Accelerator Health Physics: Program Administration and Integrated Safety Management (session 1)

2008 HPS

Professional Development School

Oakland, CA

This Presentation Provides:

Session 1:

- A primer on the Integrated Safety Management (ISM) system in use at US Department of Energy (DOE) national laboratories
- Application of ISM to an industrial accelerator accident

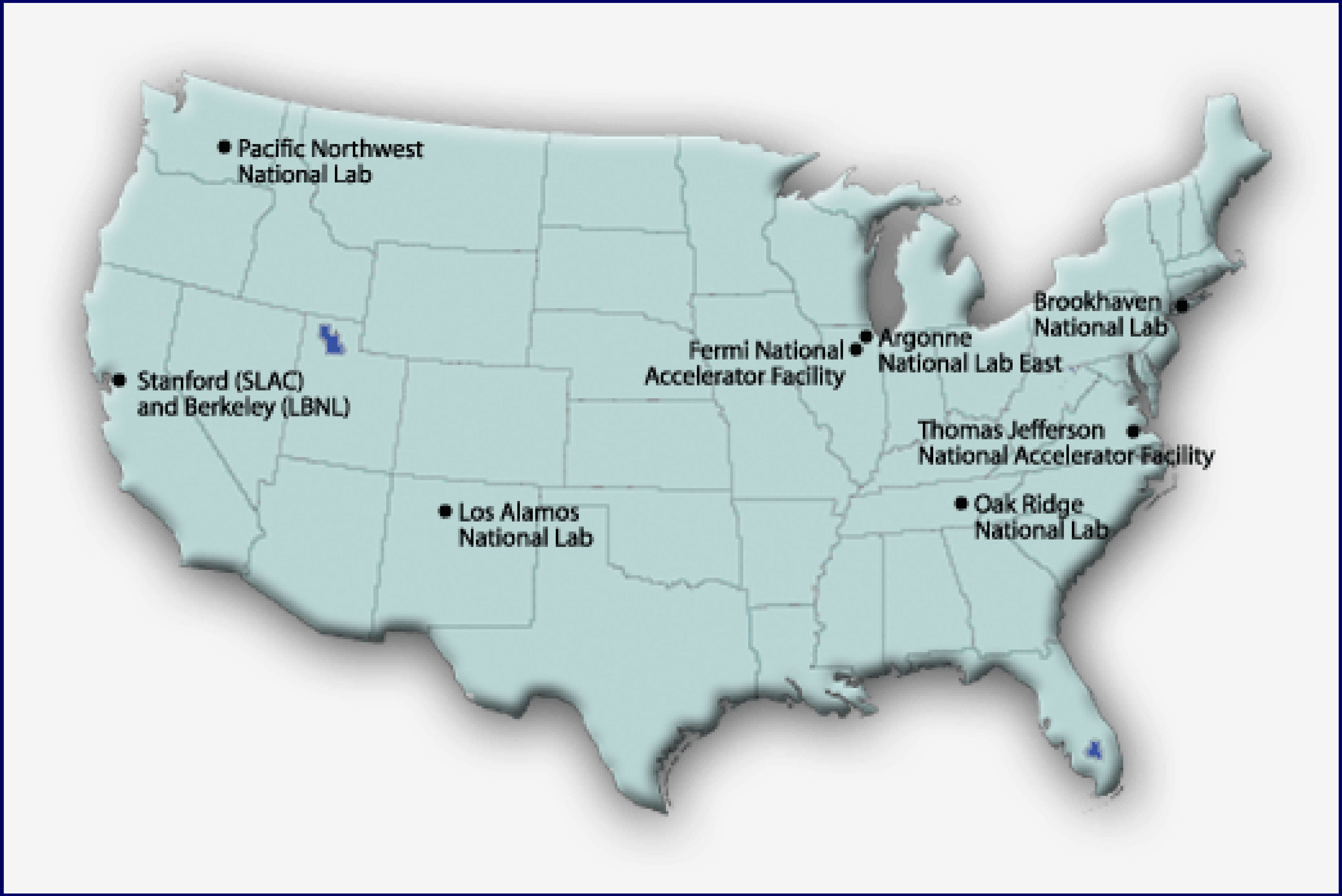
This Presentation Provides:

