CHANGE OF ACCESS CONTROLS TO SERVICE BUILDINGS DURING BEAM PERMIT

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Overview

- Service Building Access
  - Current status of Service Building access
  - Motivation and justification for alternative approach
  - Radiation Monitoring in Service Buildings

- Brief comment on Rapid Access in Hall B (& D)

Why SB access control?

- Dose rate for routine and accidental beam losses re-evaluated using FLUKA calculations
- Normal/protracted loss scenario driven by lower limit of Beam Loss Accounting System (2 μA); such loss results in dose rates > 1 rem/h above penetrations in both arcs and linacs (C-100 waveguide penet.), requiring additional controls per **10 CFR 835**
- High dose rates in case of max. credible accident, in particular in the arcs (555 mrem/s)
- FLUKA calculations were validated by results of measurements during 12 GeV commissioning

Current policy under Beam Permit

- Linac, Arc & BSY SBs posted “Radiation Area”
- High Radiation Area:
  - Above penetrations in arcs
  - Above linac penetrations associated with C-100 cryomodules
  - Work in SBs under RWP; SRPD required

- E3-E5 & W3-W5:
  - RCG-1 locks on bldgs
  - ARM/RCT escort to unlock & survey (and lock after work)
  - HRA Watch or mobile CARM (alarm, no interlock)

Observation

- Operational experience from past ~10 years indicates about one “significant event” per year – requiring vacuum system repairs:
  - Loss of ≥ 1.0 kW ➡ failure in minutes
  - Loss of ≥ 10 kW ➡ failure in seconds

- Considering the above, current policy & posting based on continuous beam loss up to BLA limit of 2 μA now appears too conservative and likely belongs to the “accident” category:
  - 2 kW @ 1 GeV; time to failure ≤ few min
  - 22 kW @ 11 GeV; time to failure = seconds

Proposal

- Consider continued point loss of **1.7 kW (tune-up beam)** as the upper limit of normal operation – this is reasonably conservative (minutes to failure, i.e. much less than 1 h)
- How does this reduce requirements (per 10 CFR 835 & Jlab shielding policy)?

NORMAL LOSS - 1.7 kW	E [mrem/h]	Comment
Above shielded waveguide penetration	80	RA, inaccessible
Side of shielded waveguide penetration	7	RA, monitoring would help ALARA
Above arc penetration	**3776**	HRA >1 rem/h ➡ watch or **barrier** or …
Side of arc penetration	26	RA >25 mrem/h ➡ SRPD or monitoring
MAXIMUM CRED ACCIDENT - 900 kW	E [mrem/s]	Comment (must be < 15 rem)
Above shielded waveguide penetration	12	24 mrem in 2 s ✓
Side of shielded waveguide penetration	1	2 mrem in 2 s ✓
Above arc penetration	**555**	1.1 rem in 2 s (**barrier**, detector DD) ✓
Side of arc penetration	3.5	7 mrem in 2 s ✓

Proposal – Arc Service Buildings

- **Implement robust physical barrier around accessible open penetrations in arcs** OR keep RCG-1 locks and HRA watch

- **Implement network of alarming radiation monitors** OR wear SRPDs

- Keep standing RWP & train workers for work in SBs; keep RA posting, warning on racks & space above penetrations - work there during beam ops requires shutting the machine down or securing PSS segment

