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

SEP 16 2013

Mr. Jack W. Anderson
Chief Operation Officer
Fermilab
P.O. Box 500
Batavia, IL 60510

Dear Mr. Anderson:

SUBJECT: DEPARTMENT OF ENERGY (DOE) ASSESSMENT OF FERMILABS ACCELERATOR SAFETY ENVELOPE APPROVAL REQUEST REVISON 4; DATED APRIL 25, 2013

Reference: Review of the Request for Approval of The Fermi National Accelerator Laboratory (Fermilab) Acceleratory Safety Envelope (ASE) Revision 4; Dated April 25, 2013 (Enclosed).

The DOE conducted a review of Fermilab's request for approval of the ASE; dated April 25, 2013 (ASE Revision 4). The DOE team reviewed the ASE Revision 4 and its supporting documentation. DOE Fermilab Site Office (FSO) submits the attached report for Fermilab that identifies required actions for ASE Revision 4 approval.

The attached report recognizes those actions already completed by Fermilab to address DOE's previous request for additional information and that Fermilab is working on the remaining items listed within the report.

Below FSO has summarized the remaining actions that need to be addressed by Fermilab prior to FSO ASE Revision 4 approval:

- Successfully complete the limited scope Accelerator Readiness Review scheduled for October 2013.
- Update ADAP-11-0001 to remove references to the Tevatron and make other changes as needed to bring the document up to date.
- Complete review of Accelerator Computer Language scripts that have safety implications and make the results of the review and management process to maintain configuration control of the scripts available to FSO.
- Implement process to require that beam trips, Radiation Safety Officer directed actions, along with removal of machine controls be documented in the Crew Chief's Log, to ensure that important events and oversight of the operation of the accelerator can be completed.

If you have any questions or concerns, please contact Mike Herr, at extension 2449, or John Scott, at extension 2250 respectively.

Sincerely,

Michael J. Weis
Site Manager

Enclosure
As Stated:

cc: N. Lockyer, w/encl.
M. Michels, w/encl.
R. Dixon, w/encl.

Department of Energy (DOE) Fermi National Accelerator Laboratory (Fermilab) Site Office (FSO)

Review of the Request for Approval of the *Fermilab Accelerator Safety Envelope Revision 4; dated April 25, 2013*

In May 2013, Fermilab formally requested FSO to approve a change to the existing Accelerator Safety Envelope (ASE). This request comes after an extended maintenance shutdown of the accelerator complex.

During this maintenance shutdown Fermilab made numerous improvements. Linac, Booster, and Main Injector (MI)/Recycler accelerators were upgraded to increase the beam intensity. The upgrades included the installation of a radio-frequency (RF) quadruple system to replace the Cockcroft-Walton. This upgrade produced tighter beam bunches thus reducing beam losses. The Booster RF cavities are also being refurbished to support the increase beam intensity to the MI/Recycler. The cavity refurbishing will be in progress for some time, precluding the increase intensity until their completion (estimated to be in 2015). The Recycler is being converted from an antiproton storage machine to a pre-injector for the MI. This will allow the MI to operate at a cycle time of 1.3 seconds as opposed to the previous 2.3 seconds. These improvements, as a whole, produce an increase in beam intensity which requires the modification in the ASE. Fermilab is also modifying their "Accident Condition Postings" as a part of the ASE modification request. Fermilab's Beam Loss Scenarios Panel recommended the change in the "Accident Condition Postings" after analyzing the impact that machine controls have on reducing both the likely hood of the accident and its duration. In light of this approach, FSO formally requested additional time to review the basis for the ASE. Specifically to review the process to justify the reduction in "Accident Condition Postings" through the use of machine controls. FSO did not preclude the Laboratory from operating the accelerator using the current approved ASE, Revision 3; dated February 15, 2012, while the additional review was conducted.

FSO Facility Representative (FR) reviewed specific documentation generated by Fermilab's Beam Loss Scenarios Panel. The FR reviewed in depth the accelerator improvements with the Accelerator Division (AD) Senior Safety Officer (SSO); interviewing AD Operations Department Head and Deputy Department Head; system experts; and observing and interviewing operators conducting numerous beam studies. The FR continued to locate and review AD documents and procedures to assure that they were adequately addressing the upgrades and associated safety impacts on operations. Generated from this review, FSO provided Fermilab a list of additional information needed to review/approve the ASE, in an email sent from the FSO Manager to the Fermilab Chief Operating Officer titled; "Additional Questions Related to the ASE-Safety Assessment Document (SAD) AD and Start-up of Accelerator;" dated June 13, 2013.

In addition, the FSO solicited the assistance of a DOE safety expert to participate in reviewing the basis for the ASE and participate in informational meetings with the Laboratory subject matter experts.

