ST OPERATION REPORT

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Abstract

The ST Operation Report gives an overview of the technical infrastructure operation under the responsibility of the ST division. The availability of the infrastructure for CERN’s accelerators and experiments is analysed in detail and the lessons learned for next year’s operation are described. Furthermore, details of the TCR operation and the electrical infrastructure are discussed. In addition major breakdowns of the electrical and cooling infrastructure other than for the accelerators as well as major tests are discussed.
1 INTRODUCTION

In order to improve the analysis of the technical infrastructure operation, the ST division introduced the “ST Major Event Report” during the year 2001. Those reports collect details on the technical faults, the time to recover and the impact on the accelerators and experiments at CERN. These data are for the first time the basis of the statistics and analysis described in this paper.

Recommendations are given with respect to the most important breakdowns, as to avoid their reoccurrence in the future. As the electrical distribution is the fundamental service that all other installations rely on, a particular analysis is presented.

2 ACCELERATOR OPERATION

2.1 Major Event Reports

After their introduction at the beginning of the year 46 “ST Major Event Reports” have been published in 2001 [1]. The TCR creates these reports and the ST equipment groups and the accelerator control rooms add details and precisions. In particular the times to repair the technical infrastructure and the recovery time of the accelerators as well as the technical details of the failures are collected.

The result of this analysis is hardly comparable with the statistics of the accelerators because different data sources are used [2, 3]. In this report the time to repair the technical infrastructure is counted from the time of the fault occurrence to the moment when all ST equipment was operational again. However, the impact on the accelerator operation is measure with the time between the fault occurrence and the moment when the accelerator recovered the same state as before the fault, although this includes repairs that are not under the control of the ST division, see figure 1.

2.2 Important Events 2001

- 6th of January: Fire in the Tunnel Ventilation BA6
- 2nd of June: Explosion in a 18kV cell on SE18 substation: 66kV tripped, Autotransfer system switched Meyrin site over to SIG supply.
- 7th of June: 48V auxiliary tripped on BE9 substation during project commissioning, LHC 18kV loop and SPS/ZN power cut.
- 16th of June: Water leak in the booster: 7,5 hours stop
- 5th of August: BA3 cooling water fault stopped compensator: 3,5 hours of SPS physics lost
- 20th of August: Incident occurred on the 400kV transformer EHT3 of the BE substation. An explosion took place in the on-load tap-changer of the transformer. SPS and PS stopped during 4 hours.
- 29th of August: Explosion in a 18kV cell on ME7 South generator PS substation, PS stopped during 24hours until repaired (LINAC water station stopped)
- 25th of September: Cooling water trip BA2 due to a thermo-trip in the refill pumps: 4,5 hours of SPS physics lost
- 5th of October: Cooling water trip BA2 due to control fault: 3 hours of SPS physics lost
- 13th of November: 18kV SPS loop tripped caused by genie civil works near BA6
2.3 Performance

The figure shows the down time of the accelerators due to equipment faults and human errors of ST/CV and ST/EL and a comparison is made with the total accelerator downtime and the total time to repair the technical infrastructure. In addition, it has been considered, whether the accelerator has been in MD or physics exploitation. Faults in the electrical distribution often affect both the CPS and the SPS, therefore the downtime due to EL cannot be split. The difference between the time needed to repair the technical infrastructure and the recovery time of the accelerator is relatively small. With 0.8% of downtime due to the access systems, we consider the SPS access safety system as performant. The ongoing consolidation process on the SPS access control system should improve the availability and the general performances for 2002.

The majority of the SPS downtime has been caused by the new cooling system [4]. Several problems with the lifts in the SPS have caused considerable delays during the cold checkout and the interventions after faults in the tunnel. The commissioning of the new BE station had as well a small impact on the preparation of the machine for the run 2001.

The 123.41 hours of ST repairs does also include faults that have not affected the accelerator operation of which 80% have been allocated to equipment fault of ST/EL and ST/CV.
3 TCR OPERATION

3.1 Corrective Maintenance

The total number of work requests for corrective maintenance increased by 16% to over 14000 after an increase of already 10% in the year 2000. Globally the request for all the groups increased. The TCR workload due to TFM (+7%) remained nearly constant over the past four years at about 50%.

