Monitoring of cabling activities during the LHC LS1

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The first LHC Long Shutdown (LS1)

The Large Hadron Collider (LHC) at CERN entered into its first two year-long shutdown period (Long Shutdown 1, LS1) in February 2013. During this period the entire CERN accelerator complex underwent major consolidation and upgrade works, preparing the machines for LHC operation at nominal energy of 7 TeV/beam. The consolidation and upgrade of the cabling infrastructure of the CERN accelerator complex represented one of the most challenging projects in terms of complexity and workload. This undertaking has required substantial project management effort and a significant deployment of resources, consisting of CERN staff and industrial support contractors, to complete all the expected tasks within the planned schedule.
The development of a reliable monitoring system has been a key element in the successful execution of this project. It supported the project management producing daily reports on the activity status, allowing the overall project schedule to be maintained.

Goals

Comprehensive

The cabling work undertaken during the LS1 consisted of a large number of installations carried out to a tight schedule, often in radioactive environments.
The project complexity has required the implementation of a comprehensive monitoring system. This system followed up on all aspects of the activities such as duration, cost, resource availability, absorbed radiation dose and installation quality.

Quick

Daily measurements assured quick feedback on activity performance. They helped the overall project management as well as the various activity responsible to see whether the project was on track or to act quickly in case it was not.

Granular

The overall project counts almost 2000 cabling installations distributed over 250 worksites. It has required a granular capacity to collect data from several and heterogeneous sources over the entire CERN site.

Typical cabling worksite

Data Collection

Staff availability

The number of CERN and industrial support contractor staff was constantly followed up on each worksite.

More or less resources were assigned to the worksite in case of acceleration, delay or special activity needs. Forecast load curves, based on estimates of future workload, allowed resource requirements to be set up in advance and manpower constraints to be mitigated.

Activity duration

The activity progress was followed through an in-house software tool called GESMAR, in which the work supervisors introduced on a daily basis the information for each pulled cable, connector assembly, test and verification.

Comparison with the initial forecast helped to identify any delays in the schedule.

Material

Stock availability and timely delivery of the material on the worksite were constantly verified.

Forecast of future needs and analysis of the historical consumption allowed pro-active planning of new purchasing orders.

Monitoring tool

Combination and analysis.

Project cost

Monitoring of the project cost was required to make sure that the project was always within the margin of the budget

Reports on payments to industrial contractors were provided together with forecasts of budget engagements.

Absorbed dose

The CERN safety rules demand a precise estimation and follow up of the radiation dose absorbed by workers.

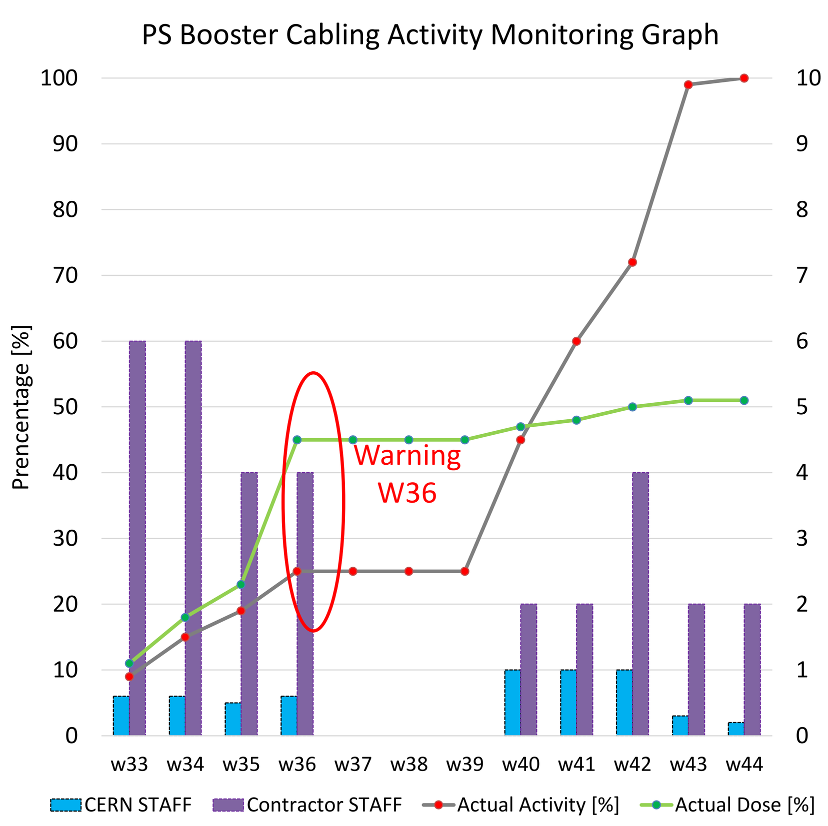
Daily reports alerted in case of the absorbed dose would exceed the estimated limit, allowing modifications to the method used and avoiding undue delays.

Installation quality

The quality of the installation delivered to the users was verified by continuous field inspections.

The analysis of non conformities detected on the worksites allowed the identification, classification and grouping of corrective actions for the installations, delivering improvement to the working method.

