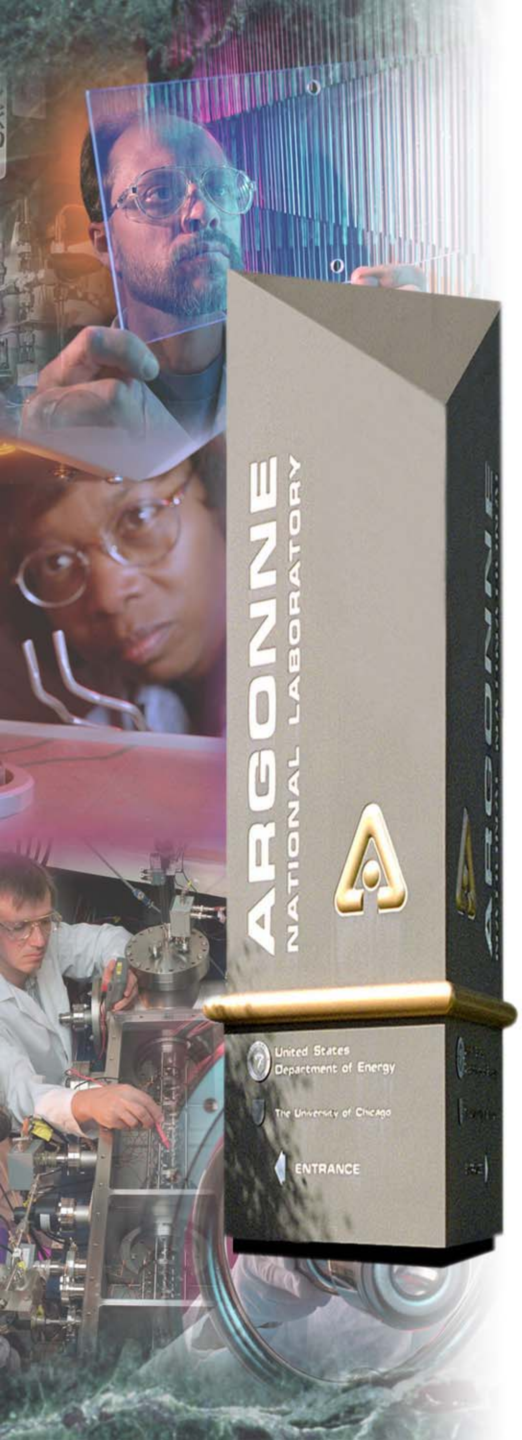


Implementation of the "Policy on Design, Installation, and Maintenance of Radiation Safety Systems"