Major increases for the other groups are:

- EL (+67%) due to the maintenance contractor who started his work and also taking over the stand-by service and a more consequent use of MP5 for TCR interventions
- HM (+75%) due to various faults of lift systems and transport equipment needed for the SPS and the LEP dismantling
- AA (+20%) that reflects an increase of the number fire brigade interventions from 390 in 2000 to 580 in 2001 [5]. Of this increase 50 interventions took place on the Meyrin site and 150 in LEP. This is mainly due to the LEP dismantling, civil engineering works. For the majority of these interventions no cause has been identified.

3.2 TCR Interventions

The number of TCR on-site interventions increased from 1500 to 1800 of which nearly 60% are carried out on the Meyrin site. This represents more than 10% of the total work requests for corrective maintenance. The main areas of work are cooling & ventilation and electricity that increased considerably in 2001. The number of control interventions is at least twice as high as indicated but are documented in various systems, so that a statistic is difficult to establish. The integration of the control equipment in MP5 will solve this problem.

3.3 Alarms

With respect to the year 2000 the total number of alarms in the TCR increased significantly by 73% to nearly 800000 alarms per year. During the shutdown period the alarm rates are comparable to previous years, but much higher during accelerator exploitation. This enormous increase is mainly due to CV
systems that generated 3 times more alarms. Above all water and ventilation equipment on the Meyrin site and the reject water installations have been major alarm generators.

The monitoring of the electrical infrastructure is gradually transferred into the Electrical Network Supervisor (ENS). The installation of the system and test of newly connected equipment as well as some major power cuts generated loads of alarms in the TCR. The TCR was inundated by electrical alarms from the ENS, which are not considered in the statistics, yet. The number of vacuum alarms decreased as only the SPS has been monitored after the stop of LEP. The increase in the safety alarms of 33% corresponds to the increase of corrective maintenance shown 3.1.

An important amount of alarms has been caused by control and communication equipment, which is due to several major problems with the TCR monitoring system and to the connection of the SCADA systems of ST/CV and ST/EL.

![Alarms per system chart]

![Alarm Progression chart]

4  ST-EL OPERATION

4.1  EL operation 2002 stepping-stones

The operation of the electrical infrastructure has been characterized by:

- The start-up of the new contract E065/ST in charge of exploitation and maintenance of the CERN electrical network since 1st of July 2001,
- The complex configuration of the LEP 18kV network due to LHC project,
- The commissioning of the new BE 400kV/18kV substation, the new 150MVAr compensator and new substation of LHC5,
- Between 1\textsuperscript{st} of January and 1\textsuperscript{st} of April entire CERN network has been fed from SIG/EOS supply, from 1\textsuperscript{st} of April to 15\textsuperscript{th} of November CERN have been supplied by EDF.

- Until 15\textsuperscript{th} of November EOS/SIG supplies Meyrin site, Prevessin site, SPS/ZN, LHC1 and LHC18. The others points LHC are fed by the EDF 20kV “Pays de Gex” Network.

4.2 Correctives maintenance on ST/EL equipment

This analysis is done with the data of MP5. A total of 1360 correctives interventions have been carried out, which is an increase of 44\% with respect to the year 2000. This is mainly due to the complete maintenance documentation in MP5. These interventions have either been requested by the TCR or ST/EL staff.

35\% of the faults have been solved by the new contractor E065/ST (since 1\textsuperscript{st} of July), 44\% ST/EL/OP (80\% in 2000) and 4\% by TCR staff. Due to the reduced run time of the accelerators and the stop of LEP the stand-by service interventions reduced from 120 to 90.

Only 14\% of the interventions correspond to the repair equipment faults. 16\% are urgent exploitation request and 7\% are due to equipment stops caused by user or safety interlocks or emergency stops. 44\% have been resolved by basic interventions like resets or equipment restarts.

