the water-cooling units. These units are constructed to operate for 10–15 years with very limited maintenance. After this period machines can be overhauled or replaced. These machines have successfully served the LEP experiment and are now replacing all CV water-cooling units. In the design phase of à new cooling installation, equipment that requires less maintenance should be preferred if the economic and technical aspects for two brands of equipment are equal.

3.3 Interventions in case of breakdowns

Since the risk of equipment breaking down can never be avoided the efficiency of the on-call service is very important. The ability to intervene quickly and effectively can minimize the minutes of downtime. The on call service is included in the maintenance contract and the persons on call stay at home [3]. Outside normal working hours the time between a problem occurring and the arrival of the on call service can be up to one hour. This ability to intervene also depends on the technical knowledge of the personnel. Especially for the old installations, where documentation on the equipment is sometimes lacking, familiarization with the equipment is very important. For the PS and SPS in particular on-call personnel appear to lack technical knowledge and require more training. For the SPS between 1 October and 30 November 1999, the on-call service needed to call a member of the operation staff in six out of seven interventions outside normal working hours.

4 FUTURE IMPROVEMENTS

To improve the CV performance the equipment has to be monitored carefully. With the new CAMM the historical figures can be viewed [4]. For instance the number and type of interventions can be used to calculate a figure for the cost of maintenance for specific equipment. Based on this figure, a cost-based analysis to determine if the equipment should be replaced or repaired can be carried out. This is not possible with the current version of CAMM. Moreover the existing structure of the data is not good, thus making it difficult to compare similar types of equipment. Along with the update, a restructuring of equipment data allows better search possibilities and more efficient access to the data.

The monitoring system, which is currently managed by several systems, will be replaced [5]. In the future all these systems will be integrated into a single system using fieldbus technology. The data will be transferred to standardized software for supervision (WISCON), which allows the operation teams to improve their function of system control. This standardization allows a lot more information for each station on the accelerators to be transferred to the operation teams. For example, it would be possible to constantly monitor the vibration of the water pumps, indicating whether the pump needs to be renovated. This would give time to take action before the equipment breaks down, thus preventing physics downtime.

5 CONCLUSION

To enable intervention to take place before equipment breaks down CAMM and WISCON should be used to their full potential. At the division level a big effort is invested in these systems to get the structure in place. Thereafter the operation teams will optimize the maintenance routines in order to help the contracting company to carry out the proper interventions.

Moreover, equipment which needs little or no maintenance during its lifetime should be chosen, lowering maintenance costs and freeing more resources for updating equipment. When breakdown occurs the downtime period should be limited through an on-call service which is able to intervene quickly and efficiently.

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