Presented to the RF Group

December 21th , 2004

A. Nassiri

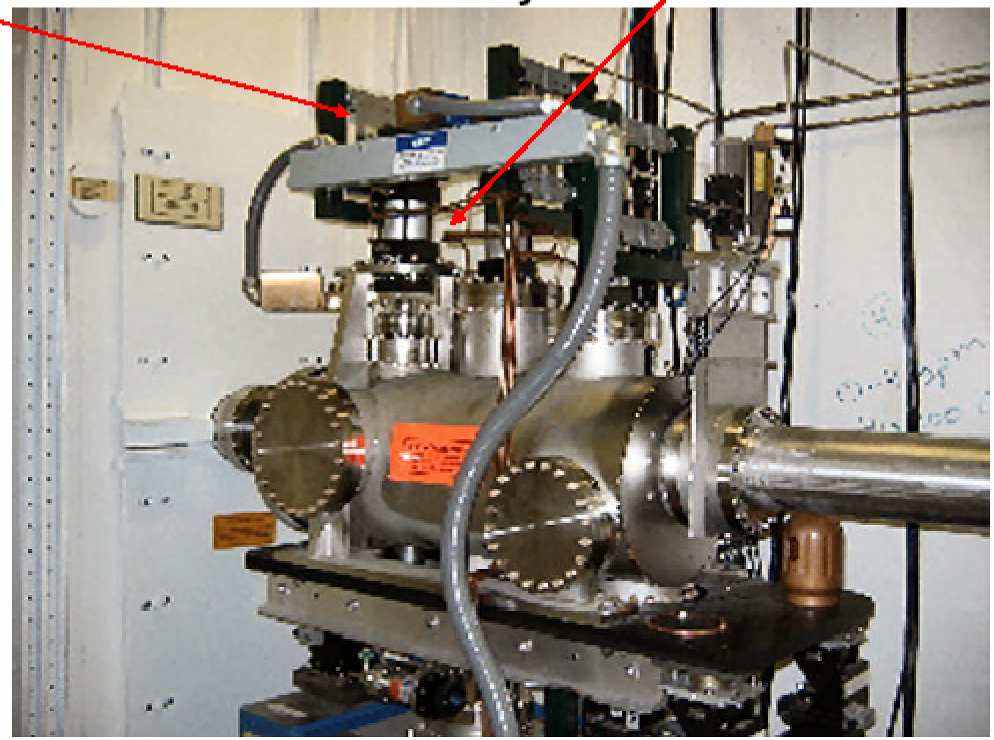
Argonne National Laboratory

Office of Science
U.S. Department of Energy

A U.S. Department of Energy
Office of Science Laboratory
Operated by The University of Chicago

2-BM Integral Shutter – July 2002

- Air lines to the pneumatic cylinder were reversed *then* PSS switches were reversed



LEUTL Rad Stop

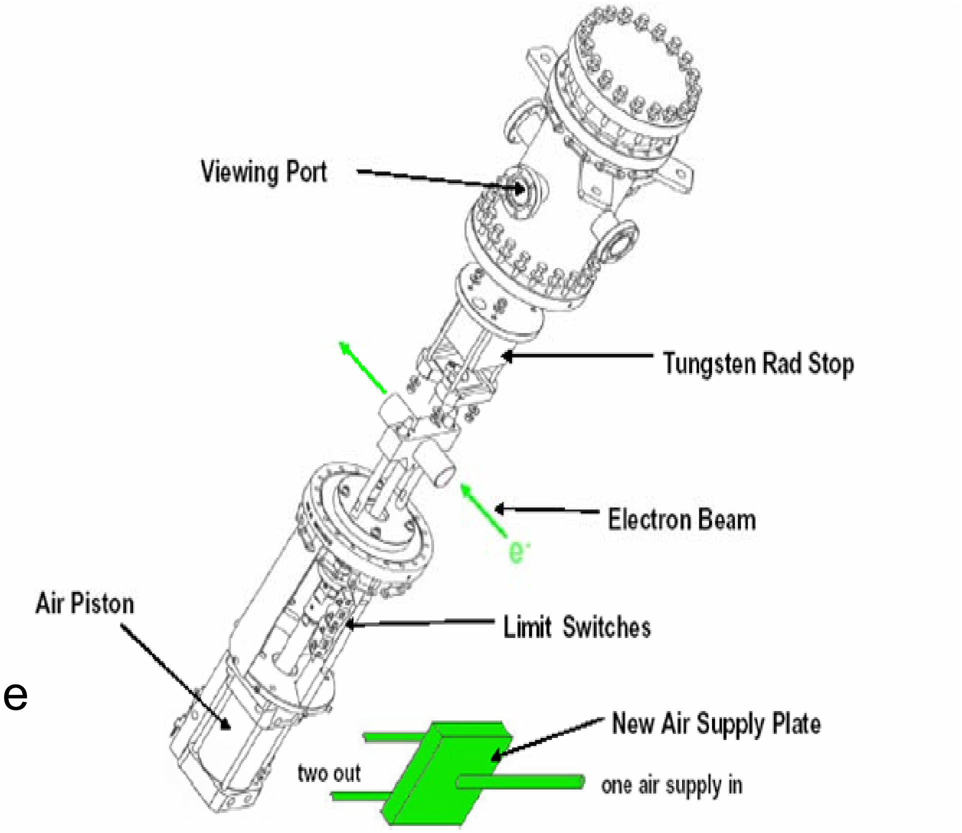
1. Wrong part ordered

2. Wrong part installed upside down

3. Therefore air cylinder air lines reversed

4. ACIS limit switches were reversed to accommodate the reversed air lines

5. ACIS validation was done by the same person
who did the electrical ACIS work and the validation procedure was inadequate