Session 2

- Information on the DOE Accelerator Safety Order and Implementation Guide
- Information on ANSI standard N43.1 on accelerator safety (if available by time of course)
- Accelerator facility case studies: accidents and best practices

"We are like dwarfs standing upon the shoulders of giants, and so able to see more and see farther than the ancients."

Bernard of Chartres, circa 1130


Pacific Northwest National Lab
Stanford (SLAC) and Berkeley (LBNL)
Los Alamos National Lab
Fermi National Accelerator Facility
Argonne National Lab East
Brookhaven National Lab
Thomas Jefferson National Accelerator Facility
Oak Ridge National Lab

Integrated Safety Management System

TITLE 48--FEDERAL ACQUISITION REGULATIONS SYSTEM

CHAPTER 9--DEPARTMENT OF ENERGY

Sec. 970.5223-1 Integration of environment, safety, and health into work planning and execution.

- Since 1996, requires that all DOE contractors manage and perform work under a documented Safety Management System incorporating 7 principles and 5 core functions.

10 CFR 851, Worker Safety and Health Program

- Effective February 9, 2007 the new DOE regulation 10CFR851 requires contractors and their subcontractors to have a worker safety and health program that reduces or prevents occupational injuries, illnesses, and accidental losses by providing DOE contractors and their workers with safe and healthful workplaces.
- The requirements of 10 CFR 851 apply to occupational and industrial hazards other than ionizing radiation, and are not further discussed in this course.

ISM Guiding Principles

1. Line Management Responsibility for Safety

2. Clear Roles and Responsibilities

3. Competence Commensurate with Responsibilities

4. Balanced Priorities

more …

ISM Guiding Principles

5. Identification of Safety Standards and Requirements

6. Hazard Controls Tailored to Work Being Performed

7. Operations Authorization

ISM Core Functions

1. Define the Scope of Work
2. Analyze the Hazards
3. Develop and Implement Hazard Controls
4. Perform Work within Controls
5. Provide Feedback and Continuous Improvement

Line Management Responsibility for Safety

- The organization of an accelerator facility must be such that the facility manager or director is responsible for safety throughout the facility. This includes radiological as well as non-radiological aspects of safety.
- While authority for many safety functions may be delegated to staff members at all levels of the organization, including health physicists, the ultimate accountability for safety lies with the facility manager.

Clear Roles and Responsibilities

- Safety professionals usually serve the accelerator facility manager in an advisory or consultant capacity.
- In many organizations the health physicists report to a corporate safety organization and serve the accelerator facility in a matrix management approach.
- Matrix management provides a separation of reporting relationships that helps to define and clarify the role of the operational health physics staff.
  - Home division supervisor: the “how” of the work
  - Customer division supervisor: the “what” of the work

Competence Commensurate with Responsibilities

- Those entering the field of accelerator health physics will benefit from participation in specific and focused professional activities to become expert in this area of knowledge. The following opportunities have proven useful to others to get into and stay in the mainstream of accelerator health physics practices:
  - US Particle Accelerator School (USPAS). http://www.uspas.org
  - N43 Accredited Standards Committee (ASC). http://hps.org/hpssc/
  - Accelerator Section of the Health Physics Society. http://www.hps.org/accel/iarpe.htm, http://www.hps.org/accel/
  - Benchmarking

Balanced Priorities

- An health physicist providing operational support to a facility or project may feel the conflicting pressure to expedite a process to meet project management milestones and timelines, on the one hand, while on the other hand maintaining exacting standards of professional conduct in an oversight role.
- These pressures can be exacerbated in accelerator facilities where the health physicist reports directly to line management. A matrix management situation can help balance these competing priorities.

