A CMS MULTIPURPOSE MAINTENANCE PLATFORM

M. BARONE

Institute of Nuclear Physics, "NCSR"Demokritos", Athens,Greece
e-mail: barone@inp.demokritos.gr

J.F.FUCHS,H.GERWIG,A.SURKOV

C.E.R.N,CH-1211 Geneva 23,Switzerland; email:Hubert.Gerwig@cern.ch

Y.MARKOUDIS

TEMKA S.A.,Larissa Aghia-Greece; e-mail: info@temka.gr

The CMS detector is a worldwide endeavour gathering an extended number of contributors and putting together many parts coming from different countries. In this context CERN operates like a sort of 'general contractor' and is obliged to put a special emphasis on strict criteria of quality, calculations, control certificates and full traceability of materials and operations, which are all of paramount importance to the successful integration and function of the parts.
This paper discusses the technicalities related to design, finite element analysis, manufacturing and assembling of a multipurpose sub-detector maintenance platform. The work has been carried out by a collaboration of researchers, engineers and managers from a Greek medium sized Company, TEMKA S.A. and research laboratories,.CERN in Geneva and DEMOKRITOS in Athens.

1. Introduction

CERN's currently major project is the Large Hadron Collider, **LHC**, which will be operational by the middle of 2008. LHC is a super-conducting particle accelerator with a 27 km circumference, currently under installation in an existing underground tunnel, previously devoted to another accelerator, the LEP.
One of the 4 experiments to be performed at the LHC is the CMS (Compact Muon Solenoid).
This experiment is built and funded by an international collaboration of high-energy physics institutes from thirty-six countries and by CERN. The CMS experiment consists of a massive magnet equipped with several dedicated particle detectors. The magnet system consists of a 4 Tesla solenoid

Superconducting Coil, having a free bore of 6 m, 13 m in length, enclosed in a Return Yoke comprising the Barrel Yoke and the two End cap Yokes.

The Return Yoke is designed as a regular twelve-sided structure. The main dimensions of the complete detector are: length 21.6 m, outer diameter 14.8 m, total mass 12500 tons. An Hadronic Forward Calorimeter (HF), supported by a mechanical lifting system and centered on a beam pipe, is attached to each long distance end of the Yoke.

This paper deals with the manufacture and testing of two main platforms (for + and –sides) together with ancillaries. These platforms will serve for the installation of various sub-detectors like, Tracker, Electron Endcap, Electron Shower and Electron Barrel.

2. Organization of the work

The CMS experiment is financially supported by mutually agreed collaboration procedures, in this respect, CERN has placed an order to the Greek Firm TEMKA S.A., the lowest bidder complying with the technical specifications. The work has been carried out by a collaboration of researchers, engineers and managers from Industry and the CERN and DEMOKRITOS,research laboratories.

The supply was covering the following items:

1) The Engineering Report (ER) which included: 1a) bill of material, 1b) Definition of machining procedures, 1c) Definition of control procedures, 1d) Quality Assurance Manual,
2) Base materials certificates,
3) Machining,
4) Dimensional and conformity measurements, 5) conservation and protection against rust 6) Packaging, 7) Transport and delivery to Point 5, Cessy, France.

In this context CERN operates as a “general contractor” and therefore has the obligation to make quality controls and the full traceability of the materials and operations, which are all of primary importance to the successful integration and functioning of the parts.

3. Description of the Platform

The conceptual design of the platform is depicted in Fig. 1. The total weight per platform is 16 tons. Each platform has a rectangular shape 4540mm by 7200mm and consists of four parts that are connected together by bolts. Three reinforced ”300mm I-profiles” at bottom side assure the rigidity of the construction. All parts are in black steel, steel, steel zinc coated and stainless steel. Adaptor

frames have also been provided in order to fit the different installation scenarios These are adapted on the barrel rings or on the endcaps. The detailed work description is contained in specification CMS-07/11/05 [1]. Safety barriers are also installed.

4. Fabrication process

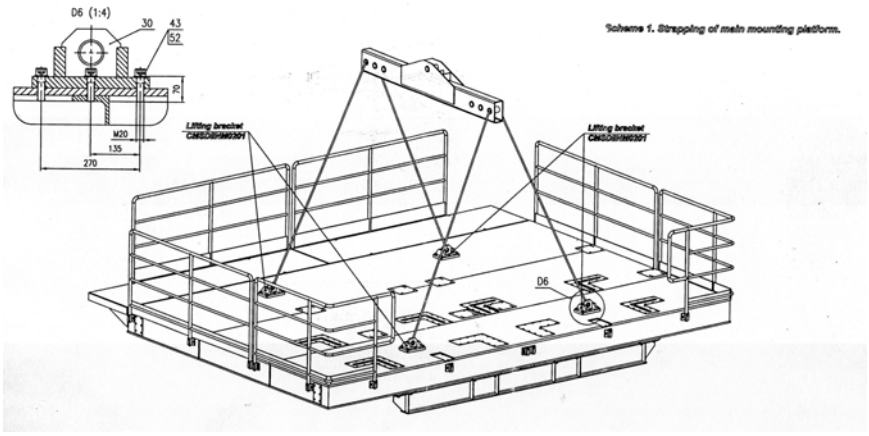

Figure 1. Strapping of main mounting pltaform.

Quality cutting, machining and welding operations were the main tasks requested. Additional machining hours were needed because of the complexity of the work. Each platform consists of 3 main sections, and a lateral extension connected to each other with bolted joints and supported by stiff beams. The operation performed at factory facilitated and expedited the final assembly of the platforms in the experimental cavern at Point 5.

5. FEM Analysis

a) Model and boundary conditions

The structural analysis was performed using ANSYS 9.0. The Finite element model consists of –39000 elements and -12400 nodes. For the platform modelling, the SHELL99 (8 nodes) element type was used. For the hydraulic spherical support and interconnection plates we used SOLID95 (8 nodes) element type. As boundary conditions contact elements Contal 74 and Contal 70 were used to model the contact interface between plates with friction (μ=0.2), while for the bottom support the "free moving at spherical radius " was applied.

An analysis was performed for the platform lifting, subject to its own weight and an additional weight of 16 tons, corresponding to the maximum load of each sub-detector. The analysis shows the results according to EC3 by increasing the dead weight of the platform by 35% and the life load (EE) by 50%. For the load "TK installation "weights of platform and adaptor were increased by 35% and the weight of TK by 50% (leading action).

It turned out that the maximum stresses for the parts in structural steel of the main platform were below 100 Mpa and the maximum bolt stress was 221 Mpa for a 8.8 bolt. Both stress levels are fine and satisfy easily EC3. For the load case "TK installation" one location has been found with 227 Mpa in the structural steel part, where a reinforcement was incorporated during the manufacturing.

6. Results and discussion

The geometric surveys were carried out on the assembled platform with satisfactory results. All measurements were within the requested tolerances. The load test foresaw a charge of 16 tons under which the platform was not allowed to deflect more than 3 mm. According to report CMS-IUR-0108[2] of the survey engineers the actual measured deflection was 1.5 mm. See Figure 2.

Fig.2 shows a platform under load,while the survey measurements are performed.

7. Conclusion

After visual inspection and load test with geometrical survey were made at the Temka's factory in Larissa , Greece, an Acceptance Certificate has been issued by CERN after delivery at site Cessy, Point 5 in France .

Acknowledgements

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References

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2. CERN Detector Installation Platform load Test by J.F.Fuchs, CMS-I-UR-0108