

U.S. Department of Energy Orders Self-Study Program

DOE O 420.2B
SAFETY OF ACCELERATOR FACILITIES



**NATIONAL NUCLEAR SECURITY ADMINISTRATION
SERVICE CENTER**

Change No: 0 DOE O 420.2B Level: Familiar Date: 3/21/05
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**DOE O 420.2B
SAFETY OF ACCELERATOR FACILITIES
FAMILIAR LEVEL**

OBJECTIVES

Given the familiar level of this module and the resources, you will be able to perform the following:

1. State the safety assessment document requirements.
2. Discuss contractor requirements in regard to accelerator facility safety.
3. Discuss the safety envelope requirements for the facility, including identifying the impact of unreviewed safety issues.
4. Define the term “shielding policy” and discuss its effect on the facility.
5. Discuss when accelerator readiness reviews are performed and at whose direction.
6. State the minimum procedural requirements that must be in place prior to operating a facility.
7. Discuss the purpose of the internal safety review system.

Note: If you think that you can complete the practice at the end of this level without working through the instructional material and/or example, complete the practice now. The course manager will check your work. You will need to complete the practice at this level successfully before taking the criterion test.
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RESOURCES

DOE O 420.2B, Safety of Accelerator Facilities, 7/23/04.

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INTRODUCTION

This module will discuss the objectives and requirements associated with the Order and the contractor requirements document. We have provided an example to help familiarize you with the material. The example will also help prepare you for the practice at the end of this module and for the criterion test.

Before continuing, you should obtain a copy of the Order at [DOE Directives, Regulations, and Standards Portal Home Page](#) or through the course manager. You may need to refer to these documents to complete the example, practice, and criterion test.

OBJECTIVES

To establish accelerator-specific safety requirements that, when supplemented by other applicable safety and health requirements, will serve to prevent injuries and illnesses associated with U.S. Department of Energy (DOE) or National Nuclear Security Administration (NNSA) accelerator operations.

REQUIREMENTS

DOE/NNSA necessitates that contractors require the following: (1) safety assessment document (SAD); (2) accelerator safety envelope (ASE); (3) unreviewed safety issues; (4) accelerator readiness reviews (ARRs); (5) training and qualification; (6) written procedures; (7) internal safety reviews; and (8) shielding policy.

Safety Assessment Document

The SAD identifies hazards and associated onsite, and offsite impacts to workers, the public, and the environment from the facility for normal operations and credible accidents. The SAD will contain sufficient descriptive information and analytical results pertaining to specific hazards and risks identified during the safety analysis process to provide an understanding of risks presented by the proposed operations. As part of the SAD development, detailed descriptions and appropriate documentation of engineered controls and administrative measures taken to eliminate, control, or mitigate hazards from operation will be provided. The SAD includes a description of the facility function, the location, and the management organization in addition to details of major facility components and their operation.

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The SAD may be prepared as a single document addressing the hazards of the entire accelerator facility or as several different SADs prepared for discrete modules of the facility such as injectors, targets, experiments, experimental halls, or other types of modules. The SAD must be maintained current and consistent with the administrative control measures and physical configuration of the facility and major safety equipment.

Accelerator Safety Envelope

A documented ASE must define the physical and administrative bounding conditions for safe operations, based on the safety analysis documented in the SAD. Any activity violating the ASE must be terminated immediately, and the activity must not recommence before DOE/NNSA has been notified. Any changes to the ASE will require a review and possible changes to the SAD to ensure the ASE is completely met.

Unreviewed Safety Issues

Activities that involve unreviewed safety issues must not be performed if significant safety consequences could result from either an accident or a malfunction of equipment that is important to safety or for which a safety analysis has not been performed. Activities involving identified unreviewed safety issues must not commence before DOE/NNSA has provided written approval.

Accelerator Readiness Reviews

ARRs must be completed prior to obtaining approval for commissioning and are also performed as part of routine operations. ARR may also be performed as directed by the DOE cognizant Secretarial Officer/NNSA Deputy Administrator or a DOE/NNSA field manager.

Training and Qualifications

Requirements must be established for each individual at an accelerator facility whose activities could affect safety and health conditions or whose safety and health could be affected by facility activities. Training and qualification must be documented and kept current.