![Interventions on ST/EL Equipment](image)

**Figure 2** ST/EL correctives interventions by month

![Solved corrective interventions](image)

**Figure 3** Solved corrective interventions
Figure 4 Nature of EL correctives intervention requests

About 43% of the corrective interventions are localized in the zone SPS/ZN. It increased continuously over recent years (35.5% in 1999, 40% in 2000, 43% in 2001). LEP/LHC 35% and Meyrin with 22%.

4.3 Contract E065/ST exploitation and maintenance CERN Electrical Network

The new exploitation contract started on 1st of July 2001. It is totally managed with MP5 and the contractor intervenes with an autonomy of 85%. Nearly 1900 interventions have been carried out since 1st of July 2001 concerning corrective maintenance, preventive maintenance and exploitation requests, which corresponds to up to 250 per month. Since the 7th of December the contract covers also the stand-by service.

Figure 5 Analysis of the intervention requests to the contractor by month

4.4 Major tests in 2001

The following major tests have been carried out with success [6]:

- Defauts surcharges, thermiques, isolement et resets 44.1%
- 44.1% panne équipements
- 14.4% fausses alarmes, divers
- 4.7% demandes assistance ou mesures clients
- 4.1% petits travaux, manoeuvres urgentes
- 8.4% Généraux
- 0.4% erreurs humaines autres que ST/EL
- 0.2% erreurs humaines contractants ST/EL
- 7.4% Interlocks, AU, defaults users
- 16.0% perturbations EDF
- 0.2% Elements extérieurs
- 0.2% erreurs humaines contractants ST/EL
- 8.4% Généraux
- Real test of the so-called autotransfert on 10th of November
- Emergency stop tests for LHC, SPS, ZN and Meyrin sites
- Tests of the switch sequences and the automatic sequences of the secured network of the main diesel generators with a real cut of the 130kV supply.

5 ST/CV OPERATION

Following these works and the new SPS operating mode in a closed loop, there were some problems at the beginning of functioning. A major part of the problems was eliminated; however some of the problems still remain unsolved. The interventions of the “on-call” staff was more frequent during the year 2001, which was due to the increase of the cooling water temperature in the SPS cooling loop.

The following incidents on equipment under the ST/CV responsibility that had a major impact on accelerator operation:

- Loss of the cooling capacity on the Booster cooling circuit (building 237) – cause still unknown, under investigation with the cooling tower’s manufacture
- Loss of the cooling capacity on the East Hall cooling circuit (building 355) – water heat exchangers clogged. Action – all the heat exchangers were cleaned and the cooling towers revised.
- Stop of the “Centre Anneau” cooling station (building 359) – the cooling tower was emptied, bleed valve stacked resulting in higher reject than make-up water flow rate. Action – regular controls on both circuits, narrow co-ordination between maintenance and water treatment contractors.
- Stop of the Booster cooling station (building 237) – due to the bad make-up water quality the pressure gauges got clogged. Action – water treatment was improved and regular follow-up of the installation set up.

6 CONCLUSION

The introduction of the “ST Major Event Reports” permitted to make more significant statistics on the accelerator operation as far as the technical infrastructure is concerned. The evolution of the downtime and the ST repair time can be analysed from next year on. The harmonisation with the statistics of the accelerators is highly desirable to allow comparison of the numbers and identify improvement areas. During the analysis of the data it became obvious that data quality of the reports has to be increased. This will be achieved by a closer follow-up in the context of the ST Operation Committee (STOC) that started its work in January 2002 [7].

The TCR again increased its contribution to the first-line interventions and had to cope with a higher workload, essentially due to the increase in the alarm rates. Efforts must be undertaken, especially by ST/CV to reduce these rates that are with 2 alarms per minute on average and many more during peak periods unmanageable.

The start-up of the new maintenance contract of ST/EL did not effect on the quality of service. The same level of service was guaranteed due to intensive initial training, systematic use of the maintenance management system MP5 and a rigorous contract follow-up.

The important changes in the SPS cooling system perturbed the operation of the SPS during the whole run. The continuous improvement of the system and the commissioning of the last details shall improve next year’s operation.

7 REFERENCES
[6] ST/EL Test Reports, CERN
[7] Description of the ST Operation Committee (STOC), ST-EDMS