REPORT

RSC Sub-committee To Investigate and Review ALS Shielding Control Procedures

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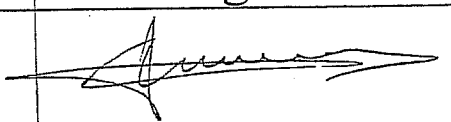
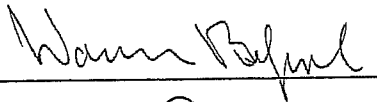
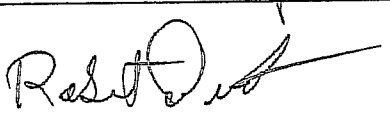
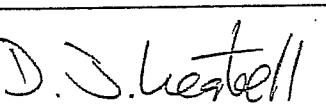
Wim Leemans (Chair)		1/18/06
Warren Byrne		1/18/06
Robert Duarte		1/18/06
David Kestell		01/18/06
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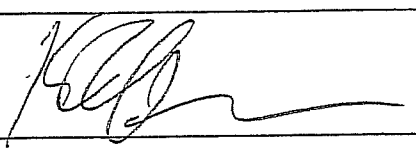
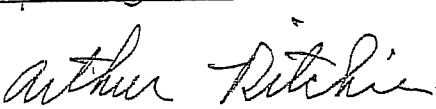
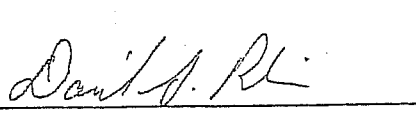
Karl Olson		1/18/06
Arthur Ritchie		1/18/06
David Robin		1/18/06

I. EXECUTIVE SUMMARY

The Lawrence Berkeley National Laboratory's Radiation Safety Committee Chair, D. Shuh, appointed a subcommittee on December 1, 2005 to review and investigate the recent shielding control incidents at the Advanced Light Source (ALS). The investigation was requested by C. Donahue, acting Radiological Control Manager from the Environmental Health and Safety Division (EH&S). The subcommittee membership was W. Byrne (Accelerator and Fusion Research Division, AFRD), R. Duarte (Engineering). D. Kestell (EH&S), W. Leemans (Chair, AFRD), M. Martin (ALS), K. Olson (Directorate), A. Ritchie (retired), D. Robin (AFRD). The charge to the subcommittee was provided by C. Donahue: "The investigation should assess the effectiveness of current shielding control procedures, engineering controls, training, EH&S staff support and management oversight as needed to develop proposed corrective actions to prevent the likelihood of recurrence."

The subcommittee has carried out detailed investigations of three recent incidents that took place on beamlines 12.3.2, 4.2.2 and 7.3 during September, October and November of 2005, respectively. It has also looked at earlier incident reports and heard from ALS staff members about related concerns with possibly common causes.

The committee recognizes the excellent cooperation it has received from the management of ALS and all personnel interviewed during this investigation. Interviewees were open and forthcoming with information and suggestions. In addition valuable unsolicited suggestions were obtained from a number of ALS users and staff members and EH&S personnel. This is evidence of a strong staff commitment to safety within the ALS and wider LBNL organization. None of the incidents involved any exposure to radiation or injury. This can be directly attributed to: (1) the high level of care that was taken during the design and construction of the facility; (2) the general care taken during the expansion and operation of the ALS; (3) astute observations by well trained staff that something was wrong and immediate corrective actions taken to ensure safety. Most importantly, the ALS continues to excel and generally operate safely thanks to a number of excellent, careful and knowledgeable people within the ALS organization and those affiliated with it.

The incident on beamline 12.3.2 involved a commercial contractor installing a new lead-lined radiation shielding hutch on the ALS floor abutting an existing and operational radiation shielding hutch. This installation activity was covered by an ALS work permit (WP). During the installation, an existing radiation shielding labyrinth was removed by the commercial contractor to allow for new hutch panels to be slid into place. The operational 12.3.1 beamline was not properly taken Off-Line and a shielding change form was not started prior to the labyrinth removal. These measures were taken immediately after discovery of the missing labyrinth. It is important to note that no personnel were exposed to radiation thanks to the fact that an ALS employee noticed internal hutch overhead lighting emanating from the labyrinth opening prior to the hutch receiving x-rays. Had the 12.3.1 beamline hutch been secured, x-rays could have been taken into this hutch while the labyrinth was missing, creating a potential radiation hazard in the area where the new hutch was being installed.

The incident on beamline 4.2.2 involved removing shielding from the mono-chromator (mono) enclosure with the beamline key-enabled. A piece of hardware inside

this enclosure failed due to a power-dip, which required that the mono be vented and manually accessed for repair. Each person involved in the incident assumed someone else had taken the beamline Off-Line and had started a shielding change form. Only after the repair was completed and a key-enable was requested, was the beamline found to be still On-Line. The beamline could have therefore been left in a state where radiation shielding was incomplete and the beamline valves and shutters were under user control which could have created a serious hazard. It is important to note that no personnel were exposed to radiation and that the vacuum valves were closed. However, the ALS does not and cannot count on these equipment protection systems for personnel protection.

The incident on beamline 7.3 involved keying On-Line a beamline that had previously been intentionally taken Off-Line for the purposes of removing a radiation protection exclusion zone to allow bake-out of beamline components. While Off-Line, radiation protection is provided by a Personnel Safety Shutter (PSS) that is closed. Thus, radiation shielding and protective exclusion zone hardware located downstream of the PSS can be safely removed for maintenance purposes. The keying On-Line of the beamline could have allowed the PSS to be opened with protective shielding or exclusion zone hardware dismantled or removed. Had there been normal accelerator operations with the PSS open, a potential radiation hazard could have been produced in the area(s) where the protective hardware was missing. It is important to note that no personnel were exposed to radiation and that the vacuum valves were closed. However, the ALS does not and cannot count on these equipment protection systems for personnel protection.

The subcommittee performed a detailed investigation and root-cause analysis for each incident. To prevent the likelihood of recurrence, the subcommittee has made specific recommendations grouped into four categories: Management, ALS ES&H and LBNL EH&S issues, Administrative and engineering controls, and Training and procedures. In the second column of this recommendations table, the recommendations were categorized and assigned one of three levels: level I means that the recommendation should be acted upon immediately, level II means that the ALS management must immediately put in place a plan of action that should be presented to the RSC and RSC subcommittee for concurrence and level III is for items we consider to be at the discretion of the management. The recommendations range from very specific to general and aim at facility safety improvements to: organizational structure, personnel development, training and tracking thereof, and performance improvement plans, EH&S, hardware and operational protocols.

The TapRooT® analysis of the beamline 12.3.2 incident determined several root causes for this incident: Work Permit Needs Improvement, Accountability Needs Improvement, Employee Feedback Needs Improvement, and Corrective Action not yet implemented. These all implicate a lack of a fully functioning work permit system and unsatisfactory supervision. Despite detailed guidance from previous Performance Improvement Team (PIT) reports about the Facility Coordinator (FC) position and the Work Permit (WP) system, the FC did not implement such a system, and his supervisor, the Deputy Division Director (DDD), did not hold the FC accountable to this task. This leads to a number of specific recommendations including a full overhaul of the work permit policy following the 2004 PIT recommendations, strengthening the FC position

consistent with the WP program, defining clear responsibilities and accountabilities for the FC, and improvement of the supervision and direction of the FC.

Our analysis of the beamline 4.2.2 incident leads us to several root causes that need to be corrected. The specifications for motors and other equipment located inside shielding need improvement, shielding accesses need trending to spot problems, beamline status displays need improvement, policies for when an ALS Accelerator Operator (OP) becomes an acting Beam Line Coordinator (BLC) were confusing, and the procedures for issuing the Tamper Proof Screw Removal (TPSR) tool were not followed. These root causes lead us to a number of detailed recommendations addressing (1) the type of Radiation Safety Security Device (RSSD) used for the 4.2.2 mono enclosure, (2) the need for standards for frequency of shielding accesses for types of RSSD's and trending analysis to identify when access frequency does not match design expectations, (3) a means of displaying status of all beamlines on the experimental floor and in the control room and archiving these statuses, (4) clear roles and responsibilities for OPs and BLCs and a plan for establishing the appropriate kind and level of 24-hr coverage at the ALS, and (5) tightening control of TPSR tools and improving related procedures.

Our analysis of the beamline 7.3 incident indicates that Electronic Maintenance personnel (EM) performing a safety interlock system test thought that something they did had caused a beamline Radiation Safety System (RSS) chassis to trip Off-Line, whereas it had in fact been taken Off-Line intentionally three days earlier for maintenance. Detailed analysis has again uncovered several root causes including: Team selection for testing of safety systems needs improvement, RSS status and intended state displays need improvement, procedures and training need improvement, and when an OP becomes a BLC needs defining. Recommendations include improving the display of the status of the beamlines, LOTO-like (LOTO=Lock Out Tag Out) Off-Line status indicators and personal improvement and training plans.

All three incidents have some root causes in common. We recommend that the ALS implement a new organizational structure to accommodate the growth in users it services, correct the structural problems that we have identified and adjust the staffing levels where needed. We recommend that the ALS organization enforces a line-management based structure with clear delineation of responsibility and accountability, and strengthen integrated safety management (ISM). We recommend that the ALS improves its relations with EH&S (and vice versa) as well as internal relations between ALS ES&H safety and ALS operations staff. When an incident occurs, we recommend that the ALS strengthens methods and techniques for fact finding, implementation of corrective actions, establishing lessons learned, and information dissemination.

We note that ALS has a comprehensive procedure management system in place that requires constant administrative vigilance to ensure quality, accuracy and effectiveness of the procedures. Instances were identified during our investigation where procedures were incomplete or inaccurate when compared to the hardware or the operating evolution they were intended to serve.

ALS also had put in place methods for critical self-evaluation and improvement (Performance Improvement Teams, PIT). The ALS Division Director and Deputy Division Director have not effectively utilized the PIT reports and failed at implementing their recommendations to a satisfactory level. An outcome of our root cause analysis for

the 12.3.2 incident was that a robust work permit system, as recommended by the 1999 and 2004 PIT reports, could have prevented this incident.

We recommend that EH&S refocus its attention towards the ALS with the aim of helping the ALS ensure compliance. We recommend that EH&S and ALS jointly establish a clear separation between compliance and technical services provided to the ALS. We also note that the levels of staffing in some areas at ALS and EH&S are inadequate. Within the ALS operations there are some personnel fits that may need to be re-evaluated in light of a review of the positions and restructuring that we recommend, and we have found in some cases that personnel are not performing at a sufficient level.

We believe that it is essential that all recommendations be properly addressed and implemented in a timely fashion to ensure the continued safe operation of the ALS. The RSC subcommittee members stand ready to work with the ALS, the RSC, EH&S and Laboratory management in the future.

CONTENTS

II. OBJECTIVES AND METHODOLOGY

The objectives of this investigation were to (1) determine the facts behind three recent ALS incidents, (2) assess the effectiveness of current shielding control procedures, engineering controls, training, EH&S staff support and management oversight as needed, and (3) develop proposed corrective actions to prevent the likelihood of recurrence of similar incidents in the future. The investigation was requested (see Appendix A) on November 22, 2005 by C. Donahue, acting Radiological Control Manager and carried out on behalf of the LBNL radiation safety committee (RSC) by a subcommittee appointed on November 29, 2005 by D. Shuh, Chair of the RSC (see Appendix B). The membership of the subcommittee was W. Byrne (AFRD), R. Duarte (Engineering). D. Kestell (EH&S), W. Leemans (Chair, AFRD), M. Martin (ALS), K. Olson (Directorate), A. Ritchie (retired), D. Robin (AFRD).

The first meeting of the subcommittee took place on December 2, 2005. Subsequent meetings took place as listed below: December 2005 5th, 7th, 8th, 9th, 12th, 13th, 14th, 15th, 16th, 17th, 19th, 20th, 21st and 22nd; January 2006 2nd, 3rd, 4th, 6th, 9th -17th.

The initial meetings were devoted to gathering facts related to three recent incidents at the ALS, involving beamlines 12.3.2, 4.2.2 and 7.3. A brief visit of the actual beamlines took place on Dec. 2, 2005. We interviewed a total of 28 personnel from the ALS, Engineering and EH&S.

The committee received excellent cooperation from the management of ALS and all personnel interviewed during this investigation. Interviewees were open and forthcoming with information and suggestions. In addition valuable unsolicited suggestions were obtained from a number of ALS users and staff members as well as from EH&S personnel.

Initial time lines were established based on the information provided by the interviewees. It should be noted that the initial reports by the ALS on 12.3.2 (Appendix G), 4.2.2 (Appendix M) and 7.3 (Appendix Q) were not based on thorough investigations, and much time had to be spent by the subcommittee to re-investigate and establish detailed time lines. For example, some of the key employees involved in the incidents had not been interviewed prior to meeting in front of the RSC subcommittee. Since time had passed between the incident and our investigation, some of the information obtained from the interviewees was at times found to be contradictory and required substantial time from the committee to analyze. Use of the ALS electronic event logger and the card–key logging system at ALS provided hard time-stamps for some of the events during the incidents, and these documents proved to be essential tools in our investigation.

After completion of the fact-finding stage of the investigation we applied a root cause analysis methodology closely following the TapRooT® Analysis System. This involved establishing a detailed time line of the events for each incident, identifying relevant conditions to the events, and identifying causal factors. Conditions are defined as an explanation of the event and causal factors are conditions or events that, if eliminated, could have prevented the incident or reduced its severity. Once the causal factors were established, the TapRooT® Root Cause Tree (see Appendix C) was followed to determine the root causes of each causal factor.

An initial set of recommendations was determined based on the identified root causes. Subsequently, we developed a list of recommendations that included the obtained recommendations, suggestions received by email from ALS management and personnel, suggestions obtained during the interview process and those arising through deliberations by the subcommittee. The recommendations were categorized and assigned one of three levels: level I means that the recommendation should be acted upon immediately, level II means that the ALS management must immediately put in place a plan of action that should be presented to the RSC and the RSC subcommittee for concurrence and level III is for items we consider to be at the discretion of the management.

