# EQUIPMENT MANUFACTURING AND TEST DATA TRACKING FOR THE LHC

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*Abstract*

The MTF system was developed at CERN to capture the design, manufacturing and test data of equipment built for LHC. Today, more than 150.000 descriptions of LHC equipment are managed using the MTF. The system handles both production data and non-conformity issues. The acquisition of the equipment data is both an organizational and a technical challenge. On the organizational side many different aspects of production and management have to be taken into account. The LHC equipment suppliers, wherever their production facilities are located, whatever their computer skills or rates of production are, need a user friendly environment to provide the data with a very limited effort on the shop floor. For expensive equipment such as the LHC dipoles a reliable and robust non-conformity methodology must be put in place while the MTF provides the required information technology support tools. The EDMS Service has developed methods, training processes and tools to cope with an extensive use of the system, a use that will grow during the next years until the LHC is installed. This paper presents the experience acquired and the solutions put in place.

## INTRODUCTION

The MTF application is an integral part of CERN’s EDMS (Engineering Data Management System) [1] and it was developed to capture manufacturing and installation data of equipment built for LHC. The MTF project was launched during 2000; it became an official service in 2001 and today more than 150.000 descriptions of LHC equipment are being managed with the MTF. The experience gained with the tracking of the dipole manufacturing process and the methods established are now applied to other complex systems such as SSS† and QRL‡ both for manufacturing and installation follow-up.

## MTF SYSTEM

The MTF application manages today an impressive amount of technical information about the LHC equipment. This includes general data such as the part identifier and the manufacturer name but also very specific properties of the individual equipment. An important part of the MTF is the workflow tracking capabilities, handling data and documentation about the different steps in the manufacturing and test processes. For each individual step, information about scheduling, applicable standards, results and possible non-conformities can be stored and retrieved. The MTF was developed using the EDMS Common Layer, our interface to two mainline commercial applications: Axalant for project and document management and MP5 for equipment management. MP5 is the CERN and LHC Asset Tracking and Maintenance Management System that will be also used to provide support for INB regulation activities. The architecture of the MTF system is described in more detail in [2].

† Short Straight Section

‡ Cryogenics Distribution Line

## MANUFACTURING FOLLOW-UP WITH MTF

### *Main Dipole Manufacturing Follow-up with MTF*

The first client of the MTF application was the group responsible for the LHC main dipole in the CERN AT Department. The complexity of the dipole design, the requirements on the traceability of components and geographical distribution of production sites [3] made this first MTF project very challenging both from the technical and the organizational viewpoints.

The traceability requirement implied the need for rapid introduction of the MTF application in the manufacturing process and quality control of the main components, about 120. Given the specificity of the dipole supply chain, where CERN appears as a component supplier to the cold mass assemblers, the campaign of MTF introduction for components was coordinated from CERN, by the EDMS Service. A valid strategy was implemented from the start: the registration of components is under the responsibility of the CERN project engineers in charge of the manufacturing follow-up. All concerned project engineers and technicians from the many different equipment groups were contacted individually; the policy of MTF deployment, the type of data contained and the data collection procedures were elaborated for each individual case. The consultancy effort invested from the side of the EDMS Service in the start-up phase was both extensive and intensive, no practical experience with the deployment of the tools was available and good examples were yet to come.

During the pre-series production of cold masses, the collection of data at the three CMAs (Cold Mass Assemblers) sites was done using MTF transfer files, based initially on Excel and later on an Access application. The data was sent to CERN before the delivery of each magnet and then imported in the MTF database by the EDMS service. At the same time, different teams working on the cryodipole assembly and test activities in SM18-SMA18 facilities at CERN used the MTF Web interface from the start of their activities for online reporting of work progress, shown in Fig. 1. With the close collaboration between the EDMS Service and the Cryodipole coordinator, and thanks to the daily feedback given by the CERN teams and the ICS (Intertec-Cegelec-AmecSpie) consortium, the MTF evolved in a few months from an archiving system into a tool which supports coordination of activities in the field. A method for the reporting of non-conformities (NCRs) and for the follow-up of corrective actions was defined and successfully deployed. This method is now generalized and is part of the LHC Quality Assurance Plan (QAP) [4]. The MTF notification feature is widely used to send an e-mail on a workflow step closing action to inform CERN project engineers, industrial support teams and equipment supplier how an equipment progresses throughout its life-cycle.

After two years experience with the MTF Web in SM18-SMA18, it was decided in late 2003 to introduce the same model at the CMA sites. The EDMS Service organized on-site training sessions and now all 3 CMAs are using the MTF Web directly for registration of manufacturing data. This training contributed to an improved quality of data and better non-conformity tracking. The use of the web avoids extra processing steps for the data import at CERN.

### *MTF for Other Complex Systems of the LHC*

The tools and methodology developed for the manufacturing follow-up of the main dipoles is now being applied to other complex systems. The start-up phase for new MTF projects is now significantly reduced due to our experience. In the SSS case, the MTF was rapidly introduced in the manufacturing follow-up for the majority of components; the concerned project engineers were already using the MTF in the dipole context.

For the QRL and its elements, the MTF has been successfully introduced in the manufacturing follow-up: the process has been very rapid and efficient thanks to the very good preparation of the responsible CERN team. The application is now being extended to collect the installation data and the first results are already available, see next chapter.

## MTF IN THE INSTALLATION PHASE

The MTF features are being extended to provide support for the installation activities in the LHC tunnel. Names, positions and structure of LHC equipment slots are provided by the LHC Layout Database and imported. The MTF record the information about what equipment is installed or will be installed in a given slot and what activities have been executed during its installation.

