Department of Energy
Fermi Site Office
Post Office Box 2000
Batavia, Illinois 60510

JUL 03 2013

Mr. Jack W. Anderson
Interim Laboratory Director
Fermilab
P.O. Box 500
Batavia, IL 60510

Dear Mr. Anderson:

SUBJECT: NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) DETERMINATION AT FERMI NATIONAL ACCELERATOR LABORATORY (FERMILAB) – LARGE HADRON COLLIDER (LHC) COMPACT MUON SOLENOID (CMS) UPGRADE

Reference: Letter, from J. Anderson to M. Weis, dated June 24, 2013, Subject: National Environmental Policy Act (NEPA) Environmental Evaluation Notification Form (EENF) for LHC CMS Upgrade

I have reviewed the Fermilab EENF for the LHC CMS Upgrade. Based on the information provided in the EENF, I have approved the following categorical exclusion (CX):

Project Name	Approved	CX
LHC CMS Upgrade	7/1/2013	B3.6

I am returning a signed copy of the EENF for your records. No further NEPA review is required. This project falls under a categorical exclusion provided in 10 *CFR* 1021, as amended in November 2011.

Sincerely,

Michael J. Weis
Site Manager

Enclosure:
As Stated

cc: M. Michels, w/encl.
T. Dykhuis, w/encl.

VI. DOE/FSO NEPA Coordinator Review

Concurrence with the recommendation for determination:

Fermi Site Office (FSO) Manager: Michael J. Weis

Signature and Date 7/2/13

FSO NEPA Coordinator: Rick Hersemann

Signature and Date Rick Hersemann 7/1/13

Appendix A – Excerpt from U.S. CMS Proposal to Participate in Phase 1 of the Upgrade of the CMS Detector to Exploit the Physics Potential of the Rising LHC Luminosity

Abstract

CERN has announced a plan to upgrade the LHC to reach a peak luminosity of $5x10^{34}$ cm^{-2} s^{-1}, which is well above the original design goal. This is now regarded as feasible given the rapid raise of the luminosity in the first year and a half of operations. Studies have demonstrated that the increased statistics made possible by the higher luminosity will significantly extend the physics potential of CMS. The machine upgrade plan involves two stages. The first stage, or Phase 1, of the machine upgrade is already underway. It is expected to lead to a peak luminosity of more than 2×10^{34} cm^{-2} s^{-1} with either 25 or 50ns bunch spacing. Phase 2 will provide a increase of an additional factor of between 2.5 and 4 in peak luminosity and another factor of two in integrated luminosity per year through the use of "luminosity leveling". The CMS detector was designed to operate at a peak luminosity of $1x10^{34}$ cm^{-2} s^{-1} with 25 ns bunch spacing. It must be upgraded to cope with the very high pile-up and severe radiation levels to take advantage of the increasing LHC luminosity. In 2010, CMS presented an upgrade plan to the CERN LHCC as a Technical Proposal aimed at maintaining its excellent physics capability through the Phase1 period. In January of 2011, DOE and NSF had a special briefing on the plan to understand further the possible U.S. role in the Phase 1 upgrade. In this document, we summarize the need and physics case for U.S. CMS participation in the Phase 1 upgrade. We then present the plans for U.S. CMS to take a leadership role in the upgrades of the forward pixel detector, the hadron calorimeter and the Level 1 trigger.

Introduction

The Large Hadron Collider (LHC) at CERN was designed to reach a luminosity of 10^{34} cm^{-2} s^{-1} at a center of mass energy of 14 TeV. The CMS detector has been designed to operate at the corresponding event rate and survive the anticipated radiation levels. The LHC produced its first collisions at 7 TeV center of mass energy on March 30, 2010. It is already opening a new frontier in particle physics. When it reaches its full energy and luminosity at the end of 2014, for the first time particle physicists will have a collider that can probe fully the TeV energy scale relevant to electroweak symmetry breaking and increase significantly the discovery reach for Supersymmetry, new particles and interactions, and extra dimensions of space and time. We expect that the LHC will lead to a revolution in our understanding of particle physics and an unparalleled opportunity for discovery.