A meeting was held on June 24, 2013, between FSO and Fermilab to address the questions in FSO Manager email. The AD SSO provided a PowerPoint presentation titled: "Accelerator Startup and ASE Approval," In which the Laboratory provided responses to FSO's questions. The Laboratory and FSO responses are summarized below:

FSO Inquiry:

During this information gathering process, the Site Office is still trying to understand who is responsible and what processes you are using to assure yourself that the accelerator upgrades and associated changes in equipment, processes and potentially personnel over the past year, have been looked at from an independent and "big picture" perspective and start-up is ready to commence. We are specifically interested in where we can go to review documentation of any independent review (consisting of Non-Accelerator Division Personnel) that has been done to determine that the accelerator is ready to start-up considering all the modifications, increased intensity, personnel changes, and consideration of the causes of recent accelerator events within DOE and the process that will be used to make the determination that the Lab is ready for operation of the accelerator.

Laboratory Response:

AD stated that the SAD Review Subcommittee, Beam Loss Scenarios Panel, Tritium Mitigation Working Group, Long-Term Radioactive Storage Task Force, have representatives from AD, FSO, Particle Physics Division, and Environment, Safety, Health, and Quality Section (ESH&Q). The AD Department Heads that were impacted by maintenance activities are also required by AD Administrative Procedure ADAP-11-0001; "Beam Permits, Run Conditions, and Startup:" dated January 27, 2009, to formally approve that work is complete and ready for beam operations.

FSO Response:

The commitment by the Laboratory to perform a limited scope Accelerator Readiness Review (ARR) is being proposed as FY 2014 Performance Evaluation & Measurement Plan; Goal 5.0; "Sustain Excellence and Enhance Effectiveness of Integrated Safety, Health, and Environmental Protection;" notable outcomes. This commitment was made shortly after the Laboratory's presentation to FSO.

Completion of a limited scope ARR will address FSO concern and seems consistent with requirements. FSO will be following future activities to stay abreast with action completion.

FSO Inquiry:

Documented administrative procedures that will be used when specific machine controls (used to reduce Accident Condition Postings) are not functioning.

Laboratory Response:

AD stated that the intent of the panel recommendations for a multiplicity of controls was to make documentation of administrative procedures unnecessary. Failures of any major system controls, Beam Permit system, Beam Switch Sum Box, Time Line Generator, and MI/Recycler Transfer Permit will shut down the machine. Individual inputs to the major controls are mask-able (signal outputs are blocked so that they do not trip the accelerator). The Low Conductivity Water Chipmunk (radiation monitoring device) monitors are not bypass-able and tied to a credited control system. This system alone would likely limit accident conditions to fewer than 2 minutes. AD SSO also clarified what machine controls will definitively not allow the accelerator to run when they are not functioning.

FSO Response:

FSO understands the approach and it seems consistent with requirements. FSO will be following future activities to stay abreast with action completion.

FSO Inquiry:

Documentation describing the necessary machine controls or administrative procedures required to be in place to run the accelerator at the reduced accident posting levels.

Laboratory Response:

AD explained that the machine controls are intended to be listed on the MI/Recycler Run Conditions. Run Condition documents provide the necessary information for the operations department to operate the machines. All operators are required to read and sign the Beam Permit and Run Condition document.

FSO Response:

FSO understands the approach and it seems consistent with requirements. FSO will be following future activities to stay abreast with action completion.

FSO Inquiry:

Operating procedures that have been changed due to the increase intensity/accelerator modifications.

Laboratory Response:

AD asserts that the machine still functions essentially in the same way as it did in the past. The changes are rather subtle to overall operations. The recycler will now be used to perform slip stacking instead of the MI thus reducing cycle time. One of the Main Control Room Lock Out Tag Out procedures changed but this was due to elimination of Tevatron operations. ESH&Q Associate Head is looking into what scripts have safety implications to determine what scripts require a review process.

FSO Response:

Accelerator Command Language (ACL-computer language) scripts are written to control the accelerator functions such as; machines start-ups, shutdown, slip stacking, and extraction. These scripts have changed. During the FSO review it was discovered that the scripts are not reviewed prior to being implemented.

FSO's will continue to monitor how Fermilab manages those scripts that have safety impact.

FSO Inquiry:

Communications to operation and key staff affected by new accident postings, increased intensity, and accelerator modifications.

Laboratory Response:

AD stated that the operations staff are the only ones that need to know additional information in regard to the changes in accident condition postings. This information is communicated via the MI and Recycler Run Condition documents.

FSO Response:

FSO reviewed Run Condition documents. These documents are discussed during shift turnover meetings and signed by operators to indicate that they have read and understand the documents. FSO understands the approach and it seems consistent with requirements and we will be following future activities to stay abreast with action completion.

FSO Inquiry:

Description of machine Controls dependent and independent upon one another.

Laboratory Response:

AD pointed out the description of the machine control's independency was included in the justification memo to the Fermilab Director, "Approval to Reduce Accident Condition Postings by two categories for the Main Injector and Recycler;" dated October 26, 2012.

This document was reviewed and provided to DOE FSO representatives on the Beam Loss Scenarios Panel. After the presentation, the AD SSO provided a list what specific machine controls will not allow the accelerator to run when they are not functioning.

FSO Response:

FSO understands the approach and it seems consistent with requirements. FSO will be following future activities to stay abreast with action completion.