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Only appropriately trained and qualified personnel, or trainees under the direct supervision of trained and qualified personnel, are permitted to perform tasks that may affect safety and health.

All personnel assigned to or using the accelerator facility (including emergency response personnel) must be trained in the safety and health practices and emergency plans consistent with their involvement and the hazards present.

Written Procedures

Written procedures and instructions for conducting activities safely must be maintained; must be clear, current, and consistent with management systems and the configuration of the facility and equipment; and must be approved by a facility contractor's senior line manager who is actively involved in the day-to-day operation of the facility.

Procedures must include descriptions of the tasks to be performed; appropriate safety and health precautions and controls; and requirements for initial conditions to be verified, operating conditions to be maintained, and data to be recorded, as applicable.

At a minimum, the contractor must prepare procedures for operation startup, normal operation, emergency conditions, conduct of maintenance, approval and conduct of experiments, review and approval of facility modifications, management of safety-related changes, and control of facility access.

Internal Safety Review System

A system must be established and maintained to periodically assess and document the condition of the facility, equipment, and engineered safety systems. Appropriateness and implementation of procedures, administrative controls, and personnel training and qualifications must be periodically reviewed and documented by the internal safety review system.

Shielding Policy

The contractor must approve and implement a written statement of the shielding policy for ionizing and non-ionizing radiation. This policy must comply with all appropriate DOE Orders.

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CONTRACTOR REQUIREMENTS DOCUMENT

The contractor is responsible for compliance with the requirements of this contractor requirements document (CRD). The contractor is responsible for flowing down the requirements of this CRD to subcontracts at any tier to the extent necessary to ensure the contractor's compliance with the requirements. In doing so, the contractor must not unnecessarily or imprudently flow down requirements to subcontractors. That is, the contractor will ensure that it and its subcontractors comply with the requirements of this CRD to the extent necessary to ensure the contractor's compliance and only incur costs that would be incurred by a prudent person in the conduct of competitive business.

The following items are required of the contractor organization.

Safety Assessment Document

A SAD will include the following minimum requirements: identify hazards and associated onsite and offsite impacts to workers, the public, and the environment from the facility for both normal operations and credible accidents; contain sufficient descriptive information and analytical results pertaining to specific hazards and risks identified during the safety analysis process to provide an understanding of risks presented by the proposed operations; provide appropriate documentation and detailed descriptions of engineered controls (e.g., interlocks and physical barriers) and administrative measures (e.g., training) taken to eliminate, control, or mitigate risks of operation; include or reference a description of facility function, location, and management organization in addition to details of major facility components and their operation; be prepared as a single document addressing the hazards of the entire accelerator facility or as separate SADs prepared for discrete modules of the facility such as injectors, targets, experiments, experimental halls, and other types of modules; and be maintained current and consistent with the administrative control measures and physical configuration of the facility and major safety equipment.

Accelerator Safety Envelope

A documented ASE must define the set of physical and administrative bounding conditions for safe operations, based on the safety analysis documented in the SAD. Any activity violating the ASE must be terminated immediately, and the activity must not be restarted before the DOE/NNSA has been notified.

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Unreviewed Safety Issues

Activities that involve unreviewed safety issues must not be performed if significant safety consequences could result from either an accident or a malfunction of equipment that is important to safety and for which a safety analysis has not been performed. Activities involving identified unreviewed safety issues must not commence before DOE/NNSA has provided written approval.

Accelerator Readiness Reviews

The DOE cognizant Secretarial Officer/NNSA Deputy Administrator or a DOE/NNSA field manager must perform ARRs prior to obtaining approval for accelerator commissioning and routine operations and as directed.

Training and Qualification

Training and qualification requirements must be established for each individual at an accelerator facility whose activities could affect safety and health conditions or whose safety and health could be affected by facility activities. Training and qualification must be documented and kept current.

Only appropriately trained and qualified personnel, or trainees under the direct supervision of trained and qualified personnel, are permitted to perform tasks that may affect safety and health.

All personnel assigned to or using the accelerator facility, including emergency response personnel, must be trained in the safety and health practices and emergency plans consistent with their involvement and the hazards present.