Result rad stop opened when commanded to Close

APS All Hands Meeting 9-28-04 J. Murray Gibson

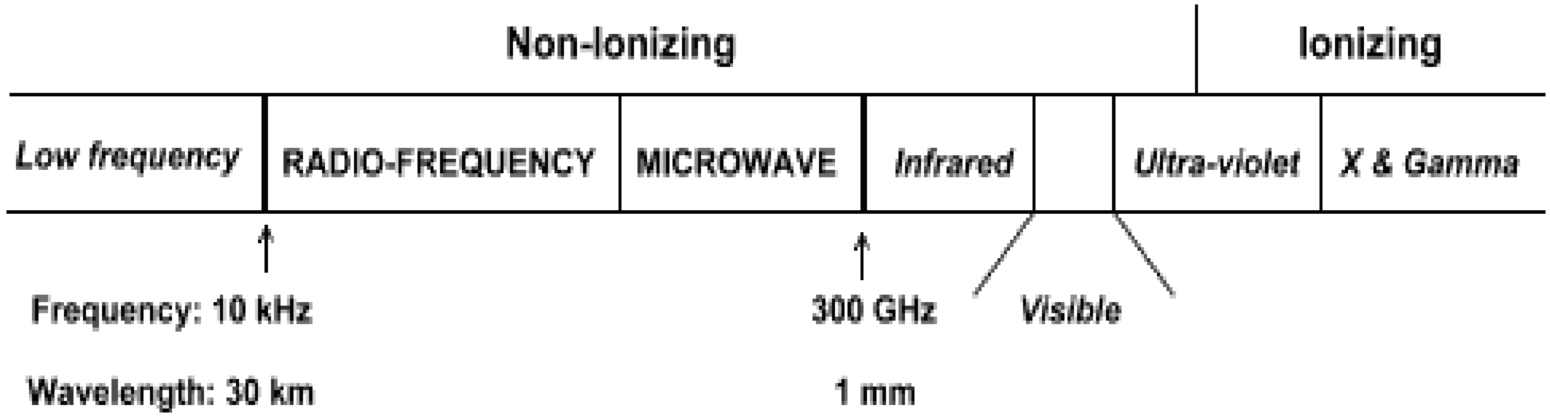
APS Laser Incident

On Friday, September 17, 2004 while aligning a Class 4 Ti:Sapphire laser, an APS PhD research physicist (PI) received a retinal burn to his left eye when he raised his laser safety eyewear from his face to rub his left eye. The PI was adjusting a polarizer/beam splitter/attenuator, which can produce a beam at right angles to the direction of the main beam path and can result in beam leaving the plane of the optics table.

During the process of doing this work the PI sensed an irritation in his left eye from an existing mild eye infection. He turned away from the alignment table, lifted his laser safety eyewear to rub the irritation, and sensed a bright flash. He later noted cloudiness in the vision of his left eye. From this, we conclude that the beam splitter was adjusted such that it resulted in stray beams leaving the table.

The eye injury described in this report was due to the failure of proper vigilance being paid to the control of recognized safety hazards on the optic table and the PI's failure to maintain his laser safety eyewear in place while in a laser controlled area. Further, other process violation occurred that contributed to this incident. As a result, appropriate disciplinary actions are being pursued.

Radiation



The frequency of electromagnetic fields is measured in Hz (hertz), or cycles per second.
1 kHz (kilohertz) = 1000 cycles/second. 1MHz (megahertz) = 1 million cycles/second. 1 GHz (gigahertz) = 1000 million cycles/second.