The document is organized as follows: Section III contains background information on the Advanced Light Source showing the lay-out and physical location of the beamlines, the growth of the user community at ALS, and a discussion about organization and staffing level. Sections IV through VI contain a narrative and root cause analysis for incidents 12.3.2, 4.2.2 and 7.3, respectively. We summarize the root cause findings in Section VII. Section VIII contains all recommendations, and Section IX contains relevant appendices. For clarity in reading the text, below we have listed of definitions relevant to the ALS safety system and beamlines:

1. Personnel Safety Shutter (PSS):
- A beamline component used to block storage ring Bremsstrahlung radiation from entering a beamline.

2. Radiation Safety System Chassis (RSS):
- An electronic component that controls the PSS interlocks.

3. Key-on beamline or put beamline On-Line:
- RSS chassis is put in a state that allows the PSS to be opened / closed. A beamline specific key that is kept in the control room key locker is required to set the chassis in the on-line state, hence to key-on.

4. Key-enable beamline:
- This is similar to keying-on a beamline except a safety checklist is completed to assure no bypasses are in place, the radiation survey and RSS interlock tests are current, the beamline shielding and exclusion zones are in place and the vacuum pressures are within a specified range. If any one of these safety items is not in compliance, the beamline cannot be key-enabled.

5. Key-off beamline or take beamline Off-Line:
- The RSS chassis is put in a state that closes the PSS and prevents it from being opened. It should be noted that "Key-off" is a misnomer since the chassis is put in the Off-Line state by pressing a button.

III. BACKGROUND INFORMATION

The Advanced Light Source (ALS) is a third-generation synchrotron radiation source located at Lawrence Berkeley National Laboratory. The ALS has been in operation since 1993 and is currently serving more than 2000 users per year. The radiation produced by the ALS is optimized for high brightness at soft x-ray and ultraviolet photon energies using undulator sources. For the soft x-ray and ultraviolet photon spectral region, the ALS is amongst the brightest sources of light world-wide. The ALS also provides world-class performance over a broader spectral range – from the infrared to the in the hard x-ray region of the spectrum.

Synchrotron radiation is electromagnetic radiation emitted when charged particles are radially accelerated (move on a curved path). In the ALS, synchrotron radiation is produced when high energy electrons radiate as they are radially accelerated when they circulate around the 200m circumference of a storage ring. The electron energy in the storage ring is typically 1.9 GeV, however the energy has been tuned to lower energies. Within the storage ring there are several devices that cause the electrons to radiate – Normal conducting dipoles, Superconducting Dipoles (Superbends), undulator and wiggler magnets.

Figure 1 is a floor plan (know as "the clock") of the ALS showing the accelerator complex (50-MeV linear accelerator, 1.5-GeV booster synchrotron, and the electron storage ring), and the beamlines that are operational or under construction with brief descriptions.

The storage ring has 12 sectors comprising a straight section and a downstream curved arc. Each sector has five possible ports for synchrotron radiation, where port 0 is an insertion-device port; ports 1, 2, and 3 are bend-magnet ports; and port 4 is a bend-magnet port suitable only for an infrared beamline because of space restrictions. Straight-sections 1 and 3, and half of straight-section 2 are occupied by accelerator hardware (injection magnets, rf cavities, and third-harmonic cavities, respectively). In addition, some bend-magnet ports are effectively unavailable because of limited space. The maximum practical number of beamlines is around 50. The abbreviations used in the clock include STXM (scanning transmission x-ray microscopy), LIGA (German acronym for technique of electroforming micro-electromechanical machines from deep-etch x-ray lithographically defined molds), AMO (atomic, molecular, and optical science), EUV (extreme ultraviolet), and IR (infrared), PEEM (photoemission electron microscope), XAS (x-ray absorption spectroscopy).

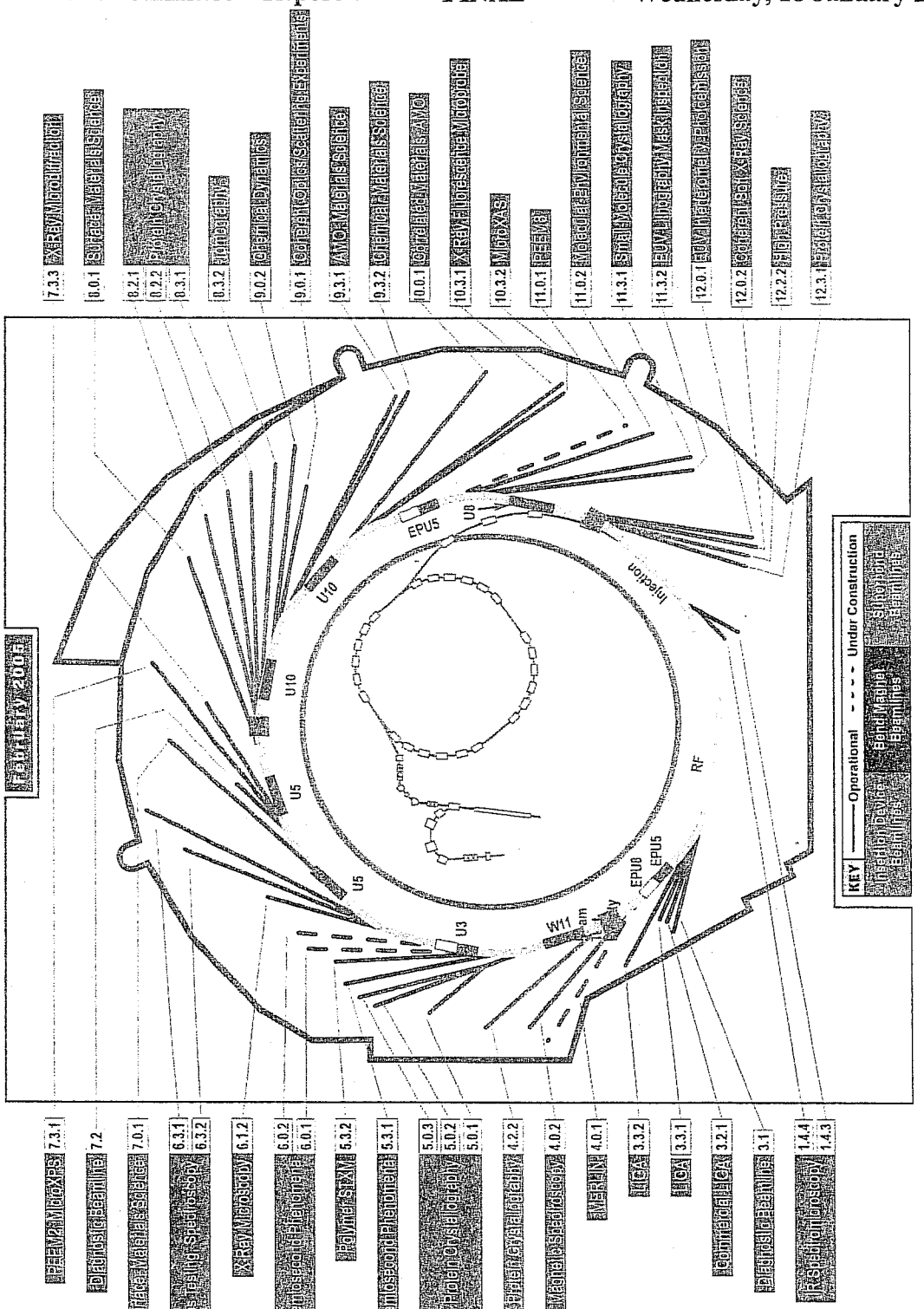


Figure 1. ALS beamlines.

The ALS is a national user facility open to scientists from academic, industrial, and government laboratories, and its mission, succinctly stated, is to

> Support Users in Doing Outstanding Science
> in a Safe Environment.

The number of beamlines has been growing steadily since the facility began operation. The growth in the number of beamlines at the ALS measured January each year since 1994 is shown graphically in Figure 2. Currently, the ALS has 35 beamlines. The storage-ring diagnostic beamline, the 50-MeV electron Beam Test Facility, and the booster-to-storage ring (BTS) transfer line are not included in any of the beamline counts, since they are not directly involved with synchrotron science. The maximum practical number of beamlines is 50, representing a fully built out machine, so at the beginning of 2005, the ALS is about 70% of capacity.

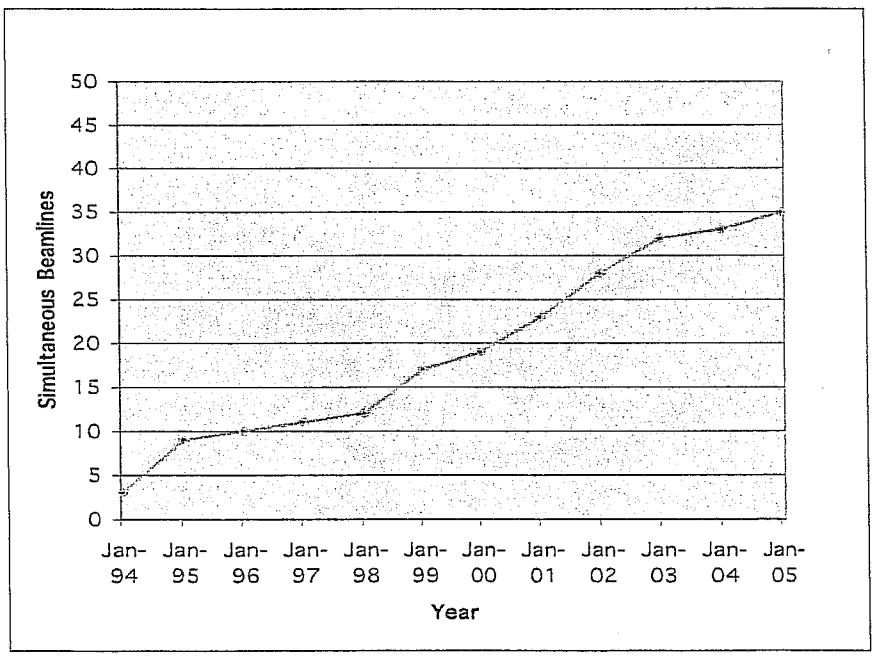


Figure 2. ALS beamline growth 1994—2005.

There has been steady growth and diversity in the user community as is shown in Figure 3 below for various fields of science.

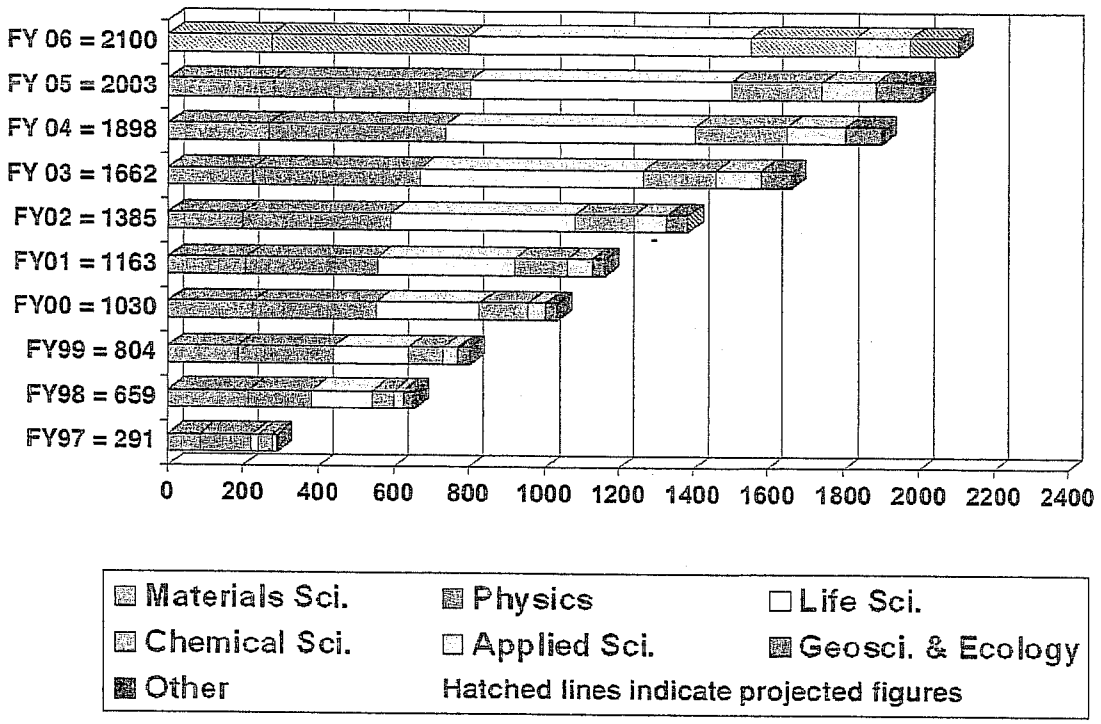


Figure 3. User community growth in the various scientific user disciplines from FY97 through FY06. As can be seen the total number of users increased by more than 7 times.

The present ALS organization chart is shown in Fig. 4.