Identification of Safety Standards and Requirements

- Federal, State or local regulatory requirements
- “Radiation Protection for Accelerator Facilities”, National Council on Radiation Protection and Measurements (NCRP) Report 144 (NCRP, 2003).
- “Radiation Safety for the Design and Operation of Particle Accelerators”, ANSI/HPS N43.1 (ANSI/HPS, 2006).

Hazard Controls Tailored to Work Being Performed

- There is great diversity in the size, configuration, and hazards associated with accelerator facilities, and consequently there is great diversity in accelerator health physics programs.
- Fundamentally accelerators differ from nuclear and radiological facilities in that they can be powered off, which immediately removes the principal radiological hazard.
- Accelerators are generally considered to be low hazard facilities for accident analyses.
- The DOE *Accelerator Facility Safety Implementation Guide* (DOE 2005) recommends using a tailored approach to application of accelerator safety requirements.

Operations Authorization

- Accelerator operations should be authorized by and subject to both internal and independent oversight.
- Internal oversight: a radiation safety committee comprised of experts, reporting to senior management
- Independent oversight: a federal or state regulator
- For accelerator facilities in the DOE complex, formal approval of an Accelerator Safety Envelope constitutes the formal authorization to operate the facility.   A Safety Analysis Document supports the Safety Envelope. A Readiness Review demonstrates final 1


KEANU REEVES MORGAN FREEMAN
CHAIN REACTION

Define the scope of work

- Radiation Work Permit (RWP) and the Experiment Safety Review (ESR) are formal means of engaging health physics personnel in work planning processes at accelerator facilities.
- RWPs are used for staff functions such as modifications, testing or maintenance work on the accelerator facility.
- ESR is used for review and approval of experiments to be done either by staff scientists or by guest users of the facility.
- In all cases the health physics team is engaged in advance work planning, review and approval. This is the best opportunity for ALARA planning.

Identify and analyze hazards associated with the work

- The health physics team is responsible for identification of radiological hazards and appropriate controls for experimental and non-experimental work.

- Radiation surveys at the time of beam-line commissioning identify areas of radiation leakage above the defined planning levels. Surveys should be repeated periodically to identify any change in radiation levels whenever shields or beam-line equipments are moved.

more …

Identify and analyze hazards associated with the work

- Conditions that may result in beam losses must be carefully analyzed for generation of secondary radiations, for example from beam enclosures or collimators, or from air bremstrahlung. Active area monitors should be strategically located to detect any unexpected or excessive losses that might cause personnel exposures.
- The health physics team should have documented the types and energies of photon, neutron, and/or other particulate prompt leakage radiations so that appropriate personnel dosimetry may be used to monitor worker exposures.
- If high energy beams are used outside of vacuum, the degree of air activation must be characterized, monitored, and ventilated to ensure control of workplace airborne radioactivity and environmental releases.

more …

Identify and analyze hazards associated with the work

- Beam-OFF radiation hazards consist of activation products and/or contamination in beam-line and vacuum equipment and experimental apparatus.
- Maintenance, repair, modifications and testing work scheduled during beam shut-down periods can be the largest source of radiation exposure to accelerator workers due to the intense gamma-ray fields around activated components and equipments.
- In some cases, beta- and gamma-ray fields associated with contaminated accelerator components require monitoring and protection from skin dose hazards.

Develop and implement hazard controls

- Prompt radiation fields (beam-ON) are generally contained by means of shielding so that they pose minimal risk to users.
- Access controls consisting of locks and interlock systems are an essential element of operational radiation safety at modern accelerator facilities.
- 10CFR835 contains explicit requirements on entry controls for high and very high radiation areas.