Written Procedures

Written procedures for conducting activities safely must be maintained; must be clear, current, and consistent with management systems and the configuration of the facility and equipment; and must be approved by the facility contractor's senior line management who is actively involved in the day-to-day operation of the facility.

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Procedures must include descriptions of the tasks to be performed, safety and health precautions and controls, requirements for initial conditions to be verified, operating conditions to be maintained, and data to be recorded, as applicable.

The contractor must prepare the following procedures as a minimum: operation startup, normal operation, emergency conditions, conduct of maintenance, approval and conduct of experiments, review and approval of facility modifications, management of safety-related changes, and control of facility access.

Internal Safety Review System

An internal safety review system must be established and maintained to periodically assess and document the condition of the facility, equipment, and engineered safety systems. Appropriateness and implementation of procedures, administrative controls, and personnel training and qualifications must be periodically reviewed and documented by the internal safety review system.

Shielding Policy

The contractor must approve and implement a written statement of the shielding policy for ionizing and non-ionizing radiation.

Note: You do not have to do example 1 on the following page, but it is a good time to check your skill or knowledge of the information covered. You may do example 1 or go to the practice.
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EXAMPLE 1 SELF-CHECK

1. State in your words what the NNSA hopes to achieve by implementing DOE O 420.2B.

The objective of DOE O 420.2B, Safety of Accelerator Facilities, is to establish accelerator-specific safety requirements, which when supplemented by other applicable safety and health requirements will serve to prevent injuries and illnesses associated with Department of Energy (DOE) or National Nuclear Security Administration (NNSA) accelerator operations.

2. Referring to DOE O 420.2B, list the eight required areas to be covered.
 - (1) Safety assessment document (SAD)
 - (2) Accelerator safety envelope (ASE)
 - (3) Unreviewed safety issues
 - (4) Accelerator readiness reviews
 - (5) Training and qualification
 - (6) Written procedures
 - (7) Internal safety reviews
 - (8) Shielding policy
3. Referring to the SAD section, state the two features that help to eliminate, control, or mitigate hazards from operations.

Engineered controls and administrative features

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3. Identify who may direct an accelerator readiness review be performed.

4. State the procedures that are required, as a minimum, to operate an accelerator facility.

5. State what must be done prior to commencing activities involved in an unreviewed safety issue.

Note: The course manager will check your practice and verify your success at the familiar level. When you have successfully completed this practice, go to the general level.
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**DOE O 420.2B
SAFETY OF ACCELERATOR FACILITIES
GENERAL LEVEL**

OBJECTIVES

Given the familiar level of this module and a scenario, you will be able to do the following:

1. List the key elements you would look for in the contractor's action plan to correct the situation described in the scenario.
2. State which requirements, sections, or elements of DOE O 420.2B apply to the situation described in the scenario.

Note: If you think that you can complete the practice at the end of this level without working through the instructional material and/or the examples, complete the practice now. The course manager will check your work. You will need to complete the practice in this level successfully before taking the criterion test.

RESOURCES

DOE Orders Self-Study Program, DOE O 420.2B, familiar level, 1/31/05.
DOE O 420.2B, Safety of Accelerator Facilities, 7/23/04.

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INTRODUCTION

The familiar level of this module introduced DOE O 420.2B. Several responsibilities and requirements from the Order were discussed. In the general level of this module, students are presented with a scenario that depicts a work situation related to the Order. The example scenario includes a situation, the actions taken to remedy the situation, and the requirements related to the situation. Students will be asked to review the contractor's actions and decide if they are correct. Students will also be asked to decide if the correct requirements were cited in each situation. Please refer to the Order and the other resources, as necessary, to make your analysis and answer the questions. You are not required to complete the example. However, doing so will help prepare you for the criterion test.

Note: You do not have to do the example on the following pages, but it is a good time to check your skill and knowledge of the information covered. You may do the example or go on to the practice.

EXAMPLE

On June 6, 2004, the division director appointed an investigation team to investigate the event, determine the cause(s) of the event, evaluate similar previous events for common causes and corrective action effectiveness, recommend improvements to address the causes and prevent recurrence, and provide a written report. The investigation team completed their investigation and issued their report on August 27, 2004.