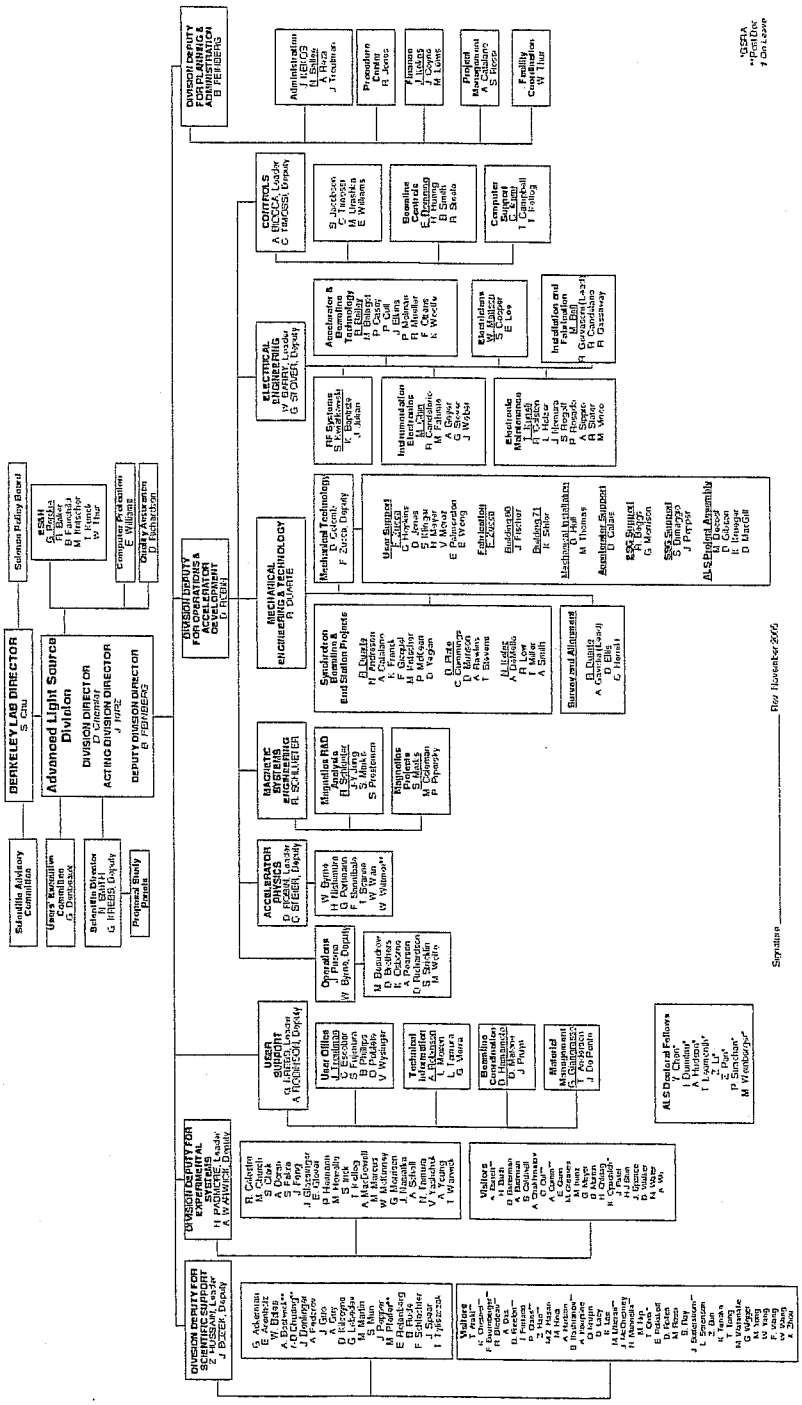


Figure 4: Present ALS organization chart (dated November 2005).

The staffing level at ALS over the past 13 years is shown in Fig. 5. Note that whereas the number of users has grown by a factor 7 over the past 8 years, the overall staffing level at

ALS has increased by less than 10%. Furthermore, the operator staffing level has reduced from 10 to 7 and the number of full time beamline coordinators decreased from 4 to 2 in the past 7 years.

In general, there have been considerable changes in the organization of the ALS over the lifetime of the facility and, as discussed below, the present structure needs to be revisited to better accommodate the phenomenal growth of the user program, and for other reasons detailed in this report.

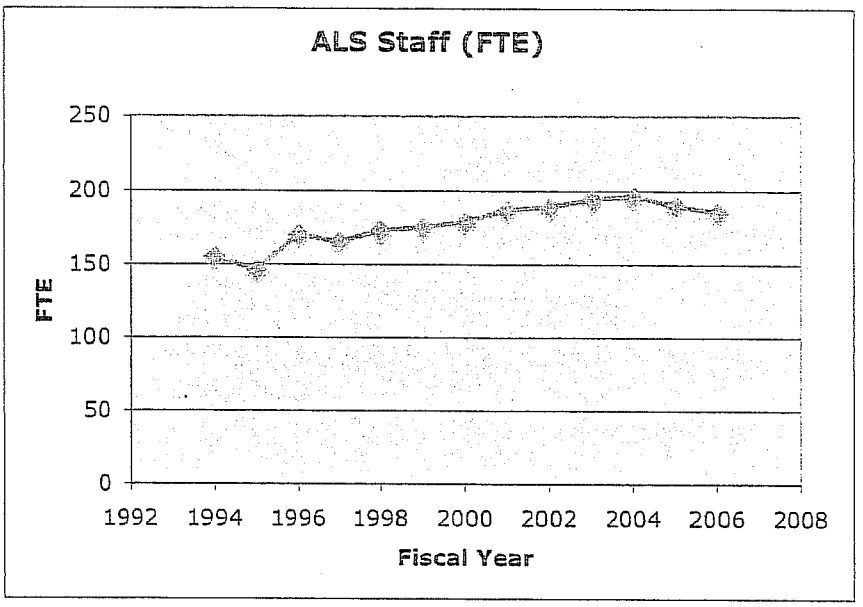


Figure 5: Staffing level at ALS (in FTE) versus Fiscal year from 1993-2006.

Table 1 contains a brief description of the various beamlines along with commissioning dates. All the beamlines are listed with their energy range and magnet source type (Ux, undulator with a period of x cm; Wx, a wiggler with a period of x cm; Sbend, a superbend; and Bend, bend-magnet).

Table 1. ALS Beamlines, January 2005

	Beamline	Source	Operational since	Areas of research*	Energy range
1	1.4.3	Bend	Jul-98	L,G	1.6–6.2 eV
2	1.4.4	Bend	Jul-98	L,G	0.002–3 eV
3	3.2.1	Bend	Apr-01	A	3–12 keV
4	3.3.1	Bend	Oct-03	A	3–12 keV
5	3.3.2	Bend	Apr-98	A	3–12 keV
6	4.0	EPU5	Sep-99	P	60–1800 eV
7	4.2.2	Sbend	Sept-03	L	6-16 keV
8	5.0.1	W11	Sep-00	L	12.4 keV
9	5.0.2	W11	Sep-97	L	5–15 keV
10	5.0.3	W11	Sep-00	L	12.4 keV
11	5.3.1	Bend	Jul-00	M,P	0.1–12 keV
12	5.3.2	Bend	Nov-01	C	200–700 eV
13	6.1.2	Bend	Jul-94	L,P	300–900 eV
14	6.3.1	Bend	Mar-99	P,G,A	500–2000 eV
15	6.3.2	Bend	Sep-94	P,G,A	50–1300 eV
16	7.0	U5	Feb-94	M,P	60–1200 eV
17	7.3.1	Bend	Jan-97	M,P	175–1500 eV
18	7.3.3	Bend	Mar-98	P,M	6–12 keV
19	8.0	U5	Dec-93	M,P	80–1200 eV
20	8.2.1	Sbend	Dec-01	L	5–18 keV
21	8.2.2	Sbend	Feb-02	L	5–18 keV
22	8.3.1	Sbend	Oct-01	L	2.4–18 keV
23	8.3.2	Sbend	Jan-03	L,M,G	5–60 keV
24	9.0	U10	Aug-94	M,P,C	5–800 eV
25	9.3.1	Bend	Nov-94	M,P	2.3–5.5 keV
26	9.3.2	Bend	Apr-94	M,P	30–1400 eV
27	10.0	U10	Jun-98	M,P	17–340 eV
28	10.3.1	Bend	Oct-93	P C,G	3–20 keV
29	10.3.2	Bend	Oct-94	M,G	2.3–17 keV
30	11.0	EPU5	Mar-03	C,G,L,P	75–2100 eV
31	11.3.1	Bend	Dec-01	L	6–17 keV
32	11.3.2	Bend	Oct-99	A	50–200 eV
33	12.0	U8	Dec-95	A,M,P	28–1000 eV
34	12.2.2	Sbend	Jan-05	M,G,C,A	6-40 keV
35	12.3.1	Sbend	Dec-03	L	5–18 keV

*Areas of research:

- A Applied Physics
- C Chemical Sciences
- G Geoscience and Molecular Environmental Science
- L Life Sciences
- M Materials Sciences
- P Physics

The Department of Energy (DOE) funds the operation of four major synchrotron light sources – National Synchrotron Light Source (NSLS) located at Brookhaven National Laboratory (BNL), Advanced Photon Source (APS) located at Argonne National Laboratory (ANL), SPEAR-III located at Stanford Linear Accelerator Center (SLAC), and the ALS. During 2005 all four of the DOE Synchrotron Light Sources were comprehensively reviewed by DOE Basic Energy Sciences. On June 29th, BES sent the reviewers' comments on the ALS to Director Chu together with a cover letter written by Pedro Montano, head of the BES's Scientific Facilities User Division. It was clear from the cover letter and the reviewer's comments that DOE considers the ALS one of its best facilities. It is worth noting that the end of the cover letter states:

> "In conclusion, I would like to emphasize that BES feels ALS serves as a model for how a user facility should operate. Congratulations on your outstanding achievements."

In fact it may be fair to say that the ALS is amongst the best and perhaps the premier VUV and Soft X-ray synchrotron radiation facility in the world.

Nevertheless, the series of incidents over the past months, points at the need for a serious investigation into structural, procedural and operational deficiencies to ensure the future safe and efficient operation of the ALS and the continuation of its prominent status among DOE facilities.

IV. INCIDENT 12.3.2

a. Narrative

Background:

The motivation for the installation of the 12.3.2 superbend beamline was to move the micro-diffraction beamline 7.3.3 to 12.3.2 to get higher energy x-rays and smaller spot sizes, and to re-engineer the endstation for greater stability. Some but not all components within the 7.3.3 hutch were going to be reused. The 12.3.2 front-end was already in place through the shield wall up to a Be window as this was installed at the time of the 12.3.1 front-end install. The part on the ALS experimental floor was to be at high vacuum and to end just inside a lead-lined hutch with a 2nd Be window. The pink beam was to be in the experimental hutch which is why lead-lining was required.

The Beamline Design Review for this beamline occurred on September 14, 2005, which is abnormally late in the review process since some components including the hutch were already starting to arrive. The hutch parts were scheduled to arrive on Monday September 19th. Representatives from the neighboring beamlines of CXRO (12.0), High-pressure (12.2.2), SYBILS (12.3.1) and Infrared (1.4) were also present. Plans for the installation of key components with a minimal disturbance of the neighboring beamlines are underway and were discussed. The beamline team was directed to continue working with neighboring beamlines on the installation plans for all major components and use maintenance days whenever possible.

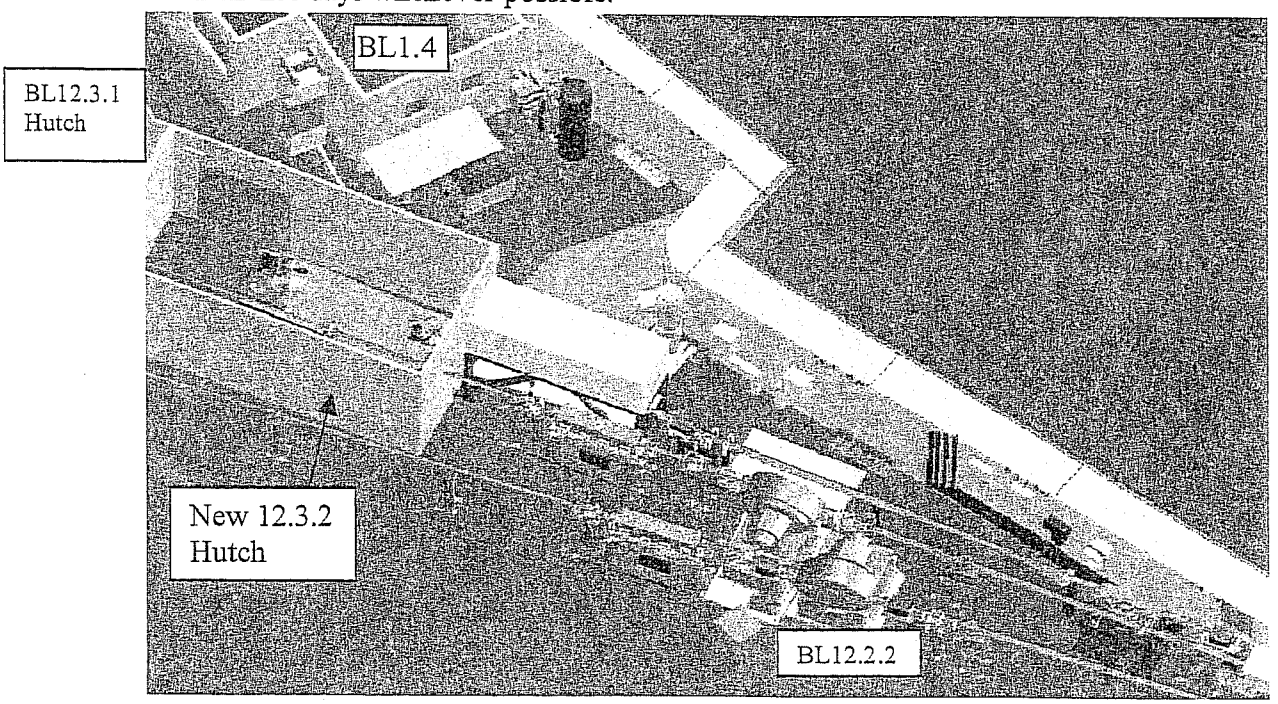


Figure 1. Overview of the designed 12.3.2 beamline showing the new lead-lined hutch to be installed.

The new beamline radiation hutch for the under construction beamline 12.3.2 was being installed on September 19 and 20, 2005. It is directly adjacent to (abutted against but not attached to) the existing and operational experimental hutch for super-bend beamline 12.3.1 (see Figure 2). The existing 12.3.1 hutch is not lead lined because this hutch is after a monochromator. The 12.3.1 hutch had a labyrinth radiation shield on the wall where the new 12.3.2 hutch was being installed. The new hutch had an appropriate hole to accommodate this labyrinth, however this labyrinth required removal to slide the new hutch panels into place, and then the labyrinth was replaced in its original position. This was an unforeseen aspect of the hutch assembly as it was not realized that the panels required being slid into the frame. As this was a shielding change, the ALS shielding change control procedure OP 02-04 had to be followed, including taking BL12.3.1 Off-Line at the Radiation Safety System (RSS) chassis before removal of the labyrinth.