Proposal – Linac Service Buildings

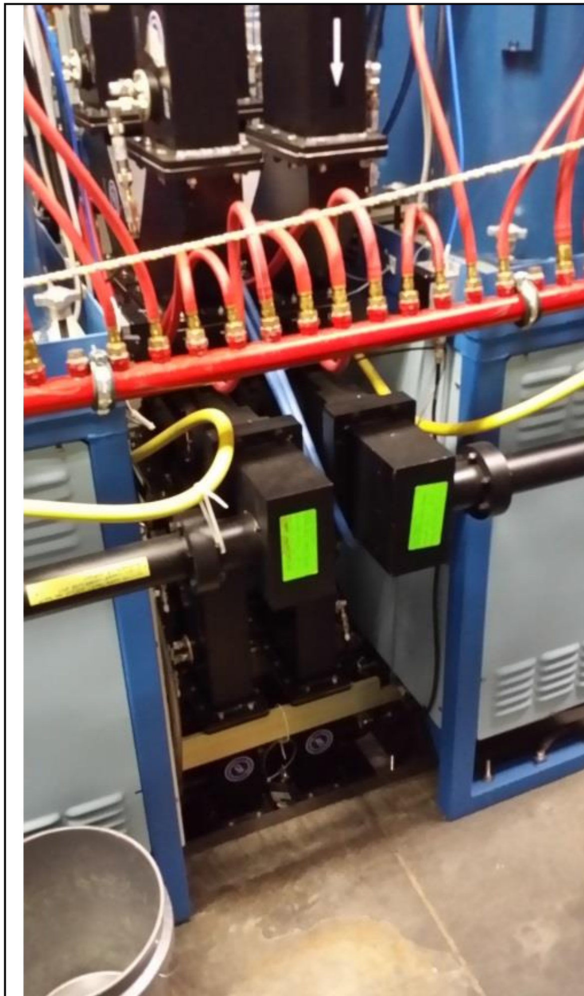
- Keep standing RWP & train workers for work in SBs; keep RA posting

- Work on racks & in space above penetrations during beam operation requires contacting/planning with RadCon

- Implement radiation monitoring as defense in depth; not a MUST, but good practice/ALARA and better understanding of our radiation environment

Linac Service Buildings

- Limited access to “whole body” above penetrations



Implementation Aspects

- Barriers in Arcs: empty covered racks or other robust barrier (metal construction) - $10-15k ?

- CARMs: Arcs only - ~$40k; CEBAF - $300k
- GLAM: Arcs only - ~$10k;   CEBAF - $40k
- GLAM: “Global Alarming Monitor” – using Si diodes, Jlab-developed components & software, with alarm function and control panel in MCC

- First GLAM implementation in Arc SBs as proof of principle, later in Linac SBs; prototype being built

- Prototype Si detector built and currently being tested

Benefits

- Reduction of administrative and logistical burden (issuing SRPDs, ARM/RCT assistance) – saving in FTEs
- Comprehensive record of radiation levels in SBs, with total area coverage
- Useful diagnostic data

SCMB review of the proposal

- SCMB approved the proposed approach, with following recommendations:
- Implement the proposed changes (see SCMB Notes of June 16th) in the Linac and the ARC Service Biuildings.
- Continue to design, develop, document the proposed radiation monitoring system. Fabricate and install the system in one or more of the ARC service buildings for the purposes of conducting operational tests.
- Report performance results for the proposed radiation monitoring system to the SCMB as they become available.

Status of Rapid Access System

- Hall B: CARMs available, but
  - Infrastructure was gutted – physical supports, power and data connections need to be reinstalled; restoration being organized
  - Initial evaluation period during operation will be needed to validate detector positioning

- Hall D: Funding for 2 CARMs and 7 probes found (~$40 k); assumes use of additional diagnostic CARM (already ordered by Hall D) – in process

End/Extra

Previous Assumptions

NORMAL LOSSES - 2 μA	E [mrem/h]	Comment
Above shielded waveguide penetration	1134	>1 rem/h ➡ HRA watch or equivalent
Side of shielded waveguide penetration	92	RA
Above arc penetration	49000	>1 rem/h ➡ HRA watch or equivalent
Side of arc penetration	324	HRA <1 rem/h
MAXIMUM CRED ACCIDENT - 900 kW	**E [mrem/s]**	**Comment**
Above shielded waveguide penetration	12	15 rem in 21 min
Side of shielded waveguide penetration	1	15 rem in 4.2 h
Above arc penetration	555	15 rem in 27 s
Side of arc penetration	3.5	15 rem in 1.2 h

Observation

- Accident assumptions (limited duration) used in **FSAD** Table 4-5 “Hazards, Postulated Initiating Events and Worst-Case Accident Scenarios” are applicable in SBs, lowering the risk rating (e.g. 1a, 1e, 1q, 1v).
- Continuous point loss of 1 to 2 μA falls into “H” ($>10^{-1}$/y) probability of accident category in FSAD. But there is no threshold for accidents, e.g. mis-steerings are part of normal operation per Shielding Policy …