High Radiation Area Entry Requirements

- Area monitoring
- Supplemental dosimetry, self reading

plus …

Physical controls for >1 rem in any one hour at 30 centimeters

Use one or more:

1. A control device that prevents entry to the area when high radiation levels exist or upon entry causes the radiation level to be reduced below that level defining a high radiation area; OR
2. A device that functions automatically to prevent use or operation of the radiation source or field while individuals are in the area; OR
3. A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; OR

Physical controls for >1 rem in any one hour at 30 centimeters

Use one or more:

4. Entryways that are locked. During periods when access to the area is required, positive control over each entry is maintained; OR
5. Continuous direct or electronic surveillance that is capable of preventing unauthorized entry; OR
6. A control device that will automatically generate audible and visual alarm signals to alert personnel in the area before use or operation of the radiation source and in sufficient time to permit evacuation of the area or activation of a secondary control device that will prevent use or operation of the source.

Perform work within controls

- Routine surveillance in the workplace is the key to ensuring that work is being performed within established controls.
- Radiation safety requirements and controls established in the facility SAD are translated into practice by means of RWPs and ESR processes.
- Workers, contractors, scientists, guest users, and visitors are provided with training commensurate with their responsibilities and the hazards they may face.
- For high hazard work, direct surveillance by health physics can be a key to ensuring compliance with requirements and for enabling detection and appropriate response to changing circumstances.

Provide feedback on adequacy of controls and continue to improve safety management.

- The process of reviewing monitoring results, incidents, and outcomes of assessments is essential to continuously improve the radiation safety program.
- An important responsibility of the operational health physics team is to generate periodic reports for facility management on health physics results and lessons learned.
- The goals of these activities are to continuously improve the radiation safety program, and to prevent accidents and incidents before they occur by learning from our own as well as from others' mistakes.
- Patterson and Thomas (1973) described 18 radiation accidents that had been reported at accelerators in the USA between the years 1944 and 1967.

Integrated Safety Management

Radiological Work Authorization Program

Define Work

- PI responsibility, accountability
- Procedures, People, Places

Analyze Hazards

- HP Review
- Hazard Classifiction

Develop Controls

- Radioisotope/radiation limits
- Administrative & Engineering Controls
- Approved by Rad. Safety Com.

Perform Work

- Training, OJT, retraining
- Start-up / periodic lab surveys

Feedback - Improvement

- Dosimetry & Incident review
- Annual authorization renewal
- RSC review
- Assessment Process

LBNL ISM/RWA model

- Form groups for discussion of case histories
- Evaluate the case according to the ISM 7 principles and 5 core functions

Case #1
Accelerator Accident in Maryland

Acknolwedgement: Thanks to David Schauer, Sc.D., CHP for reporting the incident and for providing presentation materials