RF/MW exposure limits

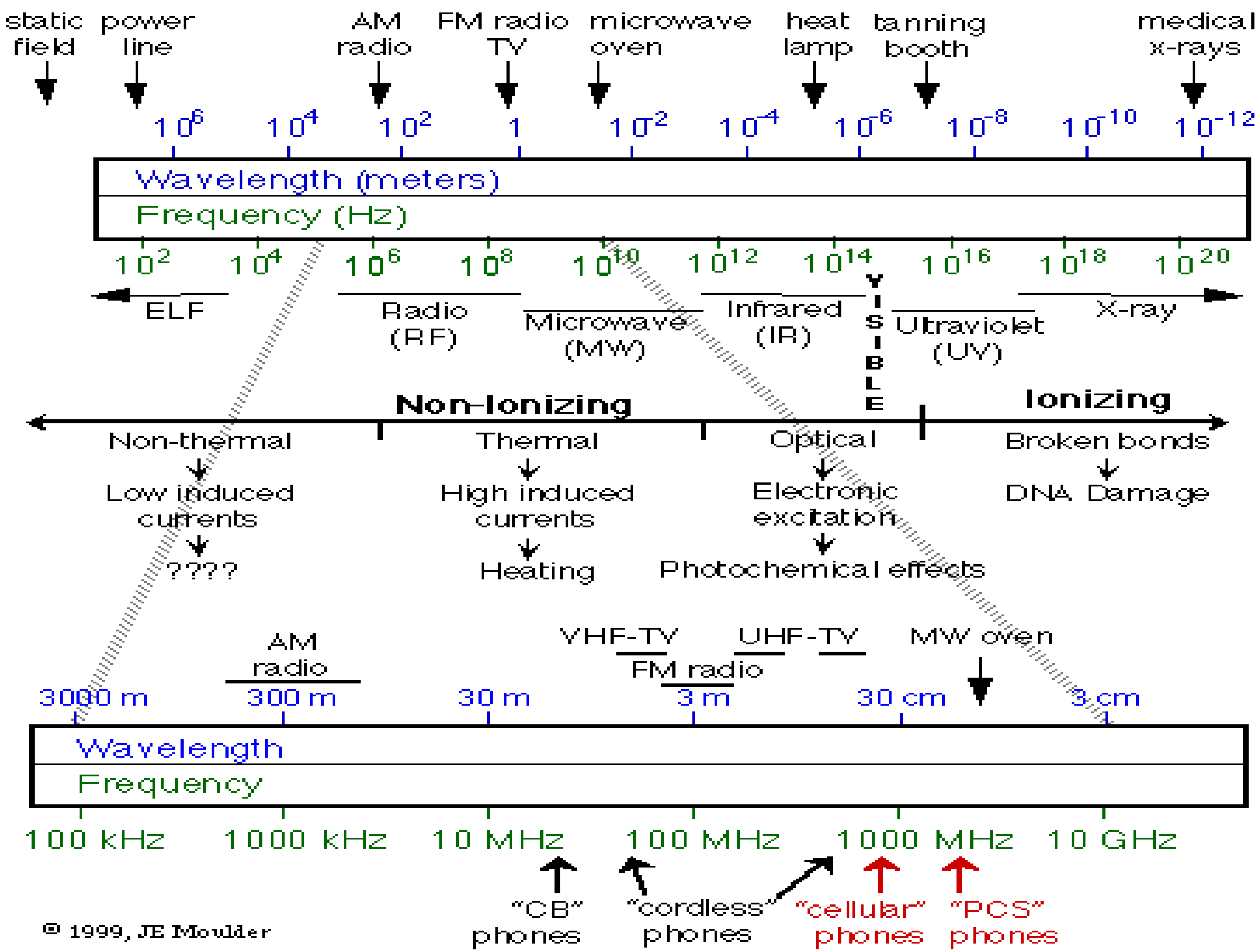


Table 1. LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	$(900/f^2)$*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