- **Perhaps access controls can be relaxed?**

From FSAD

Table 4-3 Probability Rating Levels

Category	Symbol	Description	Estimated Range of Probability of Accident Descriptive Word Occurrence per Year
High	H	Event is likely to occur several times during the facility's operational lifetime.	$> 10^{-1}$
Medium	M	Event may occur during the facility's operational lifetime.	10^{-2} to 10^{-1}
Low	L	Probability of occurrence is unlikely or event is not expected to occur during the life of the facility or operation.	10^{-4} to 10^{-2}
Extremely Low	EL	Probability of occurrence is extremely unlikely or event is not expected to occur during the life of the facility or operation. Events are limiting faults considered in design (Design Basis Accidents).	10^{-6} to 10^{-4}
Incredible		Probability of occurrence is so small that a reasonable scenario is not conceivable. These events are not considered in the design or FSAD accident analysis.	$< 10^{-6}$

Operating Experience (KW)

- Searched e-logs for "vacuum event", "burnthrough", etc.
- Significant events occur about 1 per year (significant ➡ vacuum repairs)
- Failure: ≥ 1.0 kW in minutes; ≥ 10 kW in seconds

Date	Location	Energy /curr	Power Loss	Comments
3/26/07	Hall A trnsp line	2.65 GeV /40uA CW	265 W (100 nA scraping)	Radiation event, not a vacuum event. Data from J. Lerose's report (4/16/07) on the unusual activation levels in Hall A. No vacuum data available.
12/1/09	MAL2S03	1.2 GeV /0.45 uA CW	540 W	CM fault mis-steers beam **Lost vacuum in 2 min** 500 mR/hr hotspot
12/16/10	Hall C (3H09)	1.16 GeV /4-8uA CW	9.2 kW (max)	Wrong orbit lock value entered. Series of short (seconds) runs with ion chamber trips. Then IC is masked and **burnthrough occurs in 13 seconds**. Total beam time 60 sec.
3/24/12	IPM2S00 (attempting delivery to Hall C)	1.16 GeV/ 1.6 uA CW	1.8 kW	CM fault misteers beam – causes 1.57 uA BLA loss **Vacuum lost in 1.5 min** 160 mR/hr after 4 hr decay
1/21/14	1L26-27	843 MeV /4 uA Tune beam (60 nA ave current)	50 W Tune beam	Event was triggered by vac spike at 0314, then steady decay of vacuum, during which time, Ops was intermittently dumping beam into a closed valve. **Vacuum failed** at 0550 (looks like it would have failed even without the beam on the valve). **~2.5 h**
11/11/14	8R	7.37 GeV/11 uA Tune beam (165 nA ave current)	1.2 kW Tune beam	Setting up for hall D. Steering in arc 8 to clean up beam to get to 9L. Uncertain, but event duration appears **~ 10 min**. Opened up flange at MCB1L01 (just upstream of NL). **Vacuum**

Requirements

- Comply with **10 CFR 835**:
  - Correct posting for normal operation (RA, HRA)
  - Entry control for radiological areas
  - Comply with exposure limits; …

- Comply with **Jlab Shielding Policy**:
  - Design both for normal operation and accident scenarios
  - Normal operation: 100 mrem/y; 250 mrem/y (RCA)
  - Max. credible accident: limit of 15 rem/occurence

10 CFR 835

- ***Radiation area*** - equivalent dose to the whole body in excess of 0.005 rem in 1 hour
- ***High radiation area*** - equivalent dose (whole body) in excess of 0.1 rem (0.001 Sv) in 1 hour

- Notes:
  - Chronic or continuous losses could lead to above posting
  - Short "spikes" are OK; occasional mis-steering losses considered under normal operation in Shielding Policy; the dose integral matters

§835.502

- (a) The following measures shall be implemented for each entry into a **high radiation area**:
  - (1) The area shall be monitored as necessary during access to determine the exposure rates to which the individuals are exposed; and
  - (2) Each individual shall be monitored by a supplemental dosimetry device or other means capable of providing an immediate estimate of the individual's integrated equivalent dose to the whole body during the entry.