Since the LHC will be the energy frontier machine for quite some time, CERN is planning a luminosity upgrade towards an ultimate luminosity of $5x10^{34}$ $cm^{-2}s^{-1}$, denoted as the High Luminosity LHC (HL-LHC). The HL-LHC will further increase the discovery potential at the high energy frontier and will allow more precise measurements of the phenomena observed in the early running of the LHC. For example, the HL-LHC will extend the discovery reach in Supersymmetry (SUSY) particle masses by about 500 GeV/c^2. One or more new neutral gauge bosons (Z-primes) are highly motivated in "beyond the Standard Model

☐ Radioactivation of soil or groundwater

C. Other Relevant Disclosures: Will the proposed action involve any of the following actions/disclosures?

☐ Threatened violation of ES&H permit requirements
☐ Siting/construction/major modification of waste recovery or TSD facilities
☐ Disturbance of pre-existing contamination
☐ New or modified permits
☐ Public controversy
☐ Action/involvement of another federal agency
☐ Public utilities/services
☐ Depletion of a non-renewable resource

IV. Comments on checked items in section III.

Chemical use or storage
Ethanol and printed circuit board flux removers would be used as solvents or cleaning agents in small quantities. Epoxy resins would be used for the construction of FPIX. All chemicals would be stored, used and disposed of properly to prevent entry into the environment. Their use and disposal would also be tracked for possible reporting on the annual Toxic Release Inventory.

Air Emissions
CO_2 is used for cooling FPIX. CO_2 is a regulated air pollutant since it is a greenhouse gas. Its use would be tracked to ensure Fermilab does not exceed the Environmental Protection Agency (EPA) or Illinois EPA threshold for air pollution permitting or reporting.

Solvent use would also result in the release of volatile organic compounds (VOCs). Solvent use would also be tracked to ensure Fermilab does not exceed the EPA or Illinois EPA threshold for air pollution permitting or reporting.

Hazardous or Other Regulated Waste
All chemicals designated as waste would be disposed of according to Fermilab's waste handling policies and procedures.

V. NEPA Recommendation

Fermilab staff have reviewed this proposed action and concluded that the appropriate level of NEPA determination is a Categorical Exclusion. The conclusion is based on the proposed action meeting the description found in DOE's NEPA Implementation Procedures, 10 CFR 1021, Subpart D, Appendix B3.6 – Small-scale research and development, laboratory operations, and pilot projects which states, "Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); and small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible). Not included in this category are demonstration actions, meaning actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment."

Fermilab NEPA Program Manager: Amber M. Kenney

Signature and Date 6/21/13

detector at LHC would not cope with the anticipated higher luminosity beam and higher radiation environment and would not be able to take advantage of the higher luminosity and the associated physics potential. Therefore the "no action" alternative is not feasible.

II. Description of the Affected Environment

No new building or infrastructure construction at Fermilab would be expected for this project. The existing laboratory infrastructure would be used to design and test new custom electronics for the CMS Trigger and HCAL, design and build a FPIX mechanical support structure and cooling system, and assemble and build the entire FPIX detector. Related work would also take place at universities and other non-Fermilab sites.

Fermilab test beam would be used to test the electronics prototypes for the CMS Trigger and HCAL.

The mechanical construction for the FPIX upgrade involves building four support cylinders and twelve detector half-disks. The support cylinders would be approximately seven feet long with a one foot radius, and the half-disks would be a few inches thick with about a one foot radius. The cylinders and disks are carbon-composite structures with embedded stainless steel tubes used for carbon dioxide (CO_2) cooling. Silicon sensor modules for the FPIX detector would be produced and tested at collaborating institutions, and then mounted on the support structures at Fermilab. Some of the prototype testing would take place in a Fermilab test beam. After assembly and testing of the complete system, the FPIX would be dismantled and shipped to CERN, and then reassembled and tested there. After testing the detector would be handed over to CMS operations.

Fermilab facilities to be used would include the PPD Electronics Design and Testing Workshops, Fermilab test beams, the Lab 3 carbon fiber manufacturing facility, the Silicon Detector Facility (SiDet) electronics testing and cleanrooms and the Lab C CO_2 cooling system.

III. Potential Environmental Effects (If the answer to the questions below is "yes", provide comments for each checked item and where clarification is necessary.)