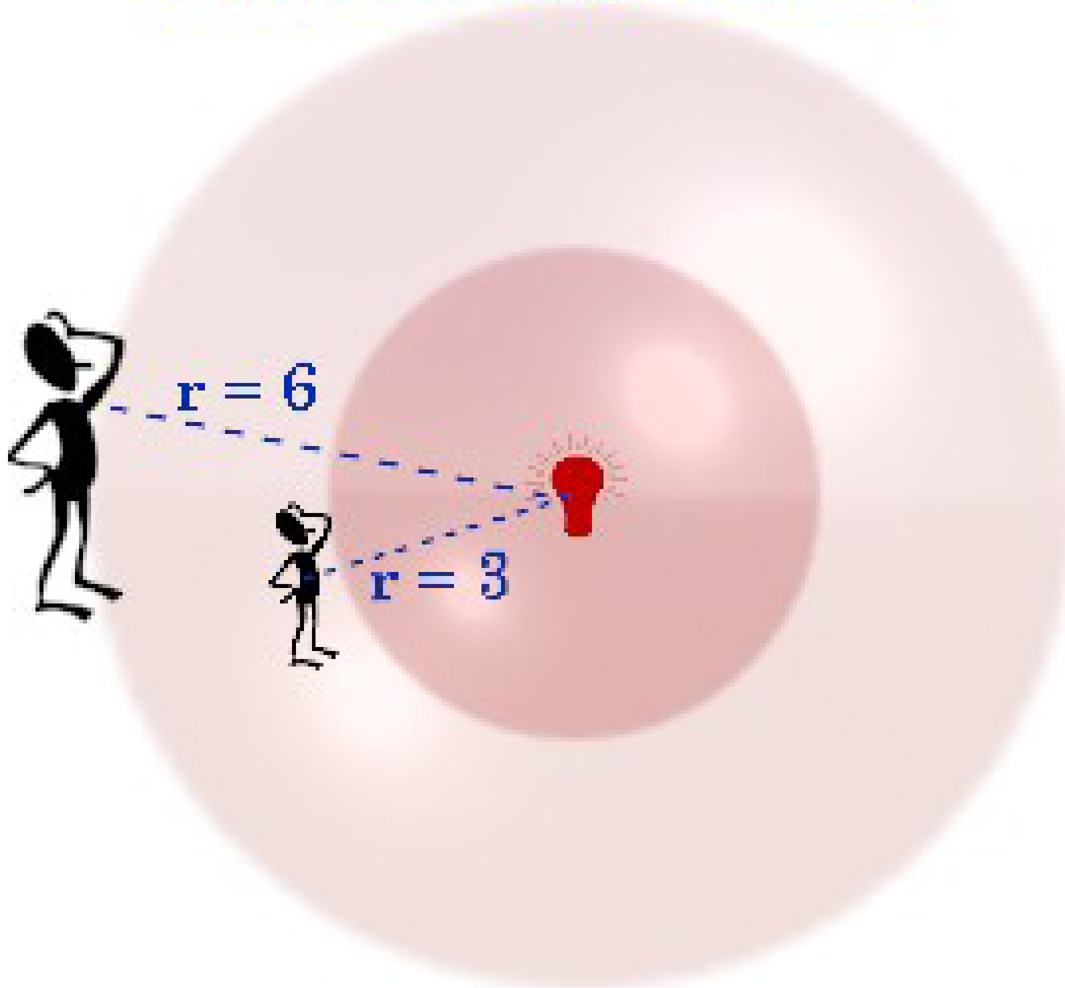
(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	$(180/f^2)$*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