Paper

A RADIATION ACCIDENT AT AN INDUSTRIAL ACCELERATOR FACILITY

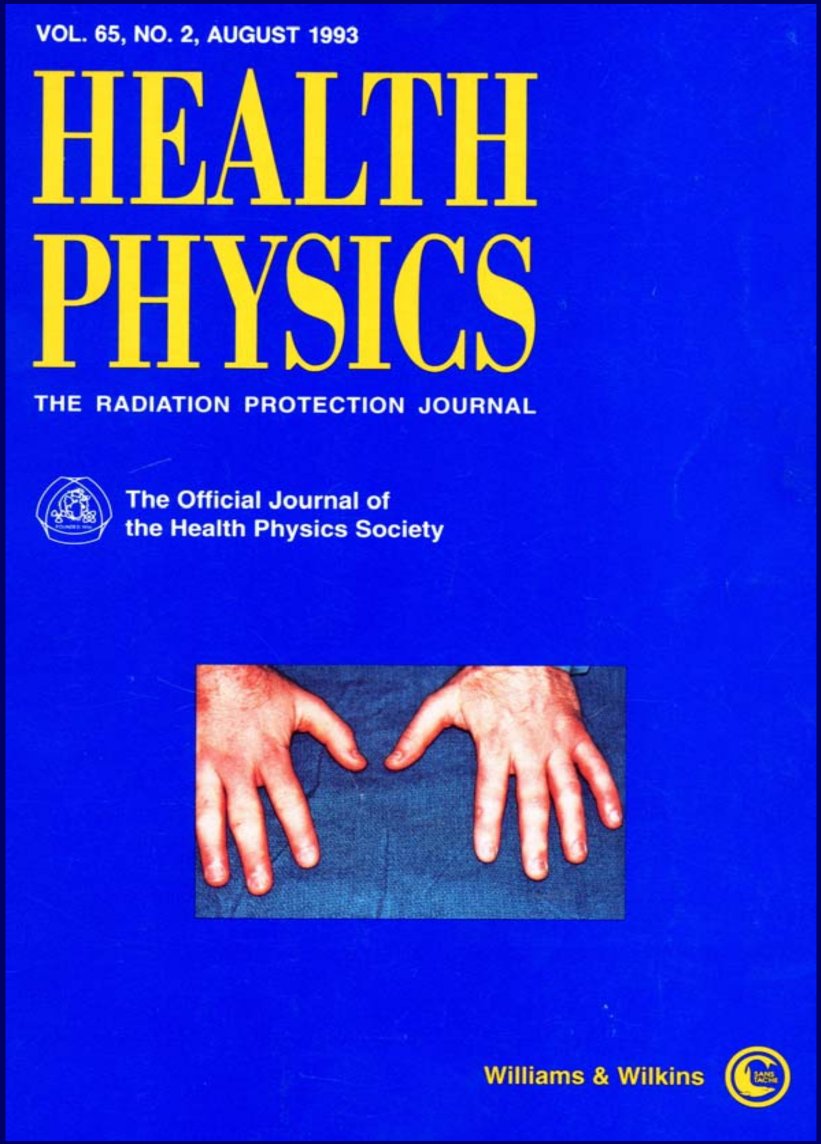
D. A. Schauer,*§ B. M. Coursey,† C. E. Dick,† W. L. McLaughlin,† J. M. Puhl,†
M. F. Desrosiers,† and A. D. Jacobson‡

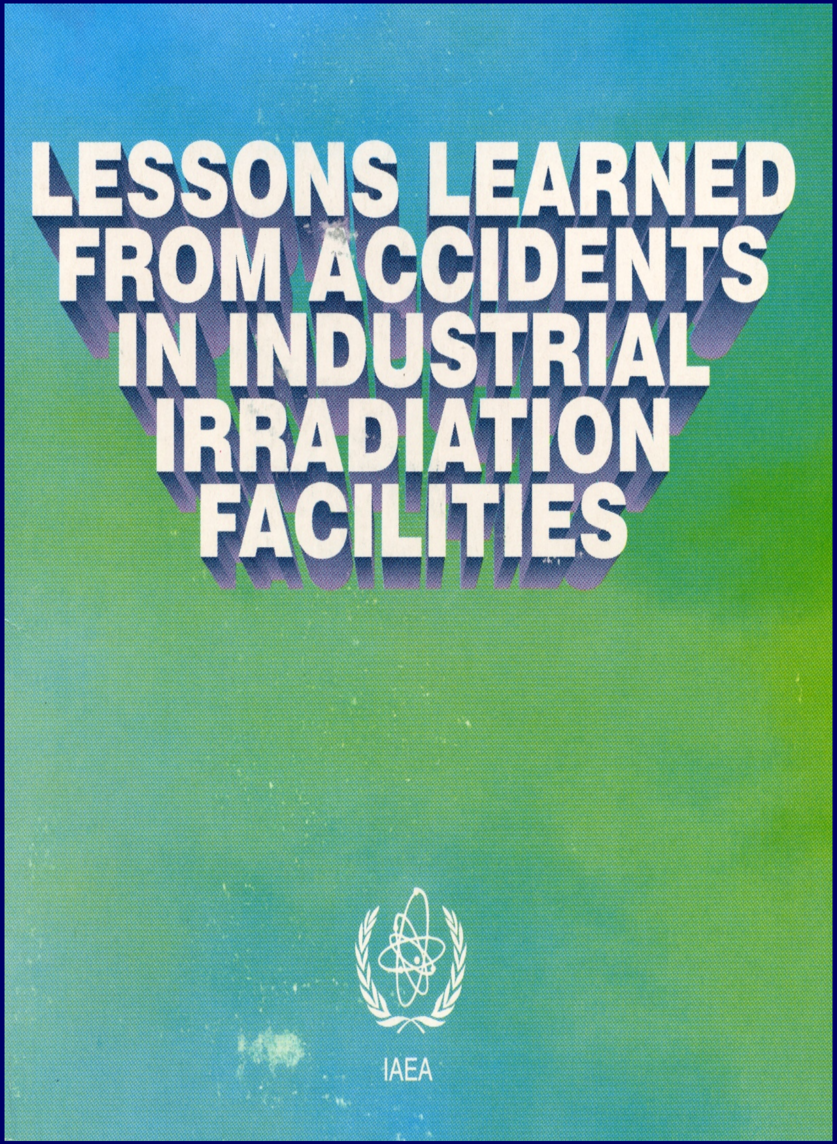
Abstract—On 11 December 1991, a radiation overexposure occurred at an industrial radiation facility in Maryland. The radiation source was a 3-MV potential drop accelerator de-