To complete the new 12.3.2 hutch, the 12.3.1 labyrinth needed to be replaced with a lead lined labyrinth to ensure that when 12.3.2 was operating there would be no radiation hazard to anyone inside the 12.3.1 hutch. For this purpose, the plan was to complete a shielding change form, key-off BL 12.3.1, drill new mounting holes in the 12.3.1 hutch and install the new lead-lined labyrinth. However the need to remove the existing labyrinth at the early stages of the new hutch installation was not anticipated.

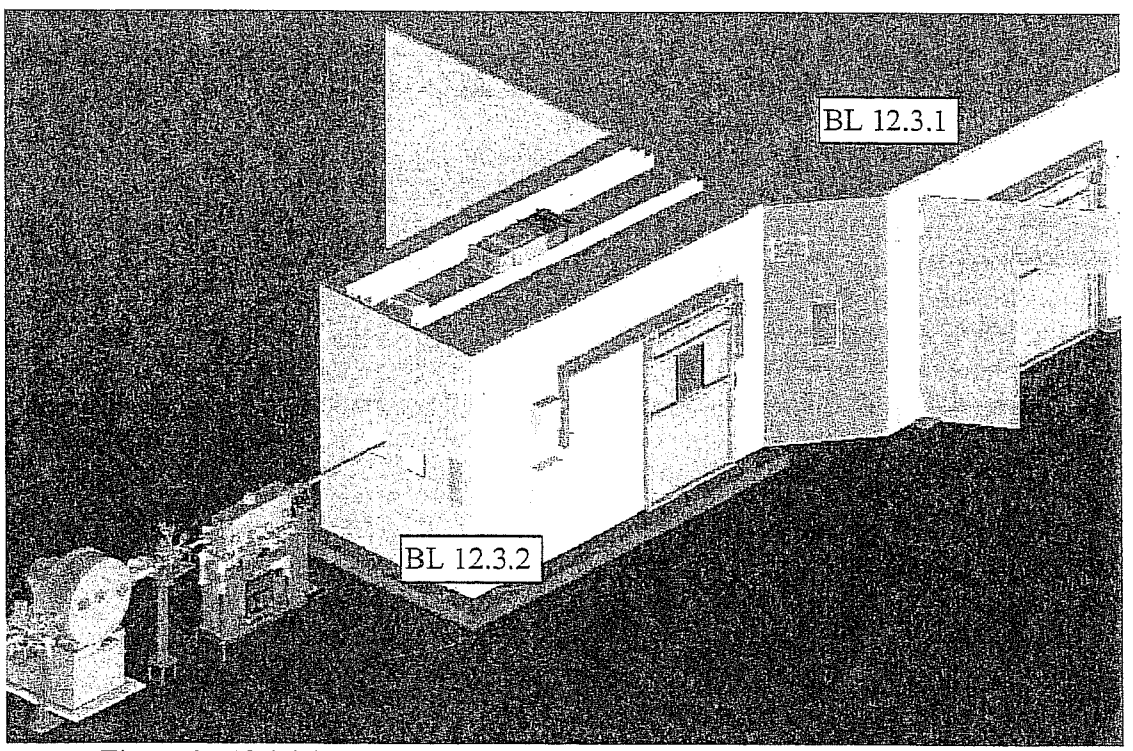


Figure 2. 12.3.2 hutch assembly details. The detailed design for the new lead-lined hutch is shown in foreground over the red section of floor. The downstream wall of this new hutch abuts, but is not attached to the existing 12.3.1 hutch.

ALS Work Permit (WP) #030 was prepared prior to this installation (Appendix D). The person in charge for the WP was an associate beam line scientist (ABLS) and the WP was written primarily by the FC and the ABLS. Sub-tasks key to this investigation which are called out in the WP are:

- All Industrial Noise Control (INC) workers trained for unescorted access to the ALS
- ALS Shielding Change form completed for removal and re-installation of labyrinth between 12.3.1 and 12.3.2 for wall install (item changed by hand on-site after it was determined the labyrinth required removal to slide on the new hutch panels. Originally this item stated that the shield change form was required for drilled mounting holes in the 12.3.1 hutch.)
- Installation of lead-lined labyrinth between 12.3.1 and 12.3.2 hutches (crossed out by hand with instructions to see note).
- Inspection of installed hutch and 12.3.1 / 12.3.2 labyrinth by the Health Physicist (HP) and/or Radiological Control Technician (RCT). ("and 12.3.1 / 12.3.2 labyrinth" crossed out by hand with instructions to see note #2.)

Complications, Risks and Safety Reminders noted on the WP:

- Any penetrations of the neighboring BL12.3.1 hutch for mounting fasteners must not compromise that hutch's radiation barrier.

Not noted on Safety Reminders: Check shielding form has been started and that 12.3.2 is Off-Line at the RSS chassis before touching the labyrinth.

This hutch installation was originally planned for Tuesday September 20th because the Person-In-Charge (PIC), the ABLS, had a long-planned vacation day on Monday September 19th. Due to concerns about floor vibrations when drilling into the ALS floor for anchoring the new hutch, it was decided to begin those installation activities that required drilling and the assistance of the riggers on Monday even though the ABLS would not be here. A mechanical designer was appointed as the technical contact in case there were any questions during the installation in the ABLS absence, and the FC would help ensure the outside contractors were briefed on the WP tasks and ALS safety requirements.

Time-line for the incident:

Monday September 19, 2005

The new hutch installation was scheduled to begin on Monday September 19, 2005. The outside contractors from INC arrived at mid-day. One contractor had previously worked at the ALS and had been trained and badged for unescorted access to the ALS floor on June 17, 2002. His badge was reactivated on September 19, 2005, but no retraining was required or done. The other contractor was not ALS trained and badged, and was escorted by the first contractor throughout this day and the following morning.

The FC met with them briefly to discuss the job and go over the WP. He then checked back on them a number of times throughout the job, but did not directly supervise. The FC commented during the interview with the RSC subcommittee that it seemed odd to stand there staring at the contractors who were working hard, so he let them do their job while he did other things and regularly checked back on them.

The goals for that day were to install the structural steel frame so that the majority of the floor drilling for anchor bolts and the use of the riggers for maneuvering the heavy steel pieces into place would be complete on this ALS maintenance day. This would minimize disturbances to sensitive neighboring beamlines as suggested by the Beamline Review Committee. This part of the job was completed that afternoon.

Tuesday September 20, 2005
INC contractors returned to continue their work. The FC again spoke with them and continued to check in on them from time to time. The wall closest to the existing 12.3.1 hutch was being assembled first.

Removal of the labyrinth may have been discussed but these details are not entirely clear. It seems that the FC was expecting that the original plan to remove the labyrinth and replace it with a lead-lined labyrinth would occur later in the installation process.

Beamline 12.3.1 was On-Line, actively taking x-ray beam in the hutch, and running some baseline flux measurements that morning. No outside users were running or present. An engineer was performing these measurements prior to adjusting some cooling water flow rates in their monochromator later that morning. For these adjustments the engineer was planning to go and get a mechanical technician (MT), take the beamline Off-Line at the RSS chassis, and have the MT make the flow-rate changes.

The lead hutch installation contractor apparently needed the labyrinth removed to allow the hutch panels to be slid into place. He went to the 12.3.1 experimental area and asked the engineer if he could enter the hutch because he needed to do some work in it. The engineer told him that he would be finished in a couple minutes and then he could go in the hutch. The engineer knew about the hutch construction going on next door and assumed the contractor needed to do something simple and didn't inquire further.

The engineer finished his data acquisition, and then opened the hutch following the normal hutch access procedure to allow the contractor in. This closed the beamline PSS, but the beamline was not taken Off-Line at the RSS chassis. The engineer then went to find the MT as that was the engineer's next step in his morning's work, so he did not observe what the contractor did inside the hutch.

The contractor entered the 12.3.1 hutch and removed the bolts holding the labyrinth. This could only be removed from inside the hutch by undoing the nuts holding the labyrinth in place.

The engineer returned with the MT some minutes later and went to the 12.3.1 mono located upstream of both hutches (shown in the Figure 3) where they starting discussing what they would need to do for water flow adjustment. The engineer says they were just talking about when to call over the Beam Line Coordinator (BLC) to key off the beamline when the engineer looked towards his hutch and saw the bright interior lights coming out of the hole where the labyrinth was. The engineer realized that the labyrinth had been removed.

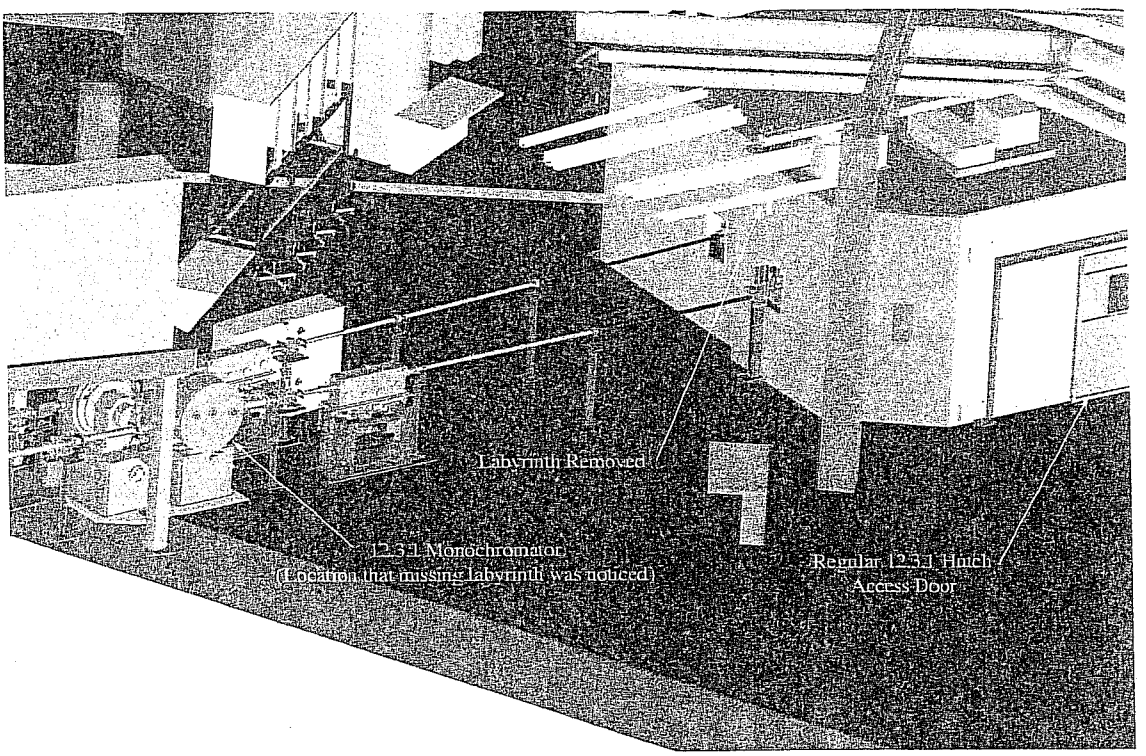


Figure 3. Layout of the 12.3.1 hutch, and the area where the 12.3.2 hutch was being installed (but no walls were yet in place as shown in the figure) upstream of the 12.3.1 hutch. The location of the 12.3.1 monochromator is noted as that is where the engineer was standing by when he noticed the missing labyrinth, also noted.

The engineer then called the Beam Line Coordinator (BLC) who came right over. The engineer says he knew the PSS was closed so there were no x-rays and therefore no immediate threat. The BLC spoke briefly with the INC contractors and then called the Radiation Control Technician (RCT) and with the RCT's concurrence took the beamline Off-Line at the RSS chassis. The ALS data archiver shows the beamline RSS went Off-Line between 9:27 and 9:30am. The RCT arrived with the HP. The RCT then started a shielding change form, and found the PIC in his office to tell him what happened.

When the PIC arrived on the scene roughly around 10:00 am, the labyrinth was still removed, and the two new hutch panels that needed installing where the labyrinth goes were still not in place. The contractors continued installing those panels, including some on-site minor modifications to ensure a proper fit both together and around the labyrinth.

After these new 12.3.2 hutch panels were installed, the original labyrinth was reinstalled either by the INC contractors or by another member of the ALS Mechanical staff. (The PIC signed as the person completing the work on the shielding change form, Appendix E, however he states that he was just in charge of the work then and wasn't sure exactly who re-installed the labyrinth). The RCT verified this installation, and then completed a radiation survey to close out the shielding change form. Beamline 12.3.1 was then key-enabled and put back On-Line at the RSS chassis between 2:00 and 2:03 PM.

At approximately 11AM, the FC brought the second INC contractor to the User Services Office to do his ALS safety training and badging for unescorted access to the ALS floor. The second contractor completed this training and his new badge was activated at 11:57 AM on 9-20-05. After this was complete, the 2nd task on the WP was initialed as complete stating that all INC personnel have been trained for unescorted access to the ALS.

ALS management was informed of the situation at some point this morning as well. The Deputy Division Director (DDD) asked the FC to investigate and summarize the incident which he did the following day.

The 12.3.2 hutch installation then continued for the next several days with no further radiation-related incidents, and 12.3.1 continued its normal operations. The last badge access into the ALS by the second contractor was on 9-22-05 at 11:55AM, and by the first contractor was on 9-22-05 at 11:59AM.

The WP was officially signed as closed out by the PIC on 9-26-05 at 9:15am.

b. Root Cause Analysis

1. Time line with causal factors (indicated in red) and incident (indicated in red, underlined and labeled [incident])

1. Beamline Design Review (BDR) of 12.3.2 – 9/14/2005, 13:00
    a. Attended by Fac. Coord.(FC), 2.3.2 beamline scientist (BLS)-presenter, associate BL scientist – Person in Charge (PIC), neighboring beamline scientists or engineer (4 beamlines), HP, RCT, BLC, Deputy Division Director, ALS EH&S, and the rest of the full beam review committee (mandatory).
    b. BDR was late – major items already purchased and arriving, including hutch.
    c. Budgetary constraints
    d. Discussion of impact on neighboring beamlines. Directed to use ALS Maintenance days when drilling & creating vibrations.
    e. Several of the key people involved in the incident left the meeting with the impression that the 12.3.1 hutch integrity would not be compromised (i.e.,

no shielding changes) and that there will be close supervision, due to the assurances to that effect given by several of the beamline team members.

f. Directed to work with neighboring beamlines on installation plans.