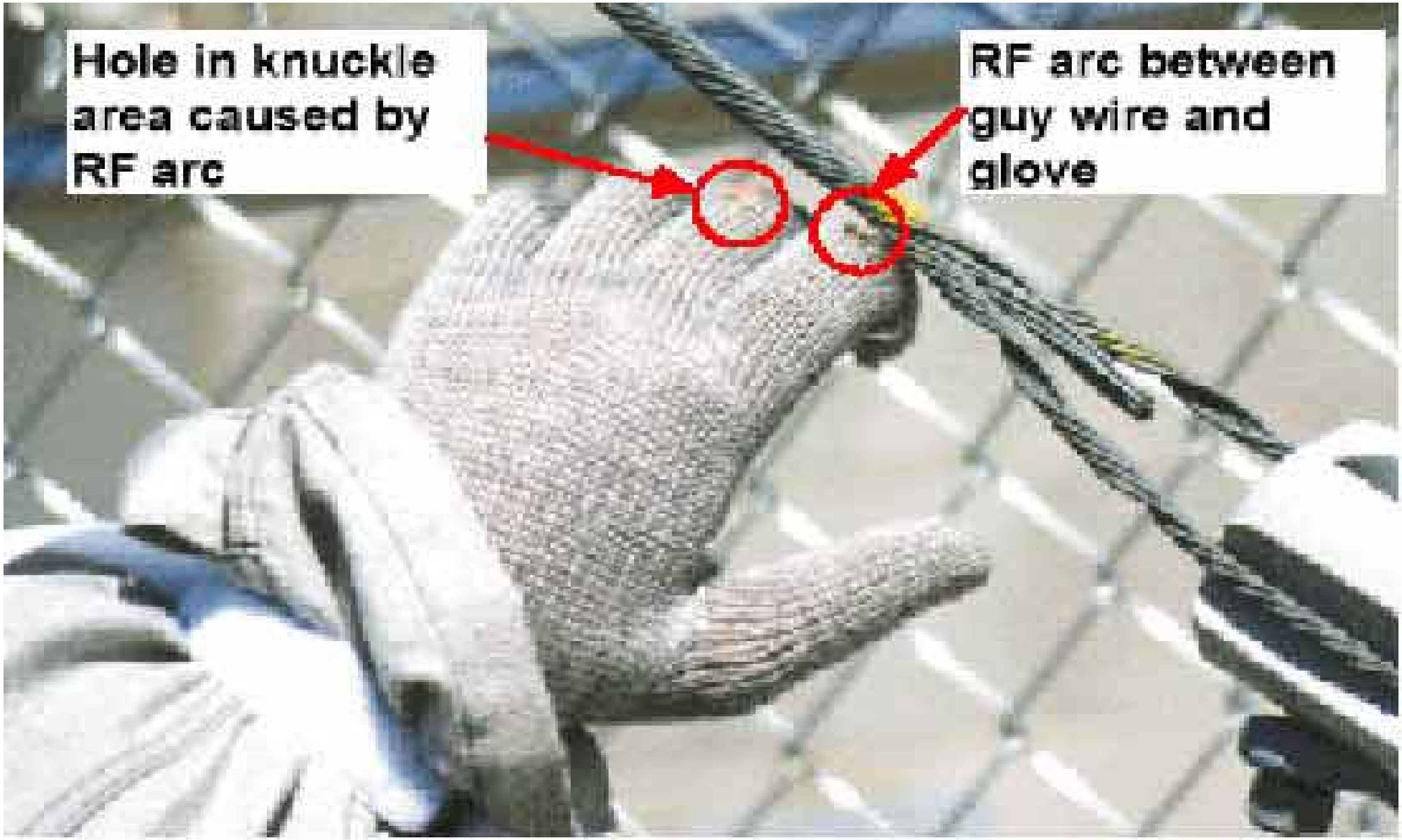
f = frequency in MHz

*Plane-wave equivalent power density

Inverse Square Law



PPE Must Be Inspected & Maintained



Why a policy??

- **Management has expressed concern over APS work planning and execution**
- **We have had multiple incidents, we cannot afford to have another**
- **Policies such as this are in common use at facilities that need to assure safety**
- **Experience at other laboratories**
  - The following quotes are from the DOE report, “Type A Accident Investigation Electrical Arc Injury on October 11, 2004, at the Stanford Linear Accelerator Center, Menlo Park, California”

Why this policy??

- **Policy based on graded approach:**
  - Put the greatest effort into those areas with the greatest risk
- **Policy must address all aspects of work planning**
- **Policy must involve all levels of management and staff**
- **Policy must (with hind-sight) have prevented previous incidents**

Is this a question of Trust?

- We have great trust in our staff.
- Yet incidents have happen.
- Multiple levels of involvement minimize the chances that something will happen.
- Many incidents have occurred at laboratories that have excellent safety programs “on paper”, so we must make sure that our programs are implemented in practice.

Radiation Safety Systems

- Radiation Safety Systems prevent unintentional exposure to ionizing and non-ionizing radiation. These systems include but are not limited to critical components. They consist of hardware to shield radiation, interlock devices, and software to control the device when a hazard is detected.

Each Device and Task has an owner

- R&I Document will define Device Owner; issues are still being worked out, particularly in the beamlines (outside of the ratchet wall)

Graded Approach

- **Risk Matrix Consequence**
  - APS will define "Consequence" – to be included in Policy's appendices A&B
  - Groups will define "Complexity" in the procedures that they write

Consequence

Complexity		LOW	MEDIUM	HIGH
	High	Low	High	High
	Medium	Low	Medium	High
	Low	Low	Low	Medium

Policy on Design, Installation, and Maintenance of Radiation Safety Systems – J. Noonan 12-14-04

Troubleshooting

- Electrical or mechanical tests of the system are for diagnostic or monitoring purposes. The tests do not disrupt normal operation of the system. Test switches that change device state are included in troubleshooting.
- Troubleshooting of radiation safety systems requires the approval of the responsible engineer, and an approved work request. Acceptable procedures include group handbook, written standard guidelines or practice, or written procedures that have been approved by the group leader and second level management (ADD, DDD, or DD as applicable).