INTRODUCTION

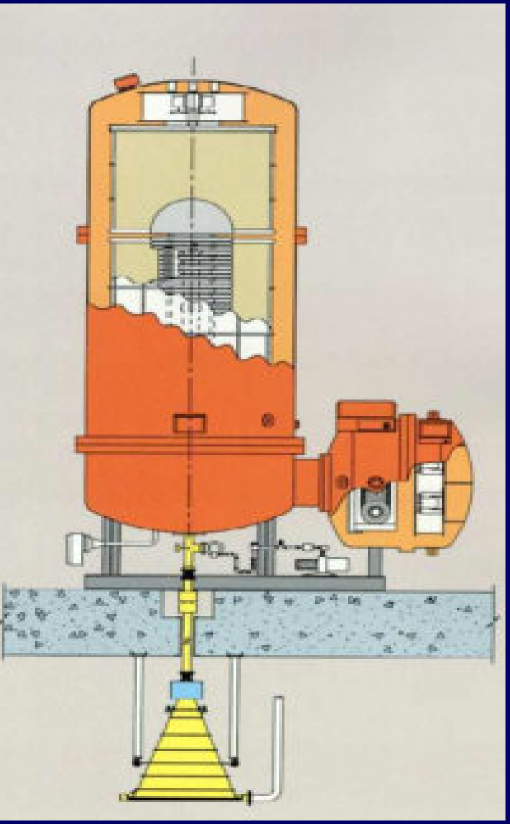
AN ACCELERATOR operator at an industrial facility in Maryland was accidentally overexposed to ionizing ra-

