



CERN Summer Student Programme 2023

CERN Safety Rules and Materials Conformity Assessment for CMS

Final Report

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ABSTRACT

The “material database” is a spreadsheet for the CMS Review of the materials used in CMS experiment with the goal of standardizing the collection of information for the further assessment of materials’ compliance with CERN Fire and Radiation hardness requirements and regulations. This report is intended to summarize the work that I did as a participant to the CERN Summer Student Programme 2023. I organized a spreadsheet and contacted the link person to provide the material data base. I also reviewed the material spreadsheet and checked its compatibility with CERN safety rules and regulations. This is helpful in identifying the materials that can be used in CMS Experiment or materials that are subject to further risk assessment for derogation on their use.

Introduction:

At the Large Hadron Collider (LHC), the Compact Muon Solenoid (CMS) is a general-purpose detector. CMS is going through major upgrade projects for the Phase2 of the experiment. Materials research is very important. An understanding of the properties and uses of materials, will help a designer during almost every stage of the design process of the experiment. Materials testing is a very important aspect of research. When setting up an experiment, an understanding of the properties of materials will help determine if a material is suitable to be used in the experiment or not. The aim of the project is to organize the technical and safety specifications of future materials used at CMS by evaluating their compatibility and conformity with CERN Safety Rules.

Regulation Conformity:

The materials used in CMS Experiment should comply with CERN Safety Rules and Regulations. There are specific CERN regulations related to cables and materials conformity, specifically:

- Specific Safety Instruction SSI-FS-2-1 Fire Safety and Radiation resistance requirements for Cables | Document 2669584 (v.1.0) (cern.ch) - Dec. 2021
- Safety Guideline SG-FS-2-1-1 Fire Safety and Radiation Resistance requirements for Cables | Document 2669629 (v.1) (cern.ch)

The CERN Safety Rule is presumed to have been followed if a Safety Guideline is followed. Deviation from a Safety Guideline is allowed as long as the Department or Large Experiment in question can show the HSE Unit that compliance with the relevant CERN Safety Rule is being upheld, unless a CERN Safety Rule specifically states that it is binding.

The selection of cables is corresponded to the following criteria:

- Fire Spread $\leq 2\text{m}$
- Peak heat release rate $\leq 60\text{kW}$
- Fire growth rate $\leq 300\text{W/s}$
- Total heat release at 1200s $\leq 30\text{MJ}$
- Vertical flame propagation $\leq 425\text{mm}$
- Conductivity $< 10 \mu\text{S/mm}$ and pH > 4.3
- No burning droplets or particles, persisting for more than 10 s, appear within 1200 s
- Peak smoke production rate $\leq 1.5 \text{ m}^2/\text{s}$ and a total smoke production after 1200s $\leq 400 \text{ m}^2$

- IS 41 REV. The use of plastic and other non-metallic materials at CERN with respect to fire safety and radiation resistance | Document 335806 (v.1.02) Nov. 2005

This Safety Instruction's purpose is to provide guidelines for selecting polymers for usage at CERN while taking into account factors such as optical density, corrosiveness, and toxicity of smoke produced, as well as radiation resistance. This instruction is applicable to any machinery or installations made entirely of plastics or containing significant amounts of plastic. Particular attention should be paid to it in all underground and experimental places. Small parts that would not significantly contribute to smoke, toxic, or corrosive gas emissions, such as knobs, handles, rollers, gaskets, fasteners, clips, grommets, rub strips, pulleys, or small electrical parts, are exempt from its application.

The requirements for all plastics and other non-metallic materials are:

- Mechanical, chemical, thermal and environmental resistance properties suitable for the desired application, and conforming to the appropriate standards.
- Satisfactory fire performance (ease of ignition, rate of flame spread, rate of heat release, etc.) to specified standards.
- Free from halogens and Sulphur.
- Low smoke density of fire gases.
- Low toxicity of fire gases.
- Low corrosiveness of fire gases.
- Adequate radiation resistance.

CMS Reviews Spreadsheet:

A Spread sheet has been done for the review of CMS upgrade projects as show in the figure (1). The spreadsheet consists of types of the systems, link person, technical team, and EDMS link of discussion and review. The task was is to contact with the link person requesting the Material Data Base.

