EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
CERN – ACCELERATORS AND TECHNOLOGY SECTOR

CERN-ATS-2012-252

Reliability and Intervention Management for the LHC

K. Foraz, J. De Jonghe, J. Richard Cook, J. Coupard, B. Daudin, F. Baltasar Dos Santos Pedrosa, E. Reguero Fuentes, C. Garino, K. Golikov, S. Grillot, M. Richard Jaekel, P. Sollander

CERN, Geneva, Switzerland

Abstract

Since 2010, CERN has entered a mode of continuous operation of the LHC and its injectors, which implies the continuous operation of all the infrastructure and support systems. High reliability of the machines is crucial to meet the physics goals. This high reliability must be accompanied by a fast restart after programmed stops. Since 2010, an important effort has been put in place, to ease the coordination process during the programmed stops and to reinforce the management of the interventions (preparation, approval, follow-up, traceability, closure). This paper describes the difficulties from the first year related to this coordination, and the impact on operation. The tools developed for the management of the interventions, their assets and the effect on the reliability of the LHC will also be presented and discussed.

Presented at: IPAC12, New Orleans, US, 20-25 May 2012

Geneva, Switzerland,
26 September 2012

RELIABILITY AND INTERVENTION MANAGEMENT FOR THE LHC

Katy Foraz, Jurgen De Jonghe, James Richard Cook, Julie Coupard, Benoit Daudin, Fernando Baltasar Dos Santos Pedrosa, Eloy Reguero Fuentes, Cedric Garino, Kirill Golikov, Serge Grillot, Martin Richard Jaekel, Peter Sollander, CERN, Geneva, Switzerland

Abstract

Since 2010, CERN has entered a mode of continuous operation of the LHC and its injectors, which implies the continuous operation of all the infrastructure and support systems. High reliability of the machines is crucial to meet the physics goals. This high reliability must be accompanied by a fast restart after programmed stops. Since 2010, an important effort has been put in place, to ease the coordination process during the programmed stops and to reinforce the management of the interventions (preparation, approval, follow-up, traceability, closure). This paper describes the difficulties from the first year related to this coordination, and the impact on operation. The tools developed for the management of the interventions, their assets and the effect on the reliability of the LHC will also be presented and discussed.

INTRODUCTION

Since 2010, the LHC complex and its injectors are operating continuously with short interruptions. In order to ensure a high level of reliability, regular maintenance (preventive and corrective) of the different systems is programmed during technical stops: 4 technical stops of 5 days, each 2 months long and a longer stop of 13 weeks during the winter. These access periods are also used for consolidation and upgrade interventions needed for the next operation period, or to improve the reliability of the machine.

In order to minimize the impact of the interventions on the restart, considering the size of the accelerator complex and its experiments, a strict control of the intervention requests and a strong coordination are essential.

INITIAL CONTEXT

During the first year of operation, each coordination team of the different facilities implemented its own tool: excel sheets, SharePoint lists, ADI (notice of intervention)… This variety and disparity of tools was problematic for the users, especially those intervening in the different facilities.

The life of an activity starts with its formal approval. This formal approval is given by a number of committees which analyse the technical aspects, both for the impact on the machine and on other equipment in service during the intervention. Other bodies are in charge of the safety analysis, the coordination and schedule…

As there was no unique repository for the interventions, this meant multiple forms and manual crosschecks for each committee. Therefore the risk of errors was not negligible and all these cross checks and re-edition of the same information was an important loss of time for the different actors.

Moreover, once approved, as the accelerator complex is classified as Basic Nuclear Installation (INB), strict control of the personnel intervening is needed. This means that each person entering an area is controlled, his accreditation (facility-related) and his intervention (check that this person has an approved intervention in this area and that particular day) verified. While the first part is checked automatically by the different access systems, the second part was not automated and induced a lot of time lost while access was being given; as an example, more than 1’000 persons per day request an access to the LHC machine during technical stops, and two operators in the Central Control Centre had to give clearance for the intervention.

INTERVENTION MANAGEMENT WORKING GROUP

After the successful implementation of the WAT (Work Acceptance Tool) in the LHC machine and the ACT (Activity Coordination Tool) in CMS experiment, it was decided in January 2011 to set up a working group IMWG (Intervention Management Working Group) in order to unify the efforts in the area of technical stop activity coordination at CERN. This working group was specifically mandated to identify the use cases of each activity and actor, to define a milestone plan, to prioritize the implementation and to follow up the development of a single tool.