Policy on Design, Installation, and Maintenance of Radiation Safety Systems – J. Noonan 12-14-04

Work Flow for Testing, Maintenance, and One-for-One Replacement

	← PRIOR TO WORK →	← AT START AND COMPLETION OF WORK →		
Risk Level	**Work Plan**	**Work Authorization**	**Validation**	**Close-out**
HIGH	Written scope of work Written procedures, group checklists, and validation plan are required The most current drawings, schematics, and specifications are available Associate Division Director/Deputy Division Director approves procedures and validation plan	Initiating group leader authorizes that work is ready to start If ACIS/PSS are affected, SI group leader authorizes that work is ready to start AOD CO approves work request for accelerators; CCSM approves work request for beamlines and front ends	Initiating group leader is responsible for validation SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS Signed validation of work and of interlocks required	Associate Division Director/Deputy Division Director closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD CO or CCSM closes out work request Group checklists are saved in group archives
MEDIUM	Written scope of work Written procedures, group checklists, and validation plan The most current current drawings, schematics, and specifications are available Associate Division Director/Deputy Division Director approves procedures and validation plan	Initiating group leader authorizes that work is ready to start If ACIS/PSS are affected, SI group leader authorizes that work is ready to start AOD CO approves work request for accelerator; CCSM approves for beamlines and front ends	Initiating group leader is responsible for validation SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS	Group leader closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD CO or CCSM closes out work request Group checklists are saved in group archives
LOW	Informal scope of work Procedures and validation plan The most current drawings, schematics, and specifications are available Standard group practice allowed Group leader approves procedures and validation plan	Responsible engineer authorizes that work is ready to start If ACIS/PSS are affected, SI responsible engineer authorizes that work is ready to start AOD CO approves work request for accelerator; CCSM approves work request for beamlines and front ends	Independent validation required SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS .	Responsible engineer closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD CO or CCSM closes out work request

Workflow for Engineering Changes and New Installations

	← PRIOR TO WORK →	← AT START AND COMPLETION OF WORK →		
Risk Level	**Work Plan**	**Work Authorization**	**Validation**	**Close-out**
HIGH	Written scope of work Written procedures, group checklists, and validation plan are required Current drawings, schematics, and specifications are available Associate Division Director/Deputy Division Director approves procedures and validation plan	Associate Division Director/Deputy Division Director authorizes that the work is ready to start If ACIS/PSS are affected, the SI group leader authorizes that the work is ready to start AOD Associate Division Director for Operations, or his designee, approves work request	Initiating group leader is responsible for validation SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS Signed, independent validation of work and of interlocks is required	Associate Division Director/Deputy Division Director closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD Associate Division for Operations, or his designee, closes out work request Group checklists are saved in group archives
MEDIUM	Written scope of work Written procedures, group checklists, and validation plan Current drawings, schematics, and specifications are available Associate Division Director/Deputy Division Director approves procedure and validation plan	Associate Division Director/Deputy Division Director authorizes that the work is ready to start If ACIS/PSS are affected, the SI group leader authorizes that the work is ready to start AOD Associate Division Director for Operations, or his designee, approves work request	Initiating group leader is responsible for validation SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS	Associate Division Director/Deputy Division Director closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD Associate Division for Operations, or his designee, closes out work request Group checklists are saved in group archives
LOW	Written scope of work Procedures and validation plan are approved by group leader Current drawings, schematics, and specifications are available Group leader approves plan	Group Leader authorizes that work is ready to start If ACIS/PSS is affected, SI group leader authorizes that work is ready to start AOD CO approves work request for accelerator; CCSM approves work request for beamlines	Independent validation required SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS	Group leader closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD CO or CCSM closes out work request

System Complexity

- **High Complexity**

  Devices: Complex interlocks and controls, multiple functions, multiple energy sources, such as electrical, pneumatic, vacuum, and water