Scheduled	Subsystem	Type	To be checked	Scope	Link person	TC team	Agenda	EDMS repo	Chair		
3/16/2022	HGCal	PRR	YES	Cast scintillator	Ted Kohlberg	Paola, Wolf	https://indico.cern.ch/event/2709775/1	https://edms.cern.ch/document/2709775/1			
4/28/2022	HGCal	PRR	YES	ToolA	Wali Rahman	Wolfram, P	https://indico.cern.ch/event/2728923/1	https://edms.cern.ch/document/2728923/1			
5/18/2022	DT	ESR	YES	DT Phase-2 Upgrade	Isabelle De Bruyn	Magnus, M	https://indico.cern.ch/event/2747384/1	https://edms.cern.ch/document/2747384/1			
6/16/2022	RPC	EDR	YES	Follow-up EDR &	S. Buontempo	Paola, Mich	https://indico.cern.ch/event/2750285/1	https://edms.cern.ch/document/2750285/1			
6/23/2022	HGCal	PRR	YES	HGCal adsorbers	Stefano Moccia	Paola, Wolf	https://indico.cern.ch/event/2753623/1	https://edms.cern.ch/document/2753623/1			
7/5/2022	INFRA	CDR	YES	CO2 main tranfer	Tym Pakulski	Paola Trope	https://indico.cern.ch/event/2753452/1	https://edms.cern.ch/document/2753452/1			
10/18/2022	BCAL	EDR/ESR	YES	Full EDR/ESR	Werner Lusterma	Paola, Mag	https://indico.cern.ch/event/2785603/1	https://edms.cern.ch/document/2785603/1			
11/1/2022	INFRA	EDR	YES	Backflange	Tristan Loiseau	Andrea (Ch	https://indico.cern.ch/event/2787704/1	https://edms.cern.ch/document/2787704/1			
12/12/2022	HGCal	PRR	YES	Thermal Screen	Thoms French	Paola, Mag	https://indico.cern.ch/event/2805812/1	https://edms.cern.ch/document/2805812/1			
12/13/2022	HGCal	PRR	YES	SiPM	Mitchell Wayne	Paola, Mag	https://indico.cern.ch/event/2801682/1	https://edms.cern.ch/document/2801682/1			
2/21/2023	HGCal	EDR	YES	Mechanics, cooling,	Stefano Moccia	Paola, Mag	https://indico.cern.ch/event/2821838/1	https://edms.cern.ch/document/2821838/1			
4/25/2023	INFRA	EDR	YES	Environmental contr	Pablo Marin	Wolfram Ze	https://indico.cern.ch/event/2881180/1	https://edms.cern.ch/document/2881180/1			
4/28/2023	INFRA	PRR	YES	2PACL piping in USC	Jérôme Daguin	Wolfram Ze	https://indico.cern.ch/event/2753648/1	https://edms.cern.ch/document/2753648/1			
5/24/2023	GEM (MEO)	EDR/ESR	YES	Overall	Isabelle De Bruyn	Paola, Mag	https://indico.cern.ch/event/2890656/1	https://edms.cern.ch/document/2890656/1			
5/31/2023	GEM (GE2)	MPR	YES	Manufacturing progr	Isabelle De Bruy	Paola, Wolf	https://indico.cern.ch/event/2890682/1	https://edms.cern.ch/document/2890682/1			
6/2/2023	INFRA	EDR	YES	Tool B & Tool C	Andrea Gaddi, Hubert Gerwig	Paola, Wolf	https://indico.cern.ch/event/2898686/1	https://edms.cern.ch/document/2898686/1			

Fig(1)

Data Collection Approach:

Material data base is a spreadsheet contain information about the material used in CMS experiment. The material spreadsheet as shown in figure(2) has information about the following:

- 1- Material Name: commercial name
- 2- Manufacture Name.
- 3- Quantity: amount of the material used in Kg or m³
- 4- Materials Composition: information about different compounds presents in the material.
- 5- Data sheet: A document provided by the supplier / manufacturer summarizing the performance and other characteristics of the material.
- 6- MSDS: Material Safety Data Sheet Document provided by the supplier / manufacturer.

In addition, there are a columns for the material compliance which are SSI-FS-2-1 for Cables and IS41 for other materials. The task was to review the data sheet of material and check their

Fig (2)

Conclusions

This report summarizes the work that I did as a Summer Student at CERN during summer 2023. The work consisted in contacting project link persons and ensure that Material database was available and updated for the specific Review. I briefly described how I reviewed the material data base and check its combability with CERN safety rules and regulations. The first screening will allow the CMS Safety Office to assess material that are subject to a derogation request. Those will be supported by dedicated risk assessment to ensure that the needed safety preventive and protective measures are identified to ensure the proper management of the risk.

Acknowledgments

Back in February 2023, when I was preparing my application for this studentship, I never imagined that a few months later I would have received a Congratulations email from CERN. Now the Summer Student Programme 2023 came to the end I can proudly say that I have been part of it. I am grateful to CERN, as an organization, for giving me the opportunity to grow, jump in the open source world and meet new people. My biggest thanks go to the mentors of this project, Michele Bianco and Roberto Perruzza. Thank you for being so nice and friendly to me and for the time that both of you dedicated to guiding me through the complexities of the work and to providing constructive feedback to my ideas. This project really gave me a glimpse on how it feels to be at the forefront of something new and experimental and how huge and important the role of open source is in advancing science.

ABOUT ME

I'm from Oman. I studied Chemical Engineering at the University of Technology and Applied Science, where I completed my Bachelor degree in July 2023. I'm passionate about Engineering and Safety and now I'm looking for opportunities to further specialize my knowledge. Feel free to reach me on LinkedIn or by email.



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