Coordination teams of each facility, safety officers, user’s groups as well as the development team (Advanced Information Systems group) were gathered in the IMWG, and each stakeholder explained to the community the existing methods and practices. Subsequently common practices were defined, and sub-working groups were created in order to define a common workflow, design a location scheme that would span across accelerators as well as experiments, clarify the required safety aspects, and further refine the data model. Each sub-working group presented regularly their progress to the IMWG; common specifications were issued during the 2nd half of 2011.

In November 2011 the new tool, IMPACT (for Intervention Management Planning & Activity Coordination Tool) was implemented successfully for the LHC accelerator and 3 out of its 4 experiments.

ISBN 978-3-95450-115-1

IMPACT – PHASE 1

In order to go ahead, and have a tool to test during the winter technical stop, it was decided to implement a first version of the tool. The first version includes the development of the core functionalities from the declaration of an activity to its execution, including the generation of the most important safety forms, a service data layer, basic reports and linked to the documentation management, and to the access system.

Workflow (actual)

The following workflow synthesizes the actual lifecycle of an intervention request. In summary, a request has to be

- Created by the user
- Submitted to the coordination team (routing done thanks to the location scheme)
- Approved technically by the appropriate committees
- Scheduled by the coordination team
- Approved by the relevant Safety bodies
- Performed: only participants with valid access rights, and intervening on an approved request, in a precise area and during a certain time window, are allowed to access.
- Closed

The workflow allows to cancel or reject a request at any time, as well as to interrupt or resume an activity, with respect to the different safety constraints.

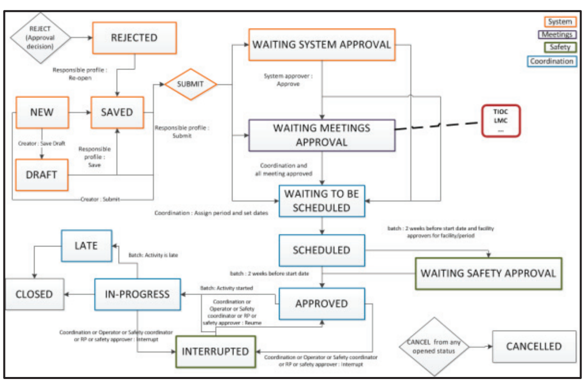

Figure 1: IMPACT workflow.

Integrations

The tool is based on one single database of intervention data that includes the common as well as the (potentially) client specific intervention data.

- It is integrated with the CERN-wide workflow engine (EDH based – [1]), with one common workflow, that is configurable so that some client specific workflow processes can be accommodated for.
- Information is available through standardized reporting facilities (e.g. who is doing which intervention, what interventions is this participant planned to take part in etc.). A simple export to Excel is also available.
- The tool integrates with the access system (ADAMS) so that participants of an intervention will be automatically granted access for the right location at the right time.
- Further integration with the CERN's Computerized Maintenance Management System is being worked on.
- Standardized interface to clients who want to provide their own tools, or who want to extend the functionality beyond what is commonly needed.

Request Form

The request form contains the following blocks of fields (see Fig. 2):

- General: title, responsible, facility, priority, activity type
- What: description, system
- When: proposed, scheduled, access dates, duration, working tie, intervention period
- Who: list of participants, with their roles
- Where: list of locations. The application automatically derives the access points to which the participants will be granted access to reach those locations. The coordinator can further restrict the access if necessary.
- How: modus operandi (which later can be used in the Work Dose Planning – [2]).
- Approval: committees which have to give their approval
- Safety: The hazards management is crucial for a good and safe coordination. Specific fields were introduced in the data-model to centralize the hazards information in one single database (i.e. IMPACT): location hazards, activity hazards, co-activity hazards and their compensatory measures. The forms are generated by or linked to IMPACT, follow their approval process through Electronic Document Handling System (EDH – [1]) and their final status is sent back to IMPACT.
- Radiation dose management: estimated duration, collective and individual dose, dose rate, surface and airborne contamination are edited, and used for the analysis of the radiological officer. Moreover, real individual dose are collected and are used for the dosimetry feedback and activity closure.
- Impact and tests: impact on other facilities and/or equipment, tests needed after the intervention, and impact on data are requested.