2. Hutch installation starts on Monday to be coincident with maintenance day.
   a. Contractor confirmed by e-mail to PIC on 9/13/05 that they would start at noon on 9/19.
3. Work permit (WP) #030 issued – 9/15/2005
   a. Written by FC and PIC only.
   b. Called for an ALS Shielding Change Form (SCF) for drilled mounting holes in the 12.3.1 hutch.
   c. Called for installation of lead-lined labyrinth between 12.3.1 and 12.3.2.
   d. Called for inspection of installed hutch and 12.3.1 / 12.3.2 labyrinth by HP and/or RCT
   e. Complications & reminders list that any penetrations of the neighboring BL12.3.1 hutch for mounting fasteners must not compromise that hutch's radiation barrier.
      i. Attendees at BDR were assured that the new hutch was free-standing requiring no drilling into the 12.3.1 hutch
   f. WP demonstrates inadequate preparation
4. Person in charge (PIC) on vacation – 9/19/2005
   a. Alternate technical contact is a Designer
   b. Unclear if FC becomes default PIC.
5. Hutch components arrive at the ALS 9/19/05
6. 12.3.1 replacement lead-lined labyrinth is not ready. (Realized either 9/19 – RCT's recollection, or later 9/20, PIC's recollection)
   a. Should have changed WP
   b. No longer should need shielding change form for switching labyrinth to a lead-lined one.
7. Contractors (two) arrive – 9/19/2005 (Badged contractor makes ALS badged entry at 1249)
   a. One contractor ALS trained and badged from a previous job in June 2002.
8. Facility coordinator (FC) meets with contractors – 9/19/2005
   a. FC discusses work permit with contractors
   b. Second contractor not ALS trained and badged, but was escorted
      i. OK for ALS access policy, but
      ii. Violates work permit
      iii. Demonstrates that WP does not need to be exactly followed
9. Contractors install frame, floor drilling done by ALS staff – 9/19/2005
10. FC does not continuously supervise contractors (FC ALS badge entries at 1228, 1308, 1309, 1345, 1402, 1456, 1508, 1631, and 1654)
    a. FC Position was recently created
    b. FC Position not well defined
    c. FC recently appointed
    d. FC and PIC roles for oversight duties not clearly defined
    e. WP does not require constant supervision

11. Alternate PIC (technical contact) does not continuously supervise contractors (Alternate's ALS badge entries at 1054, 1112, 1259, and 1409)
    a. **WP does not require constant supervision**
12. Beam to users at 00:00 AM– 9/20/2005
13. Contractors return to job site – 9/20/2005 (Contractor ALS badge entry at 0730)
14. BL engineer using beam in adjacent hutch 12.3.1-9/20/2005 (First ALS badge entry for BL scientist is 0837.
    a. No users. Beamline tests and adjustments being made this morning.
15. FC meets with contractors – 9/20/2005
    a. FC badge entry at 0822, and arrives at work site at 0823. FC therefore arrived at ALS 52 minutes after contractors arrived. FC leaves work area at 0832.
    b. FC states he anticipated shield change form would be needed only significantly later when replacing labyrinth with lead-lined labyrinth.
16. FC does not continuously supervise contractors (FC ALS badge entries at 0822, 0907, 1006, 1022, and 1254).
    a. See #12 for conditions
    b. **WP does not require constant supervision**
17. Alternate PIC (technical contact) does not continuously supervise contractors (Alternate's sole ALS badge entry for 9/20 at 0829, and arrives at work site at 0829, and leaves at 0834.)
    a. **WP does not require constant supervision**
18. Contractor decides access is needed in 12.3.1 hutch – 0841 9/20/2005
    a. **Work permit does not list this as an action item**
    b. New hutch wall pieces need to be slid into place.
    c. Labyrinth is in the way of this sliding motion
    d. No contact between Contractor and PIC or FC
        i. **Work permit does not require him to consult with PIC or FC**
        ii. Contractor is not responsible for shielding change procedures
19. Contractor asks 12.3.1 BL engineer for access to 12.3.1 hutch- 0842 9/20/2005
    a. 12.3.1 BL engineer does not ask reason why.
        i. Knew contractors were doing work on new hutch next door
        ii. Trusted BDR meeting which said that 12.3.1 hutch would not be violated.
        iii. **Assumes contractor knows what he's doing**
    b. Badged contractor is the one who asks to enter
20. 12.3.1 BL engineer completes data scan
    a. Only had a minute or two left of rocking curve scan
21. 12.3.1 BL engineer opens 12.3.1 hutch *(exact time not logged)*
    a. This keys off the hutch, and closes the PSS
    b. Hutch safe to enter
    c. Beamline still On-Line at RSS chassis
22. 12.3.1. BL engineer allows contractor to enter 0843
    a. Does not watch what contractor is doing
    b. **Assumes contractor knows what he's doing**
23. 12.3.1 BL engineer leaves area to find technical support for 12.3.1 operation 0843

24. Contractor enters 12.3.1 hutch 0843
25. Contractors remove labyrinth in hutch 0844 [Incident]
    a. Violates ALS shielding removal policy
        i. Required shield change form not done
        ii. Required that beamline keyed Off-Line not done
    b. Violates WP
    c. No supervisor present
26. Contractor leaves 12.3.1 Hutch 0848
27. 12.3.1 BL engineer returns with technician to work on monochromator (ALS badge entry by BL engineer through Hibay door at 0845)
    a. Planning to adjust water flow to a monochromator crystal
28. 12.3.1. BL engineer and technician discuss taking beamline Off-Line for mono work
29. 12.3.1 BL engineer observes light coming through opening in 12.3.1 hutch where labyrinth is supposed to be. 0856
    a. Realizes that the labyrinth has been removed.
30. 12.3.1 BL engineer calls Beam Line Coordinator (BLC).
31. BLC comes to 12.3.1 (arrives at 0902)
32. BLC talks to contractor 0902
33. BLC calls RCT
34. BLC and FC come to 12.3.1 at 0907
35. RCT and HP come to 12.3.1 (ALS Badge entry by both RCT and HP at 0924, and arrive at BL at 0924)
36. BLC takes beamline offline
    a. ALS Data Logger shows PSS Run Permit is off between 0927 and 0930.
37. RCT initiates Shielding Change Form
38. RCT goes to PIC's office to inform him about incident
39. PIC arrives at scene (ALS badge entry by PIC at 1019, and arrives at BL at 1019)
40. Deputy Division Director informed
41. Hutch construction proceeds
42. FC takes unbadged contractor to ALS user services office for training and badging at ~11:00 AM
43. Once abutting hutch panels are in place, original labyrinth is replaced 1125.
44. Second contractor badged at 11:57 AM
45. 12.3.1 Key-enabled On-Line again by BLC supervisor.
    a. ALS Data Logger shows PSS Run Permit returns between 1400 and 1403.
46. RCT performs rad survey of 12.3.1 labyrinth 1403 – 1418.
47. Division Deputy asks FC coordinator to investigate
48. FC submits summary "chronology" (dated 9-21-05) to Division Deputy.
    a. Basic chronology of events
    b. Recommendations from FC and ALS ES&H Manager (dated 10-18-2005)
    c. Not a thorough investigation and analysis.
49. Contractor work completes 9-22-05.
    a. Last badge access to ALS by two contractors was 11:55AM and 11:59AM on 9-22-05.
50. WP signed as closed by PIC on 9-26-05 at 0915.

2. Root cause tree analysis (Text in italics is RSC subcommittee explanation for the specific choice in root cause path)

10 f, 11 a,16 b, 17 a: Work permit does not require continuous supervision of contractors

- Human Performance Difficulty
  - Was a person excessively fatigued, impaired, upset, bored, distracted or overwhelmed? – *FC did not see need to supervise*
  - HUMAN ENGINEERING
    - Knowledge-based decision required – *Needed knowledgeable person supervising to help decide when something unexpected came up.*
  - WORK DIRECTION
    - Work Permit NI – *Work permit inadequately defined roles, responsibilities*
    - Pre-job briefing NI – *FC's briefing with contractors did not define stop points, need to ask knowledgeable person if anything unexpected came up.*
    - No supervision – *FC position not well supervised. No clear responsibilities defined or enforced. FC did not supervise contractors.*
    - Not qualified – *FC not qualified for position, does not understand its importance; does not take ownership of facility and its safety.*
  - Should the person have used a written procedure but did not? – *FC should have used Work Permit to better define scope, responsibilities, limits, and detailed order of job. FC should have strictly followed Work Permit*
    - WORK DIRECTION
      - Work Permit NI – *WP not well defined, needs much improvement.*
      - Not Qualified – *FC did not believe in WP system as appropriate approach*
      - No supervision – *FC not adequately supervised as evidenced by the lack of an adequate WP after over a year on the job.*
    - PROCEDURES
      - Procedure not required but should be – *Following WP procedure, and other ALS procedures it references was not required. WP was instead just used as an optional reminder.*
      - Facts wrong – *WP listed incorrect items, were not changed to reflect reality.*
      - No checkoff – *Initialing on WP was not enforced.*
      - Checkoff misused – *Steps were skipped, implying contractor could skip a critical step.*

- Situation not covered – *Removal of 12.3.1 labyrinth was not expected at this point in the job. Contractor at this point should have been required to stop and ask.*
- Limits NI – *WP needs stop points for any critical steps such as starting a shielding change form.*
- Second checker needed – *Having someone who checks that critical steps have been done before proceeding would have caught this.*

- HUMAN ENGINEERING
  - Knowledge-based decision required – *WP should have required contacting FC and/or PIC whenever a deviation from the plan occurred, or a stop-point was reached.*

18 a: Work permit does not list this as an action item
18 d i: Work permit does not require contractor to consult with PIC or FC

- Human Performance Difficulty
  - Did failure to agree about the who/what/when/where of performing the job play a role in this problem – *Yes*
    - TRAINING
    - COMMUNICATIONS
      - No comm. or not timely
      - Turnover NI
        - No standard turnover process
    - WORK DIRECTION
      - Work Permit NI – *Work permit inadequately defined roles, responsibilities*
      - Pre-job briefing NI – *FC's briefing with contractors did not define stop points, need to ask knowledgeable person if anything unexpected came up.*
      - Walk-thru NI
      - No supervision – *No clear responsibilities defined or enforced. FC did not supervise contractors.*
      - Not qualified – *Contractor works without knowledgeable person on shielding. WP does not require all contractors to be pre-qualified (e.g. only one was badged).*
  - Were policies, admin. controls, or procedures not used or missing, or in need of improvement?
    - MANAGEMENT SYSTEM
      - SPAC NI (SPAC=Standards, Policies and Administrative Controls)
        - Confusing or incomplete
      - SPAC not used
        - Enforcement NI
        - Accountability NI

- Oversight/Employee Relations
  - Infrequent audits and evaluations
  - Employee feedback NI
- Corrective action
  - Corrective action not yet implemented –*PIT report was never properly implemented*

- PROCEDURES
  - Procedure not required but should be – *Following the WP procedure, and other ALS procedures it references, was not required. WP was instead just used as an optional reminder.*
  - Facts wrong – *WP listed incorrect items, were not changed to reflect reality.*
  - No checkoff – *Initialing on WP was not enforced.*
  - Checkoff misused – *Steps were skipped, implying contractor could skip a critical step.*
  - Situation not covered – *Removal of 12.3.1 labyrinth was not expected at this point in the job. Contractor at this point should have been required to stop and ask.*
  - Limits NI – *WP needs stop points for any critical steps such as starting a shielding change form.*
  - Second checker needed – *Having someone who checks that critical steps have been done before proceeding would have caught this.*
  -

19 a iii, 22 b: BL engineer assumes contractor knows what he's doing

- Did the person need more skill/knowledge to perform the job or to respond to conditions or to understand system response? Were policies, admin. controls, or procedures not used or missing, or in need of improvement?
  - TRAINING
    - No training
      - Task not analyzed-*BL engineer was not included in preparing the job and is not expected to be a watch dog for contractor work at the beamline*
      - Decided not to train – *FC did not ensure training for the contractor in the importance of the shielding controls.*
  - WORK DIRECTION
    - Preparation
      - Work package permit NI
      - Pre-job briefing NI
      - Walk thru NI – *No introduction of contractors to BL engineer*

- Was communication needed across organizational boundaries or with other facilities required

- COMMUNICATIONS
  - Misunderstood verbal comm..-*Between BL engineer and planners and between BL engineer and contractors. Planners had told BL engineer not to worry, that there would always be supervision.*
  - Standard terminology not used

3. Root cause summary table

Causal Factor	Paths through Root Cause Tree
10 f, 11 a, 16 b, 17 a Work permit does not require continuous supervision of contractors. 18 a Work permit does not list this as an action item 18 d_i Work permit does not require contractor to consult with PIC or FC.	• Knowledge-based decision required – • Work Permit NI (NI=needs improvement) • Pre-job briefing NI • No supervision • Not qualified • Procedure not required but should be – • Facts wrong • No checkoff • Checkoff misused • Situation not covered • Limits NI • Second checker needed • Enforcement NI • Accountability NI • Infrequent audits and evaluations • Employee feedback NI • Corrective action not yet implemented
19 a_iii, 22b BL Engineer assumes contractor knows what he's doing	• Task not analyzed • Decided not to train • Work package permit NI • Pre-job briefing NI • Walk thru NI • Misunderstood verbal comm. • Standard terminology not used

V. INCIDENT 4.2.2

a. Narrative

The incident at Beamline 4.2.2 involved removing shielding from the monochromator (mono) enclosure with the beamline key-enabled. BL 4.2.2 is a superbend hard X-Ray beamline, built and operated by the Molecular Biology Consortium, for molecular structural biology research. The Beamline Scientist and Associate Beamline Scientists working at the beamline are LBNL visitors.