Case #1
Accelerator Accident in Maryland



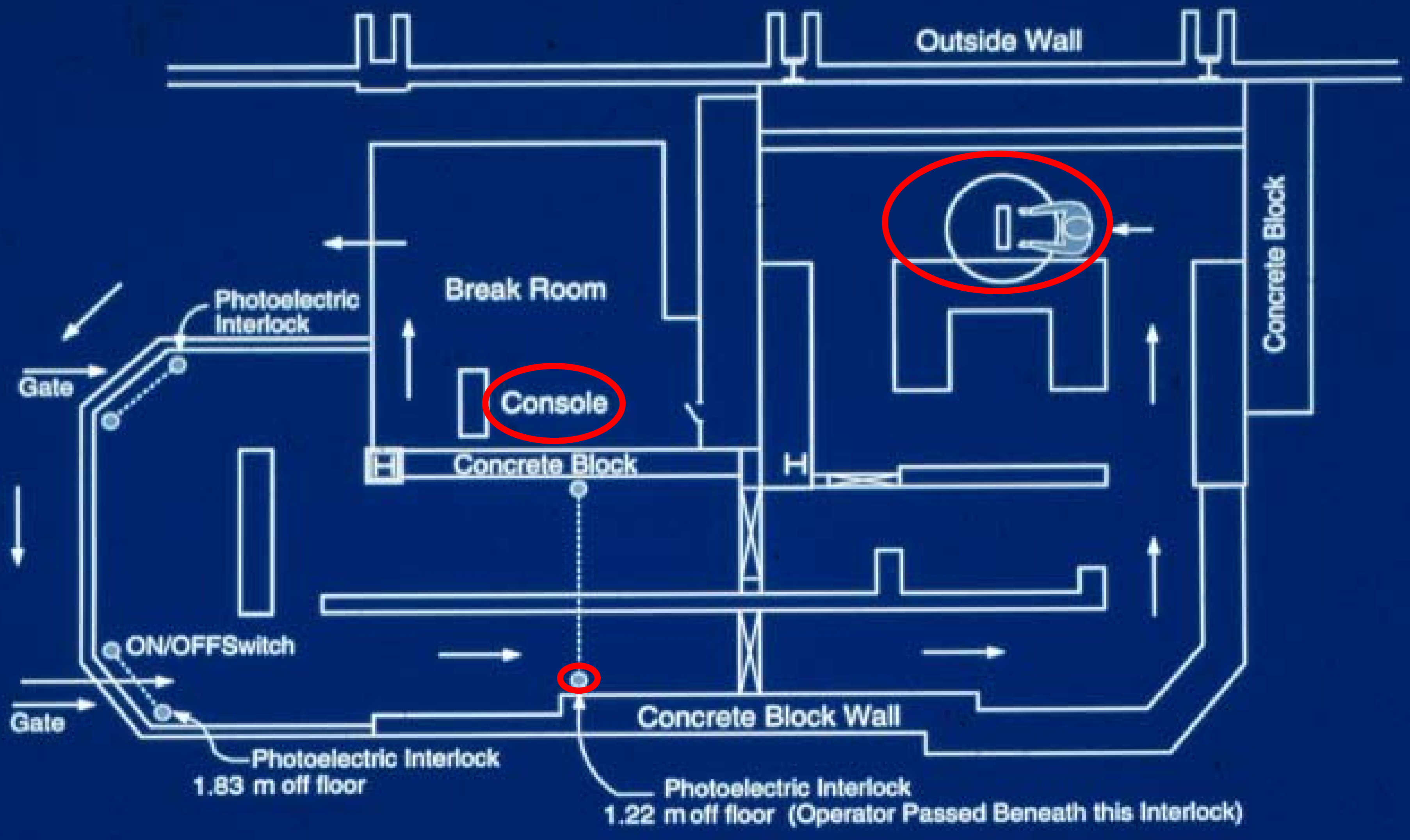


Case #1
Accelerator and Horn



3 MV 25 mA electron beam emerged vertically through a titanium window assembly to irradiate materials on carts transported horizontally through the beam on a chain drive.

Case #1
Facility Floor Plan



Case #1
Accelerator Accident in Maryland

- After performing routine maintenance on and replacing the titanium window, the operator ran the accelerator at maximum potential and current, then turned the filament voltage off before entering the irradiation room to check the titanium window.

- He believed there would be no radiation beam with the current off. Moreover he felt he could save time by leaving the accelerator potential on in case he had to do further tests.

Case #1
Console and Interlocks

Case #1
Accelerator Accident in Maryland

- Flashing warning lights were ignored because it was common knowledge at the facility that these signals were connected to high voltage, not to a radiation detection device as required.

- A chain link fenced gate equipped with a padlock to prevent unauthorized access was not locked and the padlock had been removed at the time of the accident.