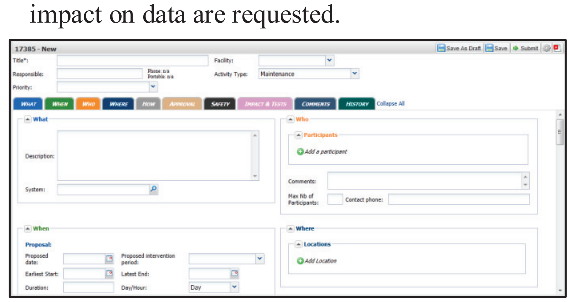

Figure 2: IMPACT activity request form.

ISBN 978-3-95450-115-1

Benefits

The direct benefits or beneficial side-effects of the tool are numerous:

- Unique repository for interventions, which improved the availability of all intervention information for discussion at the right forums, and enhanced the traceability of the interventions.
- The tool is built and (especially) maintained by one team of professionals to match the long life-expectancy of an accelerator-complex.
- Improved approval process for activities with a standardized approval workflow, based on the existing Electronic Document Handling system (EDH).
- Direct link to the access system for the *participant/place/time* triplet. This implied not only increased productivity (less waiting time for participants, less operators giving keys) but also a better control.
- Time savings for the equipment groups that intervene in different facilities and previously had to use different and incompatible tools.
- Tracking of the history of data changes for a specific intervention. Globally this adds up to a documented history of interventions for a facility.
- More effective risk mitigation thanks to the gradual integration of safety procedures.
- Encourages discussion of best practices between different facilities.

Moreover, the use of the predecessor of IMPACT, i.e. WAT (Work Acceptance Tool) as well as IMPACT had a beneficial influence on the restart of the LHC machine. In fact, in 2010, three to four days on average were needed after a technical stop of 5 days to restart operation with beam (while one to two days were foreseen); this extra duration was needed to correct faults on certain equipment on which an intervention took place. After investigation most of these interventions were not correctly managed prior to their execution, not discussed in the adequate forum, or not approved (or rejected) by the adequate body.

The workflow of the tools reinforced the control of the requests, and formalized the approval of the different bodies and committees in one single system. As a result, the duration needed to re-commission the beam decreased to one to two days, as it was foreseen.

IMPACT – PHASE 2

Since its implementation, the tool is now used in the injector complex as well as most of the LHC experiments. Its extension to all CERN sites is studied as different stakeholders request it, in particular by the Safety Unit and the Technical Infrastructure Operation Committee, which are working with all CERN infrastructure systems. The second version is presently under study, it will include corrections and improvements with respect to Version 1. In particular, the Intervention Management Working Group will focus on

- The implementation of a catalogue of interventions, regrouping recurrent interventions; this will further streamline the creation of requests.
- The workflow is being fine-tuned: in particular the parallelism of the approval phases is being considered.
- The safety sub-working group will strengthen the links (generation and communication) with existing safety procedures, in particular those related to Radiation Dose Planning. Moreover the sub-working group will propose improvements of existing safety forms, and will study new forms for specific needs (electrical lock-out for instance)
- The Maintenance sub-working group aims to establish strong links between IMPACT and the Maintenance Management Systems used at CERN (Infor EAM). The proposal is to integrate one or several work orders from Infor EAM into one request of IMPACT, and exchange information between the two systems, in particular on status and scheduled dates.
- The Schedule sub-working group will concentrate on schedule functionality inside IMPACT, including resources management or more general constraints management (e.g. general constraints as edited in the skeleton schedule). Tools should provide multiple views: the standard Gantt view, a linear scheduling view (as needed in a large accelerator) or customized views (at a specific location e.g. for experiments).

CONCLUSION

The development and implementation of IMPACT has been a success. Improvements and corrections are being studied to improve the tool. Since its usage, it had a positive impact on the restart of the machine, substantially decreasing the re-commissioning time after a technical stop. It reinforces the control and follow-up of the interventions by providing a unique repository, linked with a professional workflow engine.

The authors want to emphasize that during the development phase, the Intervention Management Working Group strengthened the professional links between coordination teams and achieved the unification of methods and procedures across the different facilities.

REFERENCES

[1] Derek Mathieson, Jurgen de Jonghe et al. – “J2EE Technology in Practice: Building Business Applications with the Java 2 Platform”, Enterprise Edition, Addison-Wesley, 2001, CERN-AS-2001-001

[2] “Safety Code F - Radiation Protection”, EDMS: 335729