In the beamline front-end area, a 4.5 mrad vertically deflecting mirror and aperture pair allow only pink reflected light to enter the beamline downstream of the storage ring shield wall. The section of beamline from the shield wall to, and including, the mono is considered the pink light section. Downstream of the mono is a second mirror, followed by a mini hutch. The pink light section is shielded with 2 mm lead. Downstream of the pink light section, the light is monochromatic; the stainless steel vacuum system and mini hutch enclosure provide adequate shielding in this section.

The lead-lined mono enclosure (Fig. 1) has 16 panels that can be opened / removed for access to the mono chamber and other components. Most of the larger panels are hinged, due to their weight, and are swung open for access; smaller panels are lifted out. All of the panels are secured in place with tamper-proof screws, and removal of a panel requires the special tamper proof screw removal (TPSR) tool. The TPSR tool is locked in the control room key cabinet and only an Accelerator Operator (OP) can issue it.

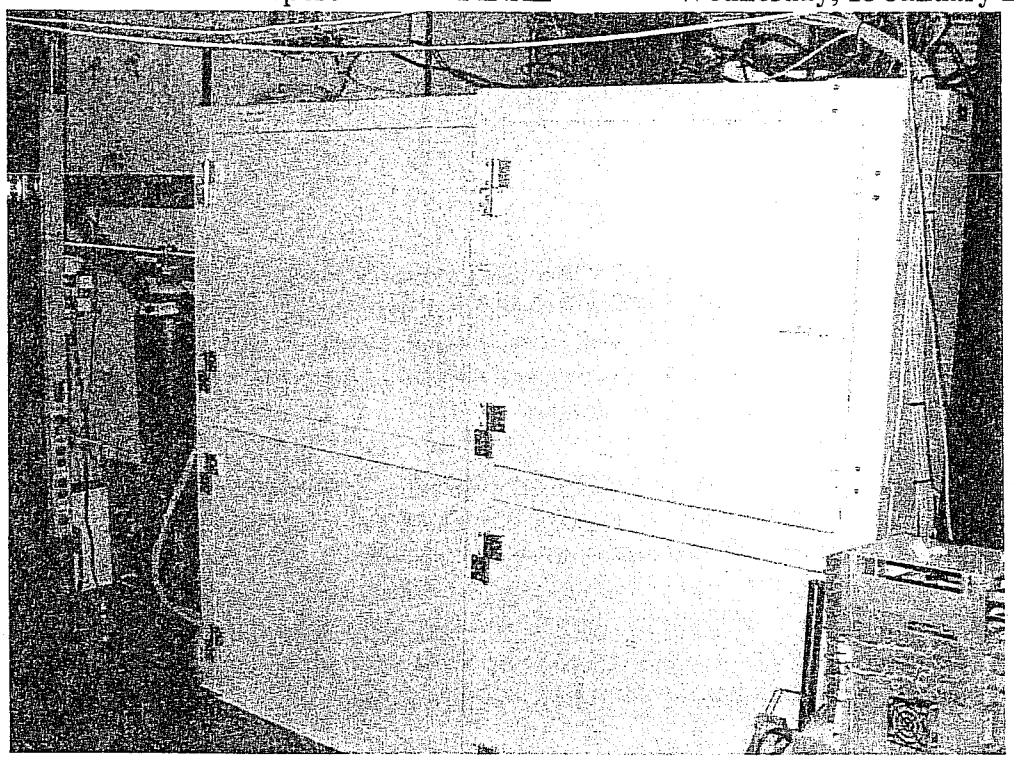


Figure 1. Side view of monochromator enclosure showing four hinged panels

When the TPSR tool is requested, the common practice is for the Beam Line Coordinator (BLC) and/or the requestor to initiate a Shielding Change form. The BLC then keys the beamline Off-Line and signs the form certifying it is Off-Line. The TPSR tool is then issued provided the requestor is on the list of individuals trained to use the tool (per ALS procedure BL 08-24). If a BLC is not available, an OP that has had the required training can act as the BLC when the TPSR tool is issued.

Inside the mono vacuum chamber are seven servomotors that adjust tilt, yaw, twist, bend and displacement of the monochromator crystals. On Saturday, 15 Oct 05 at 3:05 pm, a building power-dip caused a motor encoder to lose "homing". A move command was then sent to the motor that sent it beyond the range of allowable adjustment and a hard stop was hit. To get the device off of the hard stop, the mono chamber had to be opened and some of the hardware dismantled.

After the power-dip the ABLS, who had been exposing samples at the beamline, phoned the BLS and explained the problem with the monochromator. The BLS decided that the beamline should be "turned off" until the next morning, Sunday, Oct. 16 when he would come in to work on the mono.

The first of three Accelerator Physics shifts started Sunday at 8:18 am. During physics shifts, the Run / Fill chassis in the control room is kept in the Fill mode which inhibits beamline Personal Safety Shutters (PSS) from opening. There is, however, nothing to prevent this chassis from being put in the Run mode at any time, which would then allow

the shutter to be opened by the users. Accelerator Physics studies continued until approximately 6:30 am Monday, Oct. 17, when the storage ring and injection system were shutdown for maintenance.

When the BLS arrived at the beamline Sunday morning Oct. 16, he observed through the branch-line Equipment Protection System (EPS) that PSS 201, the PSS for BL 4.2.2, was closed. Since the PSS was closed, he assumed the beamline had been taken Off-Line at the Radiation Safety System (RSS) chassis, although he did not actually check the beamline status at the RSS chassis or discuss with the ABLS on the phone the day before whether it would be taken Off-Line. The BLS then closed the vacuum gate valves upstream and downstream of the mono, vented it, and went to the control room to sign-out the TPSR tool to open the shielded mono enclosure. Synchrotron light in this beamline can damage a vacuum valve, so the EPS interlocks inhibit the PSS from opening if a valve is closed.

The OP on duty in the control room, signed out the TPSR tool to the BLS at 9:22 am Sunday. The OP did not ask what the tool would be used for, check if the beamline was offline at the RSS chassis, or check if an active shielding change form for BL 4.2.2 was filed in the log. The OP assumed the BLS knew the procedure to follow due to the frequency that BL 4.2.2 staff sign-out the TPSR tool (19 times in previous 12 months). The OP also indicated that if someone unfamiliar had requested the tool, the OP would have asked what they intended to do with it.

When the mono shielding enclosure was approved during the review process by the health physicist responsible for shielding design, it was not expected that the mono would require frequent access. Had this been anticipated, engineering controls, rather than administrative controls, would have been implemented for accessing the mono.

The BLS did not request the assistance of a BLC when he asked for the TPSR tool, so the OP did not feel they were acting as a BLC when issuing the tool. The OP acted under the assumption that it is the user's role to ask for BLC assistance when it is required.

The TPSR tool can only be issued to individuals trained in ALS beamline procedure BL 08-24 (Beamline Mini-Hutch Maintenance Access Procedure) by a BLC. One section of the procedure deals with the removal of fixed panels from mini hutches, which requires use of the TPSR tool. A list of individuals trained in BL 08-24 is posted in the key locker in the control room, and training is verified before the TPSR tool is issued by checking the list. BL 4.2.2 has a mini hutch, and the ABLS and BLS were trained in the procedure. The OP was also trained in the procedure.

While investigating this incident it was discovered that BL 08-24 was not the applicable procedure for opening the mono enclosure. The procedure that should have been invoked is BL 08-25 (Policy and Guidelines for Installation and Control of Beamline Radiation Safety Security Devices). The tamper-proof screws that secure the mono enclosure panels are considered Radiation Safety Security Devices (RSSD). BL 08-24 makes no mention of the BL 4.2.2 mono enclosure and it should not have been used to access the

mono. However, this mono enclosure and mini hutch panels are similar, have identical tamper proof screws, and the same steps are followed to remove a panel on both enclosures. Had BL 08-25 been followed, the BLC would have gone to the beamline with the TPSR tool and been responsible for it while the mono enclosure panels were being removed or replaced. BL 08-24 allows the tool to be issued to a trained individual by a BLC.

Work inside the mono chamber was finished Sunday, Oct. 16. A turbo pump was then connected to the chamber and the vacuum roughed-down until the next morning, Monday, Oct 17. While the turbo pump is connected, the vacuum line from the pump to the mono chamber blocks one of the mono enclosure shielding panels from closing.

Monday was a scheduled maintenance shift and shutdown of the accelerators started at approximately 6:30 am. Beam was not available again for users until 9:30 pm Monday evening.

Monday morning, the turbo pump on the BL 4.2.2 mono chamber was secured and the ion pump turned on. At 11:08 am the BLS signed-out the TPSR tool to secure the mono enclosure panels. By 11:51 am, all of the panels were secured in place and the TPSR tool returned to the control room. When the BLS signed-out the TPSR tool that morning, he said that the OP on duty in the control room did not ask how he would use the tool. The OP stated, however, that he asked the BLS if a shielding change form had been filed and the BLS indicated that it had. The OP did not verify that a shielding change form was in the log or check if BL 4.2.2 was keyed-off at the RSS chassis.

Tuesday morning, Oct. 18, the BLS opened the vacuum gate valves upstream and downstream of the mono chamber. Once this was done, the EPS interlocks no longer inhibited the beamline shutter from opening. At approximately 8:00 am, the BLS contacted the BLC to key-enable BL 4.2.2. When the BLC arrived at the beamline to start the key-enable process, he found that the RSS chassis was already On-Line. The BLC quickly verified that the mono enclosure panels were properly installed and then took the beamline Off-Line at the RSS chassis. At approximately 8:15 am, the BLC notified ALS management of the incident. Following management notification, the BLC filled out a shielding change form (Appendix J) and did the complete beamline key-enable procedure. At 8:27 am, the BL 4.2.2 PSS was opened.

The open/closed status of the BL 4.2.2 PSS was reviewed in the archived data for the period bracketing the time the TPSR tool was first issued (9:22 am Sun., Oct.16), up to the completion of the key-enable procedure (8:27 am Tues., Oct. 18). The accelerator control system archives the status of approximately 20,000 channels at three minute intervals. Data from the archiver shows that BL 4.2.2 PSS 201 was closed at 7:27 pm Sat., 15 Oct 05 and not opened again until 8:27 am Tues, 18 Oct 05. Note that there is an uncertainty of up to three minutes in the time of any event logged in the archiver. In addition, transient events that occur during the three minute interval between archiver updates go unrecorded.

As an interim measure following the incident, a new log was implemented for issuing the TPSR tool and RSSD keys. A sign-off in the log by the OP certifies that a shielding change form is filed and the beamline is Off-Line at the RSS chassis before the tool or key is issued.

b. Root cause analysis

1. Time line with causal factors (indicated in red) and incident (indicated in red, underlined and labeled [incident])

1. Associate Beam Line Scientist (ABLS) taking data on Beamline 4.2.2 – 10/15/2005 (Saturday)
2. Building power dip occurs at 1505 – 10/15/2005
3. Motor encoder(s) inside 4.2.2. mono-enclosure looses "homing".
    a. Move command sent that is beyond range of allowable adjustment of mono crystal and hard stop hit.
4. The ABLS phones the BLS to explain problem with the mono-chromator.
5. The BLS decides mono-enclosure needs to be accessed to fix the motor problem
    a. **Motor hitting hard stop is an unrecoverable event w/o accessing mono-enclosure**
    b. The BLS informs the ABLS that he plans to come next day to deal with problem
    c. The BLS did not discuss with the ABLS on the phone the day before, if PSS would be taken Off-Line.
6. Electronic archiver shows BL 4.2.2 PSS 201 was closed at 1927, 10/15/2005
7. First of three Accelerator Physics shifts begin- 10/16/2005, 0818
    a. Run/Fill chassis in control room put in the Fill mode for physics shifts
    b. Beamline Personnel Safety Shutters (PSS) inhibited from opening.
8. The BLS arrives at ALS to work on mono – 10/16/2005, 0905
9. The BLS arrives at beamline
10. The BLS observes through branch-line Equipment Protection System (EPS) that BL 4.2.2 PSS 201 is closed.
    a. **The BLS assumes beamline is Off-Line at Radiation Safety System (RSS) chassis and that hence shielding change form is in place**
11. The BLS closed the vacuum gate valves upstream and downstream of the mono and vented the mono
    a. Synchrotron light in this beamline can damage a vacuum valve, so EPS interlocks inhibit shutter from opening if a vacuum valve is closed.
    b. It is ALS policy that EPS cannot be relied upon for personnel safety.
12. The BLS went to the control room to sign-out the TPSR tool to open the shielded mono enclosure.
    a. No full time BLC available
    b. Operator on duty can act as BLC with appropriate training
13. The OP on duty in the control room receives the request for the TPSR tool from the BLS

a. It was not clear to the OP what roles and responsibilities the OP was fulfilling when the BLS asked for the TPSR tool
    i. The OP acted under the assumption that it was the user's role to request BLC assistance when it is required.