Case #1
Accelerator Accident in Maryland

- A photocell interlock at the entrance gate had had an on/off switch installed and was in the off position intentionally bypassing it.
- A pressure-mat interlock that would automatically shut down the accelerator had been removed.
- The only operating interlock was in the labyrinth 1.22 m above the floor, and the operator passed under it.

Case #1
Accelerator Accident in Maryland

- When the operator entered the room the accelerator the filament voltage was off, but the high voltage remained energized. With the filament voltage off, it was estimated that a *cold* or *dark* current continued to flow on the order of 50 -100 mA.

- After entering the room the operator felt the window for heat, and placed his head near it at an oblique angle to view it. He was there for an estimated 1-3 min during which time his body, especially his fingers and head, were exposed to the electron dark current.

Case #1
Actions in the Radiation Beam

The maximum radiation dose was later estimate to be 55 Gy to the fingers.

Case #1 Legal Aspects

WORKERS' COMPENSATION COMMISSION
6 NORTH LIBERTY STREET
BALTIMORE, MARYLAND 21201-3785

CLAIM NO

CLAIMANT

EMPLOYER

INSURER

CLAIM FOR COMPENSATION

DISALLOWED

Hearing was held in the above claim at Baltimore, Maryland on September 1, 1992 on the following issues:

1.) Did the claimant sustain an accidental injury arising out of and in the course of employment?

2.) Is the disability of the claimant the result of an accidental injury arising out of and in the course of employment?

3.) Wilful misconduct?

The Commission finds on the issues presented that the claimant was well aware of the danger involved in his occupation. He received training and passed the required tests to become a qualified operator of the machine. In this incident, all safety devices were in operation and the claimant choose to ignore and in fact, did bypass them. The Commission finds there was no accidental injury or causal connection and that, in fact, there was wilful misconduct and will disallow the claim filed herein.

It is, therefore, this 3rd day of September, 1992, by the Workers' Compensation Commission ORDERED that the claim filed in the above-entitled case by the above-named claimant, against the above-named employer and above-named insurer, be and the same is hereby disallowed.

Case #1
Lessons learned

- Engineering controls in themselves are not enough.
  - The accelerator facility was designed to be operated in a way that prevented access during testing.
  - But radiation safety procedures and interlock systems were routinely bypassed when these activities were conducted,
  - and a flashing warning light was ignored.

Case #1
Lessons learned

- Standard radiation safety practices were not followed. The radiation worker was not wearing a personal dosimeter nor using a survey meter to enter the exposure room.

Case #1
Lessons learned

- Breakdown in the management's attention to operational radiation safety programs:
  - radiation safety systems and procedures had deteriorated creating an unsafe working environment where radiation safety was routinely ignored
  - employees had not been trained in the hazards associated with cold cathode discharge

Case #1
Lessons learned

- It was reported that the licensed inspector, who was not an agency employee, had failed to document any of the items of noncompliance.

- Competent ongoing oversight is an important element in preventing failure of safety systems.

ISM Guiding Principles

1. Line Management Responsibility for Safety
2. Clear Roles and Responsibilities
3. Competence Commensurate with Responsibilities
4. Balanced Priorities
5. Identification of Safety Standards and Requirements
6. Hazard Controls Tailored to Work Being Performed
7. Operations Authorization

ISM Core Functions

1. Define the Scope of Work
2. Analyze the Hazards
3. Develop and Implement Hazard Controls
4. Perform Work within Controls
5. Provide Feedback and Continuous Improvement

This Presentation Provides:

Session 1:

- A primer on the Integrated Safety Management (ISM) system in use at US Department of Energy (DOE) national laboratories
- Application of ISM to an industrial accelerator accident

This Presentation Provides:

Session 2

- Information on the DOE Accelerator Safety Order and Implementation Guide
- Information on ANSI standard N43.1 on accelerator safety (if available by time of course)
- Accelerator facility case studies: accidents and best practices