FSO Inquiry:

Beam accident response procedures.

Laboratory Response:

AD stated that required actions will be included in the Run Conditions. Namely, if an interlocked chipmunk were to trip, the machine cannot be restarted without AD Radiation Safety Officers (RSO) approval. This allows the RSO to work in conjunction with the crew chief to determine if an accident actually occurred or if it is equipment failure. If an accident is determined to have occurred, the procedure response to violations of the beam safety envelope would be invoked to insure accurate recording of the event and proper notification of individuals. AD is changing their Run Conditions to provide more detail of actions taken in response to beam accidents.

FSO Response:

FSO's will continue to monitor how Fermilab implements the new Run Conditions.

FSO Inquiry:

Specific equipment requirements for the machine controls (testing requirements, manufacturing specs, and maintenance.)

Laboratory Response:

AD explained that since these are machine controls and not credited controls; the design, installation, maintenance, and testing requirements are much different.

FSO Response:

FSO understands the approach and it seems consistent with requirements. FSO will be following future activities to stay abreast with action completion.

Post meeting discussions and deliberations of the DOE staff occurred. Both AD and ES&HQ provided information to answer some of the concerns. The FSO responses above were generated following these discussions. FSO has summarized what actions must be completed by Fermilab in the below list prior to ASE Revision 4 approval:

- Fermilab needs to successfully complete the limited scope Accelerator Reediness Review.

- Update ADAP-11-0001.

  Procedure is outdated, still has references to the Tevatron.

- Fermilab needs to complete its review of ACL scripts that and have safety implications. FSO needs to be provided with the results of the review and informed of how Fermilab will manage these scripts.

- Documentation needs to be developed to require that beam trips, RSO directed actions when beam trips occur; along with removal of machine controls be documented in the Crew Chief's Log.

  This requirement is necessary to ensure that Laboratory and FSO can review important events and provide oversight of the operation of the accelerator complex.

The clarifications provided by the AD SSO were very helpful. The language used in the presentation was stronger and more concise than what was provided in the Beam Loss Scenarios Panel work. However, the FSO requests the above be provided prior to the approval of the *ASE, Revision 4; dated April 25, 2013*:

Documents reviewed by DOE staff included:

DOE G 420.2-1; U.S. Department of Energy Guide; "Accelerator Safety Implementation Guide for DOE O 420.2B Safety of Accelerator Facilities;" dated July 1, 2005.

ADAP-11-0001; Accelerator Division Administrative Procedure; "Beam Permits, Run Conditions, and Startup;" dated January 27, 2009.

Fermi National Accelerator Laboratory Safety Assessment Document "Section I, Overview of Fermilab Facilities;" Revision 0; dated October 26, 2010.

ADAP-11-0002; Accelerator Division Administrative Procedure; "ES&H Review of Experiments, Test, and R&D Projects;" dated January 3, 2011.

DOE O 420.2C; U.S. Department of Energy Order; "Safety of Accelerator Facilities;" dated July 21, 2011.

Memorandum; from Roger Dixon and Nancy Grossman to John Anderson Jr. and Don Cossairt; titled; "Machine Beam Loss Scenario Panel;" dated December 13, 2011.

Memorandum; from John Anderson Jr. and Don Cossairt, to Roger Dixon and Nancy Grossman; titled; "Machine Beam Loss Scenario Panel – First Stage Report;" dated May 3, 2012.

Paper; "Main Injector & Recycler Beam Loss Controls;" Dave Capista; dated July 5, 2012.

Memorandum: from Pier Oddone to Roger Dixon and Nancy Grossman titled; "Machine Beam Loss Scenarios Panel – First Stage Report and Proposal Approval;" date July 16, 2012.

DOE G 420.2C; U.S. Department of Energy Guide -DRAFT; "Accelerator Safety Implementation Guide for DOE O 420.2C Safety of Accelerator Facilities;" August 3, 2012.

Letter, from Ioanis Kourbanis to John Anderson Jr. titled; "Request Approval to Reduce Accident Conditions by Two Categories for the Main Injector and Recycler;" dated August 3, 2012.

Approval Letter; "Approval to Reduce the Accident Condition Postings by Two Categories for the Main Injector and Recycler; "dated October 26, 2012.

Fermilab Radiological Control Manual; Chapter 2; "Radiological Standards;" November 2012.

Fermi National Accelerator Laboratory Safety Assessment Document; "Linac Accelerator; "Revision 0; dated March 18, 2013.

Fermi National Accelerator Laboratory Safety Assessment Document; "Main Injector/Recycler Area;" Revision 0; dated April 23, 2013.

Fermi National Accelerator Laboratory Safety Assessment Document; Revision 5, dated April 30, 2013.

Fermi National Accelerator Laboratory Accelerator Safety Envelope; Revision 4; dated April 25, 2013.

Fermilab Environmental, Safety, and Health Manual, Chapter 2010; "Planning and Review of Accelerator Facilities and Their Operations," May 2013

PowerPoint Presentation; "Accelerator Startup and ASE Approval;" John Anderson Jr; presented June 24, 2013.