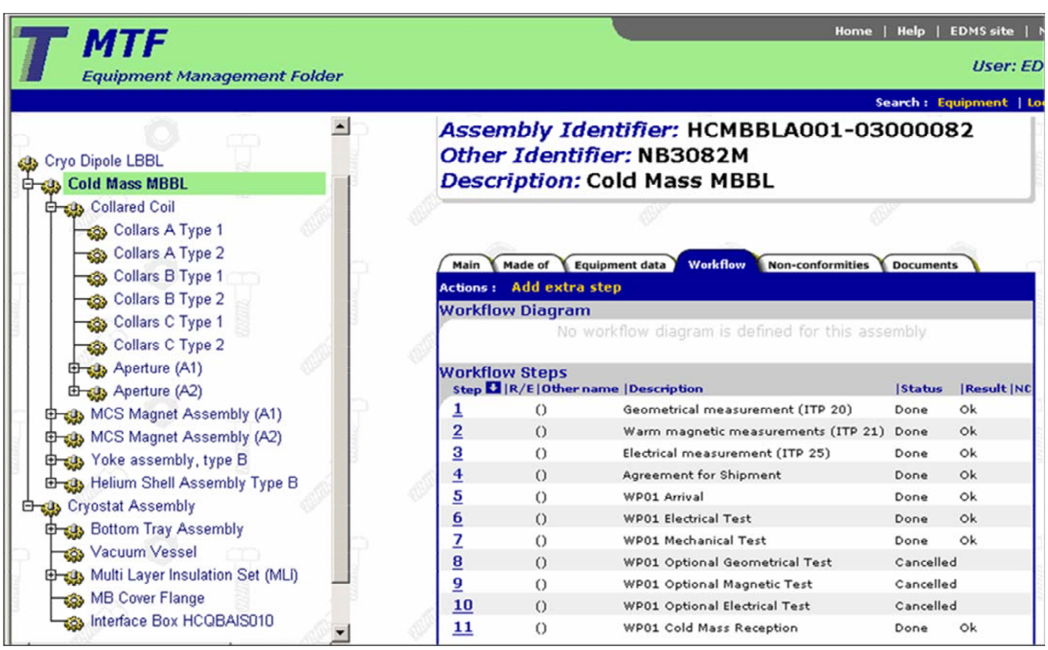


Figure 1: A typical screen-shot from the MTF Web application, showing the status of the work progress on a cold mass. The data related to the first four steps is entered by the corresponding CMA, the rest is filled in at SMA18.

The first application of MTF in the installation context was the tracking of non-conformities related to the preparation of the general services. The procedure for recording and follow-up of non-conformities [5] was elaborated from the existing procedure used in the manufacturing context. A reporting tool has also been developed which allows a rapid access to all open NCRs, sorted by location or class (critical, non-critical).

The present efforts of EDMS Service are concentrated on providing the tools and methods to support the follow-up of the installation of the machine components. A close collaboration has been established with two equipment installation team: those responsible for the QRL and LHC interconnections..

The QRL installation data is being collected by the contractor, in Excel format. The data is extracted and imported into MTF on a weekly basis. The possibility of having a more interactive reporting in the future is conditioned by the contract terms and internal sub-contraction organization of the main contractor.

The follow-up of the installation of the LHC interconnections and the related quality control activities will be supported by daily reporting in MTF. Assuming the absence of a fast network connection in the tunnel, the EDMS Service is preparing an offline MTF interface. This will allow the teams working in the tunnel to collect the data about executed operation during the day and to package the related documents containing measurement results into a single file. At the end of the day, all collected data have to be brought to the office and submitted to the EDMS Import queue to be processed overnight. The following day, the responsible project engineer will be able to access the loaded data and monitor the progress of the installation work.

## SCALING-UP OF THE SERVICE

### *Information Campaigns and User Training*

Early in 2003, an MTF workshop was held to familiarize project engineers and technicians with the features of the tool, to explain the methodology of its deployment, and to share the dipole experience. About 80 persons attended the workshop, and presentations were given by 12 MTF users. The minimum information to provide about any equipment data that will be installed in the tunnel to comply with the LHC QAP was also described. Subsequently, 22 half-day training sessions were held with about 200 participants: engineers, technicians and operators from CERN and contracting industries.

The results of the information and training campaign were immediately reflected in the increased use of the system and a very considerable reduction of time and effort required from the central team for launching the MTF for a new type of equipment.

### *New Data Import Mechanism*

The policy to promote the direct use of MTF Web interface for registration of data as close as possible to where the data is generated has been established and accepted by certain equipment manufactures, in particular the LHC dipole cold mass assembler. However, in most of the manufacturing locations the data is collected using the MTF Excel transfer files, sent to CERN by e-mail and then imported into MTF by the EDMS Service. With the request to import 15.000 equipment descriptions and about the same number of related documents per month, and the rate constantly increasing, the present manpower oriented tools are being reoriented to become more automatic. A new import system, called MICADO (**M**TF **I**mport **C**hain to **A**void **D**ata **O**verdose), is aiming to automate the import steps and minimize the manual interventions of the EDMS Service. Users will be able to submit the data directly to the import queue: an automatic e-mail will inform the user about the success of the operation or give an error report asking for correction on the data (similar to the drawing archiving in CDD [6]).

## CONCLUSIONS

The large scale deployment of MTF is both an organisational and technical challenge. Extensive use of the MTF in the manufacturing process of LHC dipoles provided the solid basis for the development of system features and for the formalization of the quality assurance procedures and methods. Close collaboration between the EDMS Service and the different equipment groups in the initial phase of the project allowed optimisation of the tools and made it usable on the shop floor. The training and information campaigns resulted in rapid acceptance and use of the system across the project. The experience gained with the dipole manufacturing process tracking and the methods established are now applied to other complex systems (SSS, QRL) for both manufacturing and installation follow-up.

## REFERENCES

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