1. Determine if the investigators' analysis is appropriate. Explain your answer.
2. Determine if the corrective actions cited are complete and applicable to the scenario.

SCENARIO

On June 1, 2004, at approximately 1330, while adjusting the settings of a new chemical laser, the operator experienced a large flash. The operator had her safety goggles off during the adjustment operation. The operator completed her laser operations and continued with her workday. At 1700 the operator had to pull off the road on the way home due to blurry vision. That evening she had blurred vision and headaches, and she called in sick the following day. On June 3, 2004, the operator reported vision problems and headaches to her line manager and also informed him of the incident in the laboratory. At the time of the incident, the operator believed the laser was not powered-up. The operator stated that while adjusting the settings of the experiment, she saw a flash. After reporting this to her line manager, she was sent to operational medicine to be examined. The doctor stated that he suspected a damaged retina, with possible cornea damage. The operator was promptly referred to a private eye specialist, and by the end of the day it was concluded that extensive eye damage had occurred, due to exposure to laser light. As of this date, the operator's prognosis is a loss of some sight in both eyes, with possible full recovery very unlikely without surgery.

The operator's eye injury was caused by an inadvertent laser pulse on a machine that was assumed to be de-energized. This inadvertent pulse directed high energy to the operator's eyes. Two conditions—the production of inadvertent laser pulses and inappropriate personal protective equipment (PPE) for the optical radiation hazard created by those pulses—allowed the injury to occur. The two conditions were created by the inappropriate

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work practices that existed in the laboratory and the lack of training dealing with safety and PPE.

The configuration in which the laser was found indicated that it was fully charged and in the operate position. The operator inadvertently operated the fire control locally and initiated the laser operation. The team identified the following two potential scenarios that could have allowed this to happen:

1. The previous operator left the laser in that condition due to being called away and failed to power down the laser. The device was powered up and no indication was left to the next operator that the equipment was not shut down, allowing for inadvertent operation.
2. Poor attention to detail and written procedures led to an improperly shut down machine, and inattention to detail by the operator allowed for inadvertent operation of machine.

The review team recreated the incident and found it quite easy to accidentally initiate firing of the laser once it is charged. The investigation team identified the following as causal factors of the accident: inadequate performance monitoring, inadequate work planning and control, and inadequate response. These causal factors are described below.

The laser exposure to the operator resulted from improper and/or no use of engineering controls and PPE during routine operations. Additionally, a poor understanding of the existing safety analysis by laboratory personnel contributed to their lack of understanding of the possible accidents that may occur. The production of laser pulses and the lack of mitigation for the optical hazard created by the pulses resulted in the injury. The work in the laboratory was poorly planned, and hazards were not identified or controlled prior to commencing work. Poor work practices and inattention, not only to detail but also to written procedures, left equipment in an improper configuration. Routine monitoring of activities and system configuration was not evident. Furthermore, reporting of the incident was poor; the fact that it took two days to notify any level of management shows a disregard for operational and personnel safety.

As a result of the delay, it was impossible to establish event-scene integrity for an investigation. Significant time elapsed from the time of the accident until the accident was

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reported and the scene could be isolated and reviewed. Several operations had taken place since the accident, and there was no way to know the exact configuration of the system that led to the incident. Although all personnel involved with operations were interviewed, it was not possible to determine why the laser was left energized. The following corrective actions will be implemented to prevent recurrence of this type of accident:

- Provide risk-based oversight program review of a performance monitoring system
- Evaluate recommendations of the risk-based oversight program review of a performance monitoring system
- Evaluate multiple behavior-based safety management tools
- Assess the safety of laboratory-wide laser operations
- Correct safety issues in the technical area
- Review and re-approve the division current integrated work documents
- Implement a documented integrated work management process
- Conduct periodic reviews of institutional integrated work management implementation
- Dictate disciplinary and personnel actions taken
- Review actions to be taken during upcoming performance reviews
- Increase the frequency of management walk-arounds
- Enhance the division is nested safety meetings
- Develop an approach to balance rewarding scientific achievement with operational excellence
- Review the shielding policy to ensure that all requirements are addressed in a complete manner

Because of the scope of the operations, laboratory management should have reviewed training and daily operations with a much more stringent eye. Also, the operator did not follow approved laboratory procedures and PPE mandates; the true root cause could not be determined. This stresses the importance of following procedures for all laboratory employees.