A. Sensitive Resources: Will the proposed action result in changes and/or disturbances to any of the following resources?

- ☐ Threatened or endangered species
- ☐ Other protected species
- ☐ Wetland/Floodplains
- ☐ Archaeological or historical resources
- ☐ Non-attainment areas

B. Regulated Substances/Activities: Will the proposed action involve any of the following regulated substances or activities?

- ☐ Clearing or Excavation
- ☐ Demolition or decommissioning
- ☐ Asbestos removal
- ☐ PCBs
- ☒ Chemical use or storage
- ☐ Pesticides
- ☒ Air emissions
- ☐ Liquid effluents
- ☐ Underground storage tanks
- ☒ Hazardous or other regulated waste (including radioactive or mixed)
- ☐ Radioactive exposures or radioactive emissions

FERMILAB ENVIRONMENTAL EVALUATION NOTIFICATION FORM (EENF) for documenting compliance with the National Environmental Policy Act (NEPA), DOE NEPA Implementing Regulations, and the DOE NEPA Compliance Program of DOE Order 451.1

Project/Activity Title: Large Hadron Collider (LHC) Compact Muon Solenoid (CMS) Upgrade

ES&H Tracking Number: 01106

I hereby verify, via my signature, the accuracy of information in the area of my contribution for this document and that every effort will be made throughout this action to comply with the commitments made in this document and to pursue cost-effective pollution prevention opportunities. Pollution prevention (source reduction and other practices that eliminate or reduce the creation of pollutants) is recognized as a good business practice which will enhance site operations thereby enabling Fermilab to accomplish its mission, achieve environmental compliance, reduce risks to health and the environment, and prevent or minimize future Department of Energy (DOE) legacy wastes.

Fermilab Project Owner: Joel Butler (X3148)

Signature and Date Joel Butler 6/21/2013

Fermilab Project ES&H Coordinator: Stefan Gruenendahl (X8760)

Signature and Date S. Gruenendahl 2013-6-21

Fermilab ES&H Officer: Angela Aparicio (X3701)

Signature and Date Angela Aparicio 6-21-13

I. Description of the Proposed Action and Need

Purpose and Need:
The CMS detector at LHC has been successfully operating for several years at the energy frontier of particle physics at CERN. CERN has announced a plan to upgrade the LHC to reach a peak luminosity well above the original design goal. To adapt the detector to this planned LHC luminosity increase and mitigate effects of radiation aging and damage, a comprehensive upgrade is needed for the CMS detector, and in particular for the US-contributed components of CMS: the CMS Trigger, the Hadronic Calorimeter, and the Forward Pixel.

Proposed Action:
The LHC CMS Detector Upgrade Project would replace and rebuild parts of the electronics in the CMS Trigger and the Hadronic Calorimeter (HCAL). In addition, it would also completely rebuild and replace the Forward Pixel (FPIX) detector. These proposed actions would enable CMS operations to continue in a higher luminosity and higher radiation environment.

Alternatives Considered:

The CMS detector was designed to operate at the LHC's designed peak luminosity. The only alternative would be "no action" and continue to operate the detector as originally designed. The current CMS

(BSM)" scenarios. A factor of 10 increase in luminosity extends the Z-prime reach by up to 1.5 TeV/c^2. In addition, precise measurements of properties of new particles discovered at the LHC will benefit from the tenfold increase in luminosity. For example, the ratio of Higgs boson couplings to fermions and bosons can be measured with the HL-LHC to an accuracy of about 10%, providing incisive testing of the electroweak symmetry breaking mechanism. Rare decays of the Higgs boson such as H to μ+μ- will become accessible with the data sample provided by the HL-LHC.

The luminosity upgrade plan has two phases. The Phase 1 Upgrade aims at providing reliable LHC operation at a peak luminosity exceeding $2x10^{34}$ cm^{-2} s^{-1} by strengthening the LHC injection chain. CERN has already taken the first step in this effort by beginning the construction of a new linear accelerator. Phase 1 will be completed during a long shutdown now scheduled for 2018. Phase 2, which would be implemented a few years after 2020, would enable the experiments to record 5 times the effective luminosity per year by increasing the peak luminosity further and by implementing a scheme of "luminosity leveling" to increase the average, and therefore the integrated, luminosity.