Examples of Analysis and Reporting

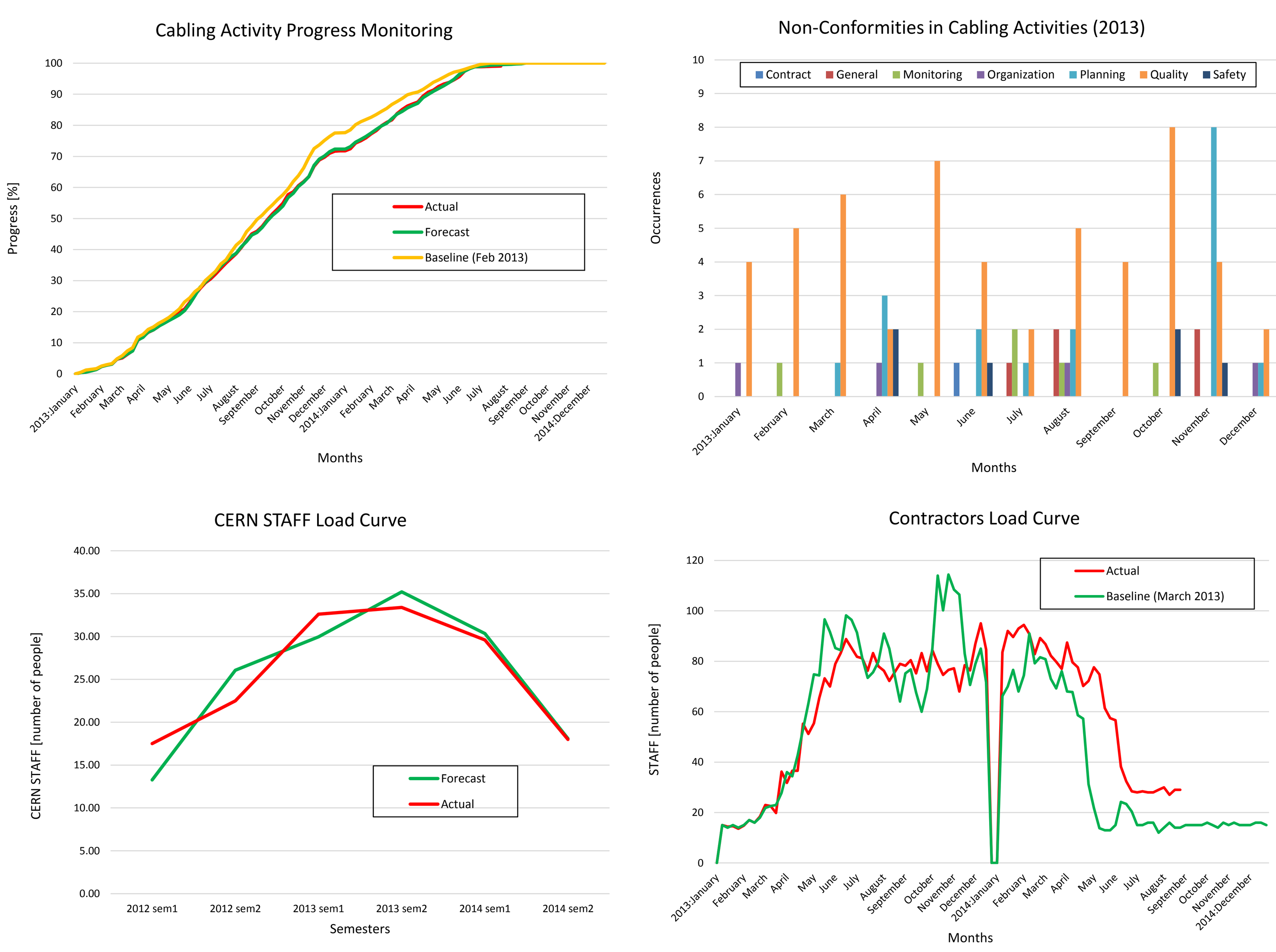


Data analysis

Offline analysis and the cross checking of the collected data allowed detection of potential issues such as planning delays, resources constraints or failures to comply with the approved working procedures.

Automatic reports on project performance were extracted and used as indicators.

The example of the PS Booster cabling activity has proved the effectiveness of the tool. During the cabling installation, the tool predicted that the radiation dose absorbed by the workers would exceed the safety limit, alerting management and allowing a pre-emptive adjustment to the method used.



LS1 Overall Monitor Graphs

Data reporting

The tool summarised a large number of data sources related to the project in simple graphs and tables. It simplified the decision making and gave quick overviews of the project status.

The tool supported the overall project management process to implement changes and to improve the general working method.

It supported also individual activity responsible overseeing the activity execution, addressing rescheduling activities and providing warnings in case of the radiation safety or quality requirements at risk of not being satisfied.

Conclusions

The development and implementation of a monitoring tool played a fundamental role in the successful execution of the cabling activities during the LS1. About 1300 kilometers of cables, distributed in different machine areas and representing an investment of about 23 MCHF, have been installed respecting the schedule.
The tool proved its effectiveness and reliability throughout the LS1 by assisting the overall project management as well as the individual activity responsible. Detailed status reports on activity performance helped detecting potential issues and implementing changes to keep the project on track. Furthermore the tool supported the improvement of the general working method, demonstrating a gradual decrease in the number of non-conformities on the worksites.

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