  Work: New installation requiring multiple groups, disassembly of limit switch circuits, removal of shield block

- **Medium Complexity**

  Devices: Single purpose function with possibly several energy sources, several interlocks and controls

  Work: Replacement of components that do not change the alignment, limit switches etc., e.g. in situ replacement of a pneumatic cylinder on a front end photon shutter

System Complexity

- **Low Complexity**

  Device: Single function but only a static installation

  Work: Maintenance that does not disturb the radiation safety assembly or system, such as flushing water lines in masks or photon shutters, replacement of pneumatic seals

Radiation Safety Systems Policy

- **Design Review**

Design of radiation safety systems in the HIGH and MEDIUM CONSEQUENCE categories require a division director review, as described in the APS Design Review Procedure. The review will include findings, commendable practices, comments, recommendations, and action items.

For the LOW CONSEQUENCE category, the group leader can perform internal design review.

However the group leader shall inform division management of impending design changes, so the Division Director can request a more formal review if deemed necessary. In any event, the group leader must submit the report and responses to the report to the Division Director for archiving.

Radiation Safety Systems Policy

- **Design Review**

  The design of radiation safety systems shall have clear delineation of interfaces and responsibilities. For example, the mechanical design of a shutter should include the location of limit switches and the wiring to a terminal block. The ACIS/PSS system will start at the terminal strip at which the local wiring connects to the ACIS/PSS wiring. Therefore, the mechanical device can be validated independent of ACIS/PSS. The SI group procedures shall have a place for the other groups to sign and date stating that the device is ready to return to service.

Radiation Safety Systems Policy

- **Design Review**

  The technical group requesting installation, maintenance, repair, or testing of radiation devices has the responsibility to coordinate the work performed, including insuring that proper procedures and hazard controls are in place, all work authorizations are secured, and the device is validated for return to service according to written procedures.

  The engineer initiating the work request is responsible

  for insuring each group's work on a subsystem has an approved work procedure. Each group is accountable to the responsible engineer that their work was performed properly. Validation and return to service are performed according to the written procedures under the oversight of the responsible engineer.

Policy on Design, Installation, and Maintenance of Radiation Safety Systems – J. Noonan 12-14-04

Radiation Safety Systems Policy

- **Design Review**

  Before any work is performed, all drawings, schematics, technical specifications, and documents that describe the device and the work procedures must be current. Procedures must be approved by division management according to the risk tables. The work must be performed with strict adherence to the procedures. If any deviation from procedures is identified, work will be stopped until the problem is resolved. The responsible engineer is authorized to resolve LOW Risk issues. The responsible group leader shall resolve deviations arising for HIGH and MEDIUM Risk.

Radiation Safety Systems Policy

- **Work Request System**

All work on accelerator, front end, and beamline radiation safety systems must have a work request approved before the work can start.

The work request must identify the engineer initiating the work, who becomes the responsible engineer for the work. The request will identify the work to be performed, flag that the work is on a radiation safety system or device, what groups are needed, the consequence level, and the complexity level.

The work request system will have a work flow engine to select proper authorization personnel, validation, and close-out personnel. Work on a radiation safety system will generate an electronic image of an oversight checklist. If the system involves either the accelerator or front ends, the checklist must be closed out before APS machine operations can continue.

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Open Issues

- **Concern regarding the writing of procedures**
  - Some of you feel overwhelmed by this. We need to get a sense of the scope of the task, and provide help where possible
- **Design Review Process**
  - Should we provide training on this as well?

From Executive Summary, Page ES-1

"The accident resulted from deficiencies in SLAC's work control planning and implementation processes. The Site Engineering and Maintenance Department (SE&M) exhibits a culture where safety is often secondary to operations. **The Board identified deficiencies in the line management organizations** of the DOE Stanford Site Office (SSO), **SLAC**, and Bay Span, Inc. (Bay Span), the electrical subcontractor performing the work."

"The events leading up to and during the installation of the circuit breaker and the resultant arc flash are characteristic of an unstructured and largely undocumented approach to work that does not ensure the safety and health of workers at SLAC. **Managers, supervisors, and support staff do not take action to enforce compliance with the safety requirements** for this very dangerous task."