14. The OP checks out TPSR tool to the BLS - 10/16/2005, 0922
    a. The OP knew the BLS was on the TPSR tool list in control room to receive the TPSR tool
    b. TPSR tool list lists the individuals trained in procedure BL 08-24, (Beamline Mini-Hutch Maintenance Access Procedure)
    c. The list also states "ALS Staff and Users trained in BL 08-24 — able to check out tamper proof screw tool" which contradicts BL 08-24
        i. Only BLCs can check out TPSR tool per BL 08-24
        ii. After BLC takes beamline Off-Line, BLC can hand tool to user
        iii. The note in procedure OP11-01, Section 5, "*Other keys and tamper-proof screw tools can only be issued to persons trained in the appropriate procedures; contact the Procedure Center Manager at Ext. 7723 if necessary.)*" does not specifically require OP checking if a shielding change form is in place
        iv. In effect, the operator issues the TPSR tool to self and then (as a BLC) signs out the tool to the BLS
    d. The BLS did not request the assistance of a BLC when he asked for TPSR tool
        i. The BLS was trained in BL 08-24
    e. The OP did not check if the beamline was Off-Line at the RSS chassis
        i. Violates procedures BL 08-24, BL 08-25 and OP 02-04
        ii. The OP was trained in all three procedures
    f. The OP did not check if an active shielding change form for BL 4.2.2 was filed in the log.
        i. Violates procedures BL 08-24, BL 08-25 and OP 02-04.
    g. The OP assumes the BLS knew the procedure to follow due to frequency TPSR tool was requested
        i. This assumption leads to the assumption that shielding change form was filled out for 4.2.2.
    h. Shielding change form is physically not located in same place as TPSR tool
    i. BL 08-24 is common procedure for accessing BL 4.2.2 mini-hutch
    j. BL 08-24 not applicable procedure for opening mono enclosure.
        i. Removal of mono enclosure panels requires TPSR tool that was not properly controlled.
    k. However, BL 08-24 was used 18 times for accessing mono-enclosure and 1 time for mini-hutch on 4.2.2 during the previous 12 months
    l. The tamper-proof screws that secure mono enclosure panels are considered Radiation Safety Security Devices (RSSD) requiring the use of BL 08-25 (Policy and Guidelines for Installation and Control of Beamline Radiation Safety Security Devices).

m. BL 08-25 allows only BLC, Vac. Tech supervisor or the RCT to take the TPSR tool to the beamline and BL 08-25 designates them as being responsible for tool, panel removal and reinstallation
n. The BLS had requested and received the tool 6 times before during the previous 12 months. The OP had given this BLS the tool 1 time on 08/19/2005
o. 4.2.2 users signed out TPSR tool 19 times in previous 12 months

15. The BLS opens mono-enclosure hinged panel(s). 10/16/2005 [incident]
16. TPSR tool returned to OP at 1014, 10/16/2005
17. Work completed inside the mono chamber. 10/16/2005
    a. Turbo pump connected to mono chamber
    b. Vacuum line from the pump to the mono chamber blocks one mono panel from closing leaving shielding incomplete
18. The BLS leaves ALS to go home
19. Mono vacuum roughed-down until Monday morning, 10/17/2005.
20. Accelerator Physics studies ends and maintenance shutdown starts Monday, 10/17/2005, 0630
21. The BLS returns to ALS - 10/17/2005, 0934
22. The BLS removes roughing pump hose from mono chamber allowing enclosure to be closed, ion pump turned on – 10/17/2005, morning
23. The BLS signs-out the TPSR tool to secure mono panels – 10/17/2005,1108 am
    a. OP on duty in the control room, per BLS does not ask how tool will be used.
    b. OP reported to committee that he did ask BLS if shielding change form was in place and BLS indicated that there was one
    c. Issues listed under 13,14 apply
24. All mono panels secured in place and TPSR tool returned to control room. 10/17/2005 11:51
25. Shutters are placed under user control, beam available again for users – 10/17/2005, 2130
26. BLS opened the vacuum gate valves upstream and downstream of the mono chamber - 10/18/2005
    a. With vacuum valves open, EPS interlocks no longer inhibit beamline shutter from opening.
27. BLS contacts BLC to key-enable BL 4.2.2. – 10/18/2005, ~0800
28. BLC arrived at beamline to start key-enable process
    a. Checked beamline log book and control room log book and found no entries
    b. Fails to recognize that there should have been an entry if beamline had been correctly taken Off-Line
29. BLC checks vacuum which is slightly out of specification range
    a. Doing this first allows BLC to provide vacuum techs advanced warning in case of vacuum system trouble
    b. Vacuum monitor is located near RSS chassis
30. BLC notices that RSS chassis is enabled.
31. BLC rechecks with BLS what is going on
32. BLS describes mono-enclosure access
33. BLC verifies mono enclosure panels are properly installed.

34. BLC takes beamline Off-Line – 10/18/2005, ~0800
35. BLC tells DDD of incident – 10/18/2005, ~0815
36. BLC fills out shielding change form with BLS
    a. There is a late entry procedure for entries in log books after the fact
37. BLC performs complete key-enable procedure.
38. BL 4.2.2 is key enabled and shutter is opened by BLC – 10/18/2005, 0827

2. Root Cause Tree Analysis (Text in italics is RSC subcommittee explanation for the specific choice in root cause path)

5a. Motor hitting hard stop is an unrecoverable event w/o accessing mono-enclosure

- EQUIPMENT DIFFICULTY
  - DESIGN
    - DESIGN SPECS
      - Problem Not Anticipated
        - Equipment environment not considered.
      - Had management been warned of this problem or had is happened before?
        – *Yes, ABLS had warned BLS of repeated problems requiring access.*
        - Specs NI
        -- No equipment design specifications for equipment located inside shielding.
  - REPEAT FAILURE
    - MANAGEMENT SYSTEM
      - Corrective Action
        - Trending NI
        -- ALS management needs to implement trending to spot repeated shielding access that might be reduced by an equipment modification or procedural change.

- HUMAN PERFORMANCE DIFFICULTY
  - MANAGEMENT SYSTEM
    - Had management been warned of this problem or had it happened before
      - MANAGEMENT SYSTEM
        - SPAC NI
          - No SPAC
          -- No ALS standard policy for how robust a system has to be if it is located within shielding.
        - Oversight/Employee Relations
          - Infrequent audits & evaluations
          -- No ongoing audits of shielding access and use once it is on the floor of the ALS.

10a. BLS assumes beamline is Off-Line at Radiation Safety System (RSS) chassis and that hence shielding change form is in place

- HUMAN PERFORMANCE DIFFICULTY
  - Individual Performance
    - Were alarms or displays to recognize or to respond to a condition unavailable or misunderstood?
      - HUMAN ENGINEERING
        - Human – Machine interface

- Displays NI
  -- *BLS could not easily observe the status of his beamline from where he was working.*
- Team Performance
  - Did verbal communications or shift change play a role in this problem?
    - COMMUNICATION
      - Turnover NI
        - No standard turn over process
        -- *No communication between ABLS and BLS about the status of the beamline.*

13a, 22c. It was not clear to OP what roles and responsibilities the OP was fulfilling when BLS asked for the TPSR tool

- HUMAN PERFORMANCE DIFFICULTY
  - Team Performance
    - Did failure to agree about the who/what/when/where of performing the job play a role in this problem.
      - PROCEDURE
        - Not Used / Not Followed
          - No procedure
          -- *Not clear if or when OP becomes BLC.*
  - Management System
    - Was a task performed in a hurry or a short cut used? *(tpsr tool checkout list)*
      - Management System
        - SPAC NI
          - confusing or incomplete
          -- *The use of procedure (BL-08-24)was replaced by list in the control room stating "ALS Staff and Users trained in BL 08-24 — able to check out tamper proof screw tool". This practice violates the procedure-many people who are not a MT/BLS are on the list.*
    - Had management been warned of this problem or had it happened before?
      - Management System
        - SPAC NI
          - confusing or incomplete
          -- *OP giving the TPSR tool to beamline scientist had happened before; it became standard practice.*
    - Were policies, admin. controls, or procedures, not used, missing, or in need of improvement?
      - PROCEDURES

- Not Used / Not Followed
  - no procedure

-- Not clear if or when OP becomes BLC.

14c, 22c. The list also states "ALS Staff and Users trained in BL 08-24 — able to check out tamper proof screw tool" which contradicts BL 08-24

- HUMAN PERFORMANCE DIFFICULTY
  - Individual Performance
    - Should the person have had and used a written procedure but did not.
      - PROCEDURE
        - Not Used / Not Followed
          - Procedure use not required but should be.

-- It became standard practice that the use of procedure (BL-08-24)was replaced by list in the control room stating "ALS Staff and Users trained in BL 08-24 — able to check out tamper proof screw tool". This practice violates the procedure and many people who are not a MT/BLS are on the list.

  - Management System
    - Were policies, admin. Controls, or procedures, not used, missing, or in need of improvement?
      - MANAGEMENT SYSTEM
        - SPAC NI
          - Confusing or incomplete

-- Use of the list implies that BL-08-24 is being followed. In addition use of the list caused the OP to lose track of the fact that the tool should only be issued to BLC who then could issue it to the trained BLS.

          - Not strict enough

-- List made it easy to circumvent the procedure.

        - Oversight / Employee Relations
          - Infrequent audits & evaluations

-- Infrequent auditing by ALS management of practices and how procedures are actually followed on a routine basis.

14 k_i. Removal of mono enclosure panels requires TPSR tool that was not properly controlled.

- EQUIPMENT DIFFICULTY
  - DESIGN REVIEW
    - Independent Review NI

- *No independent review of shielding design and access control.*
- *This points to management Systems for not requiring independent review in the process of design.*

- HUMAN PERFORMANCE DIFFICULTY
  - Management systems
    - Were policies, admin. Controls, or procedures, not used, missing, or in need of improvement?
      - MANAGEMENT SYSTEM
        - SPAC NI
          - not strict enough

          -- *Independent review not part of shielding design process and no follow up. Decision to use the same tool for shielding controlled under different procedures leads to possible errors and was never reviewed.*

3. Root cause summary table

Causal Factor	Paths through Root Cause Tree
5 a Motor hitting hard stop is an unrecoverable event w/o accessing mono-enclosure	• Equipment environment not considered. • Specs NI • Trending NI (see Appendix K) • No SPAC (SPAC=standards, policies or administrative controls) • Infrequent audits & evaluations
10 a BLS assumes beamline is Off-Line at Radiation Safety System (RSS) chassis and that hence shielding change form is in place	• Displays NI • No standard turn over process
13a, 22c It was not clear to OP what roles and responsibilities the OP was fulfilling when BLS asked for the TPSR tool	• No procedure • SPAC confusing or incomplete
14c, 22c The list also states "ALS Staff and Users trained in BL 08-24 — able to check out tamper proof screw tool" which contradicts BL 08-24	• Procedure not required but should be • SPAC confusing or incomplete • SPAC not strict enough • Infrequent audits & evaluations
14 k_i Removal of mono enclosure panels requires TPSR tool that was not properly controlled.	• SPAC not strict enough

VI. INCIDENT 7.3

a. Narrative

Beamline 7.3 consists of three branch lines: 7.3.1.1 and 7.3.1.2, which are hutchless branchlines, and 7.3.3, an X-ray micro-diffraction beamline with a hutch. The front-end 7.3 Personnel Safety Shutter (PSS), located inside the storage ring outer shielding wall, blocks beam to all three downstream beamlines when closed. Beamline 7.3.3 has a secondary PSS located outside the shield wall on the experimental floor and is used for protection during hutch access. This PSS does not interfere with beam to beamlines 7.3.1.1 or 7.3.1.2 when closed. Beamlines 7.3.1.1 and 7.3.1.2 are protected by the 7.3 front-end PSS. Both 7.3 PSS and 7.3.3 PSS are controlled by independent RSS chassis located near the outer peripheral wall in locked RSS racks. Front panel controls and indicators are accessible. An additional beamline, 7.0, is located in sector 7 and also has a PSS control chassis located in the same RSS rack as the 7.3 and 7.3.3 chassis.

In accordance with the DOE Accelerator Safety Order, all RSS interlocks must be tested semi-annually. The ALS RSS is a modular system allowing testing of certain modules without interrupting other modules. Each module includes overlapping tests to ensure integrity between connected modules. Some module tests must be conducted during accelerator maintenance periods. These include the main ring interlock system and the beamline summation interlock system. The beamline summation interlock tests verify the ability of a beamline RSS to turn off the accelerator in the event of a detectable fault, and ensure all PSS are closed during a storage ring fill and during Beam Physics operations.

The ALS Procedure Center maintains the testing schedule and notifies the Electronic Maintenance (EM) shop when tests are due to be conducted. The Procedure Center also provides the EM shop with up-to-date copies of the procedures needed to conduct the tests. A thirty day grace period is allowed if accelerator operations conflict with the testing schedule. The ALS has periodic shut down periods for maintenance, usually on Mondays and sometimes Mondays and the following Tuesday. The Facility Coordinator holds a weekly maintenance meeting on Thursday, preceding the next scheduled shutdown day, to schedule work for the upcoming shutdown day(s) and put the planned work on the Shutdown Work List. The EM shop supervisor attends these meetings and ensures scheduled RSS interlock tests are added to the Work List.

On November 17, 2005 a Thursday, a shutdown meeting was held to schedule work for the two-day shutdown period following the Thanksgiving holiday period. Maintenance and Installation was planned for Monday and Tuesday, November 28 and 29. The accelerator was scheduled to run Physics Operations all day Wednesday, November 23 and shut down after that for the long four-day holiday weekend.

The Beamline Summation interlock tests include some tests in the beginning of the procedure that require the main storage ring interlock system to be intact. That means all access gates, concrete doors, etc., must be made up and ready for beam. Under these

conditions other scheduled shutdown maintenance tasks inside the storage ring shielding are prohibited and must be delayed until the RSS tests are finished. After these initial tests are conducted, the accelerator can be opened up for general maintenance work inside the shielding while the remainder of the test is conducted on the experimental floor beamlines.

During the November 17 shutdown meeting the Beamline Summation interlock tests were scheduled for Saturday, November 26. This was a period when no maintenance was scheduled. The accelerator would be shutdown so the tests would not interfere with the other maintenance work scheduled for the following Monday and Tuesday, November 28 and 29. The plan was for the control room operators to leave all storage ring RSS interlock systems intact and secure after shutting down the accelerator after the Wednesday, November 23 Physics Shift. This would allow the EM shop to come in on Saturday, November 26 and immediately commence the Beamlines Summation interlock test.

This test requires three people: EM2, an EM who is normally assigned to the Owl shift, was scheduled to work Saturday, November 26 from 0400 to 1200 and assist the two day shift EMs, EM1 and EM3, in conducting the test.

Accelerator Physics shift commenced on Wednesday, November 23 at 0715. Later that morning, an ABLS requested that a BLC initiate an ALS shielding change form (ALS Shielding Control Procedure OP 02-04) to allow removal of a beamline exclusion zone in order to bake out a section of beamline 7.3. The BLC took beamline 7.3 Off-Line at the RSS chassis at 1058. This action closed the beamline 7.3 PSS and allowed the ABLS to remove the exclusion zones for bakeout.