Write your answers below and then compare your answers to the ones contained in the example self-check.

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EXAMPLE SELF-CHECK

1. Determine if the investigators' analysis is appropriate. Explain your answer.

The analysis is appropriate. The requirements stated in DOE O 420.2B, section 4 have been addressed by the review team.

2. Determine if the corrective actions cited are complete and applicable to the scenario.

The corrective actions cited are applicable to the scenario. The corrective actions were also complete to meet the requirements of DOE O 420.2B.

PRACTICE

On Friday, September 17, 2004, an Advanced Photon Source (APS) research physicist (PI) was struck in the eye by a Ti:sapphire class 4 laser beam. This incident occurred while he was aligning the diagnostics for the laser. He turned away from the optics table and raised his laser safety eyewear from his face to rub his left eye to alleviate an irritation. As he displaced the glasses, he sensed a bright flash and subsequently detected a slight cloudiness in the vision of his left eye.

The PI left a voice mail message on his supervisor's telephone the next day, Saturday, September 18, informing her that he believed that he had sustained an injury. The supervisor received the message the following Monday morning and immediately informed her management. Upon learning of the occurrence, APS management sent the PI to the Medical Department.

Please review the scenario and answer the following questions.

1. Was the situation handled correctly? If not, what should have been done?
2. Was the list of requirements, sections, and elements complete and correct per the Order? If not, state the correct or omitted requirements.

SCENARIO

While aligning the diagnostics for an ultrafast Ti:sapphire class 4 laser (800 nm), an experimenter raised his laser safety eyewear to rub his eye to alleviate an irritation due to an existing eye infection. As he displaced his personal protective equipment, he felt a bright flash and afterwards a noted light cloudiness in his left eye.

While aligning the optics table components, the PI failed to cover the lateral ports on a polarizer/attenuator/splitter device. In the process of obtaining the signal he wanted, he rotated the elements of the polarizing beam splitter, resulting in an unwanted/undetected beam leaving the plane of the table. It was this beam that subsequently struck his eye.

An investigation revealed the following conditions:

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The direct cause of the injury was the PI's removal of his laser safety eyewear while in a laser controlled area, resulting in the class 4 laser light from the optics table entering the PI's eye.

The investigation identified several contributing causes that set the stage for the occurrence:

- The group leader who appointed the laser controlled area supervisor (LCAS) did not provide clear direction regarding LCAS roles and responsibilities to monitor safe work practices and workplace conditions or explain the extent of his authority. Nor did the group leader subsequently confirm that the LCAS was adequately executing his responsibilities.
- An unshielded beam splitter was put into use on the optics table without guards in place to control a recognized hazard.
- Verbal agreements between the laboratory's laser safety officer and the PI following several postponements of the formal review of the laser table layout obfuscated their understanding of the work that could be performed prior to the start of class 4 laser operations.

The following lessons learned have been identified:

1. Line management must assure that all individuals assigned collateral safety responsibilities understand their assigned roles and responsibilities.
2. Employees assigned collateral safety responsibilities must exercise these roles and responsibilities and be vigilant for unsafe work practices and workplace hazards.
3. LCASs must regularly reinforce the requirement to wear appropriate PPE in their laser controlled areas to visitors and users.
4. Remind staff and users that all injuries must be reported promptly or disciplinary action will be invoked.

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The incident was the result of two root causes whose elimination would have prevented the accident:

- The experimenter failed to follow established laser safety hazard control rules and procedures. The PI failed to assure hazard controls were in place on the equipment on the optics table, and he removed his protective eyewear while still in a laser controlled area with the class 4 laser in operation.
- The PI conducted his work without a prescribed review or appropriate oversight. A review of the condition of the optical table, while it was being set up and “modified,” by either the laser safety officer or LCAS would most likely have revealed the absence of the guard on the optical splitter.

Write your answer on the next page and then bring the completed practice to the course manager for review.

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Note: The course manager will check your practice and verify your success at the general level. When you have successfully completed this practice, the course manager will give you the criterion test.