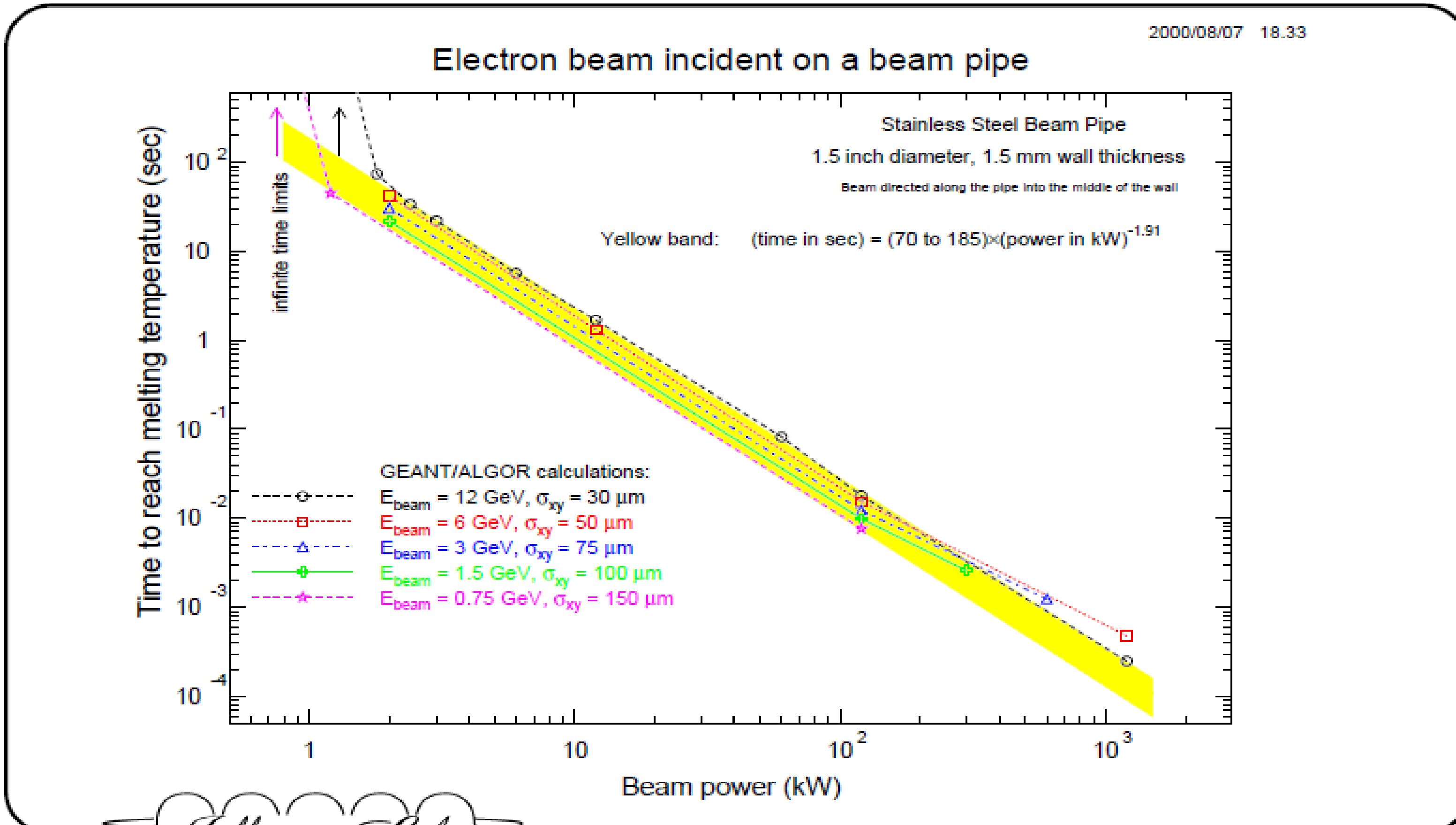
§835.502

- **(b) [Physical controls](#)**. One or more of the following features shall be used for each entrance to a high radiation area where radiation could exceed 1 rem in any one hour :
- (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;
- (2) A device that functions automatically to prevent use or operation of the radiation source or field while individuals are in the area;
- (3) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering HRA and the supervisor of the activity are made aware of the entry;
- (4) Entryways that are locked. During periods when access to the area is required, positive control over each entry is maintained;
- (5) Continuous direct or electronic surveillance that is capable of preventing unauthorized entry; HRA WATCH
- (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.

Modeling

- Estimates of power required to burn through beamline (Degtiarenko)
  - Based on small, optimal beam
  - Useful benchmark

0.75-12 GeV Results, Function of Beam Power



Linac Service Buildings