Note: Once a beamline RSS chassis has been placed Off-Line, a watch dog circuit is activated to guard against accidental opening of the PSS or the accidental disconnection of PSS cables. Should either occur, the RSS turns off the storage ring RF system and dumps the ring. These are considered detectable faults and are indicated by LED lamps on the beamline RSS chassis. The beamline RSS chassis also has lamps indicating the On-Line or Off-Line status.

The ALS was shut down for the holidays on Thursday and Friday, November 24 and 25 with the storage ring RSS interlock systems remaining intact.

On Saturday, November 26, 2005, at 0750 interlock testing commenced using the Beam Line Summation and Main Control Room Storage Ring Fill Procedure (EC 02-15). The tests were conducted by three EMs. EM1 was the lead EM and supervised the actions of EM2 and EM3 via walkie-talkie radios. OP, a control room accelerator operator, assisted from time to time by switching the RSS Run/Fill switch located in the control room when directed by EM1.

EM1 and EM3 had performed this test one time before as assistants while EM2 had performed the test twice before as an assistant. None had ever supervised the test and the previous EM shop supervisors historically personally supervised this test.

Initially, the EM crew discovered some RF interlocks (not RSS) had to be completed before the RF trip verification tests could be performed. This is not uncommon. The interlocks typically are vacuum, RF cavity water flow, etc. associated with the SR RF system. The RF interlocks were made up at 0814 as recorded by the control system's event logger.

The test requires the lead EM to station himself at the beamlines sector 7 RSS equipment rack. A picture of the front of this rack is shown in Fig. 1. This is where all of the 12 beamline sectors are summed and sent to the main accelerator ring RSS interlock module. At this position, the lead EM can view indicator lamps that verify system integrity as each sector test is conducted by the two assistants. However, the first tests ensure continuity to the main ring RSS. For these tests, the lead tech flips test switches associated with each beamline RSS chassis located in sector 7 while the two assistants are stationed over the storage ring shield wall at the SR RF and the BTS B1 and B2 magnet power supplies to verify the sector 7 beamline tests turn off the SR RF and BTS B1 and B2 magnet power supplies.

BERKELEY LAB

Radiation Safety Committee Memorandum

TO: Steven Chu, Director
Graham Fleming, Deputy Director
David McGraw, Chief Operating Officer
Howard Hatayama, Division Director, EHS

CC: Radiation Safety Committee Members
RSC Subcommittee Members

FROM: David K. Shuh, Radiation Safety Committee Chair Jeffrey Knight (Deputy Chair) For David Shuh

DATE: 18 January 2006

SUBJECT: Radiation Safety Committee Subcommittee to Investigate the Violations of Shielding Control Procedures at the Advanced Light Source

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The Radiation Safety Committee (RSC) has reviewed the report of the RSC subcommittee investigation team regarding the recent Advanced Light Source (ALS) shielding control procedure violations. The subcommittee has performed an extremely thorough, technical, and objective investigation responding to the charge to investigate "the effectiveness of current shielding control procedures, engineering controls, training, EH&S staff support and management oversight as needed to develop proposed corrective actions to prevent the likelihood of recurrence." The investigation focused primarily on the three recent shielding control incidents and the events relevant to these incidents. LBNL and ALS are fortunate that there have been no personnel exposures as a result of these incidents.

The RSC-appointed subcommittee on ALS shielding control violations consisted of W. Byrne (AFRD-ALS), R. Duarte (Engineering-ALS), D. Kestell (LBNL~~—EHS)~~, W. Leemans (Chair-AFRD), M. Martin (ALS), K. Olson (Directorate), A. Ritchie (ALS-retired), and D. Robin (AFRD-ALS). The subcommittee included several members who are either matrixed to the ALS from other LBNL divisions or are ALS employees. These appointments were made intentionally to ensure technical excellence and to involve the ALS in the investigation process for internal credibility. None of the subcommittee members were directly involved in the ALS incidents investigated by this committee. The potential for line-management conflict of interests was recognized by both the RSC and the RSC subcommittee, and the RSC believes objectivity in this respect was maintained.

The RSC subcommittee has made a substantial number of constructive recommendations that must be addressed. These recommendations fall into four key areas: Management, ALS ES&H and EH&S issues, Administrative and Engineering Controls, and Training and Procedures.

The report from the RSC subcommittee is attached. After evaluation of the report, the RSC has determined the primary root causes belong to the basic cause category of failure in management systems, including line management accountability, supervision, and staffing. In addition, other significant causal categories include failures in procedures, training, and work direction.

The Acting Radiological Control Manager (C. Donahue, LBNL EHS) amended the ALS Class I Radiological Work Authorization (RWA) 5123 on 11/29/06 to "revoke authorization to remove any beamline or accelerator shielding at the Advanced Light Source as described in ALS Procedures BL-08-25 and OP 02-04 pending revision of all applicable procedures and approval by the Radiation Safety Committee to reinstate full authorization." The ALS has been allowed to modify shielding under emergency circumstances with specific additional controls and explicit authorization from the acting RCM as set forth in Class III Radiological Work Permit (RWP) 05-016 and RWP 06-017 during the course of the RSC subcommittee investigation.

The RSC has determined that there are four essential corrective actions that must be met and approved by the RSC prior to reinstatement of full operations under RWA 5123. The RWA will remain in the current amended status and rely on the RWP process until the RSC approves reinstatement of RWA 5123.

- The ALS Division Director and Deputy Division Director must enforce a line-management based structure with a clear delineation of responsibility and accountability for integrated safety management. The ALS and LBNL management must provide a plan to implement appropriate organizational structures and staffing levels.

- In the present organizational structure, the ALS and LBNL management must provide assurance that the staff in the following ALS positions possess and have demonstrated the required technical and communication skills, as well as a commitment to properly perform these safety-critical functions:

  1. ES&H Management
  2. Facility Coordination
  3. Electronic Maintenance
  4. Beam Line Coordination and Accelerator Operation

- The Level I recommendations detailed in the RSC subcommittee report must be successfully implemented.

- ALS management must develop a documented response and/or implementation plan for Level II recommendations detailed in the RSC subcommittee report.

The RSC looks forward to and is committed to working together with the ALS, LBNL EH&S, and LBNL management in this process.

Attachment: RSC Subcommittee Report

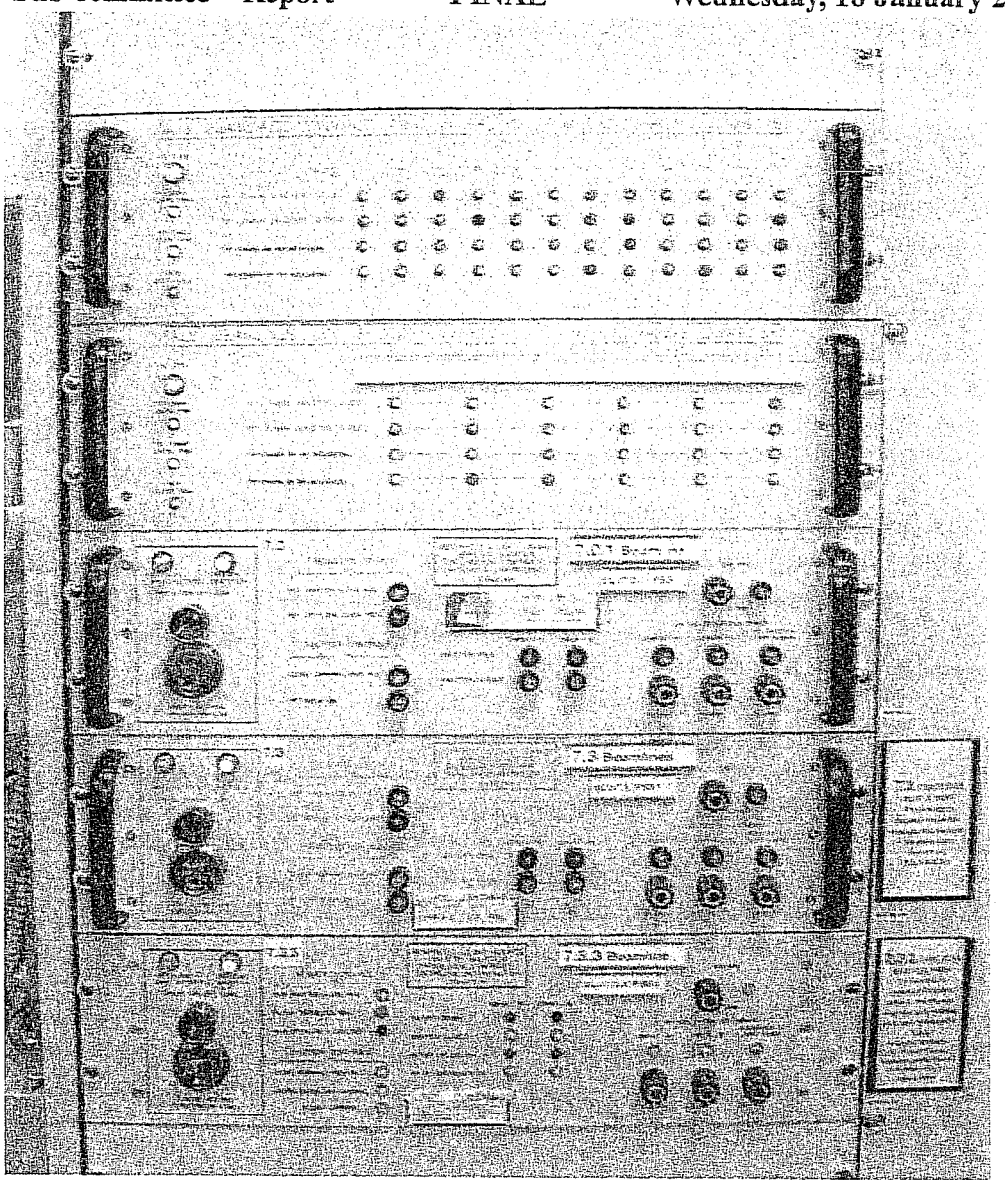


Figure 1: Front of beamline sector 7 RSS equipment. The top unit is the ring summation chassis with a column of 4 lights for each of the 12 sectors. The next unit down is the sector 7 summation chassis. An identical unit is located at each sector. Below this unit are the beamline 7.0.1, 7.3 and 7.3.3. RSS chassis. On the lefthand side of each of these three bottom units is a red cup for the Off-Line push button and below it the On-Line key switch lock-cylinder. The green lights above and to the right of the red cup indicates that these three beamlines are presently On-Line. The Off-Line indicator light is to the left of the green light and would it be red when the beamline is Off-Line and the green light would be extinguished.

Note: The BTS B1 and B2 magnets are interlocked off if a fill operation is attempted and all beamline PSS are not closed. Likewise for Accelerator Physics operations when the Accelerator Physics key is removed from the key switch in the control room. This sends a shutter close request to all beamlines and after all are confirmed closed, the BTS B1 and B2 magnets are allowed to be turned on. With the accelerator physics key removed,

the accelerator can not be accidentally placed in a 'Stored Beam' mode which allows users to control their beamline PSS'.

Beamline 7.0 was tested at 0930. Beamline 7.3 was tested at 0941. Beamline 7.3.3 was tested at 0951. EM2 reset the SR RF interlock at 0955. At that time he and EM3 went over the shield wall to assist in the continued testing of the individual beamline RSS chassis interlocks that are summed at sector 7 where EM1 was stationed.

Three tests are used to test control room RSS functions. The first is the Fill Request that closes all shutters, the second is the Stored Beam function that interlocks off the BTS B1 and B2 magnets and relinquishes control of the beamline PSS to the user, and the third is the Beam Physics test. This test ensures all PSSs are closed during Beam physics operations and prevents accidental Stored Beam operations.

At 0955, the Control Room Fill Request interlock test was conducted. The control room operator presses the fill request push button switch. This sends a PSS close command to all beamline RSS chassis and the summation chassis at sector 7. An assistant walks around the ring and verifies proper indicator lamps are lit on all beamline RSS chassis. This was completed at 1014.

The next test requires the control room operator to press the Stored Beam push button switch. This interlocks off the BTS B1 and B2 bend magnets and relinquishes control of the beamline PSS to the users. An assistant goes over the storage ring shielding to verify the BTS B1 and B2 magnets are interlocked off and another assistant walks around the ring and verifies control of the beamline PSS is given to the users. This is indicated by an LED indicator on the individual beamline RSS chassis. This test was completed at 1021.

The final test of control room functions is the Beam Physics test. The control room operator removes the Beam Physics key from its key switch. This closes all PSS and requires an assistant to walk around the ring and verify all beamline PSS are closed. This test was finished at 1102.

Testing continues starting with beamline RSS chassis in sector 12 and going in a counter clockwise direction, skipping sector 7 because it was conducted earlier as the first verification test to the main ring interlock system. These tests require the lead EM to be positioned at sector 7 to verify each beamline RSS test is registered there on the summation chassis while the two assistants are located at each of the sectors. One of the assistants is stationed at the rear of the safety rack and flips test switches while the second assistant verifies indicator lamps on the front panel of the RSS chassis in that sector. He relays his observations to the lead EM who initials the steps on the test procedure.

The first step of this section of the procedure was conducted at 1102 and the last step finished at 1124. This 22 minutes is considered an unreasonably short time to complete all the steps. Furthermore, only 6 RF trips were recorded on the control system's event

logger for this period. Proper execution of the procedure should have recorded a minimum of 1 for each sector in the test (9).

Note: The test was later conducted on December 13, 2005 by the RSS System Engineer and an EM crew. This portion of the test took 89 minutes however the number of RF trips were not logged because of storage ring access needed due to time constraints.

At this point EM1 made a note in the margin of the procedure that sector 7 tests were missing from the procedure. In fact, sector 7 tests are the very first tests conducted as explained earlier. This indicates the EM crew did not understand the procedure.

The EM crew began a re-test of sector 7 without procedural guidance. If they would have referred to earlier pages in the procedure for these steps, they would have seen that they had already performed the sector 7 tests. Instead, the EM crew flipped test switches and observed indicators for sector 7 using their best judgment and not the procedure to determine if the RSS tests were proper. EM2 was in the rear flipping test switches while EM1 was in front observing indicator lamps. A picture of the rear of the sector 7 RSS equipment rack is shown in Fig. 2.

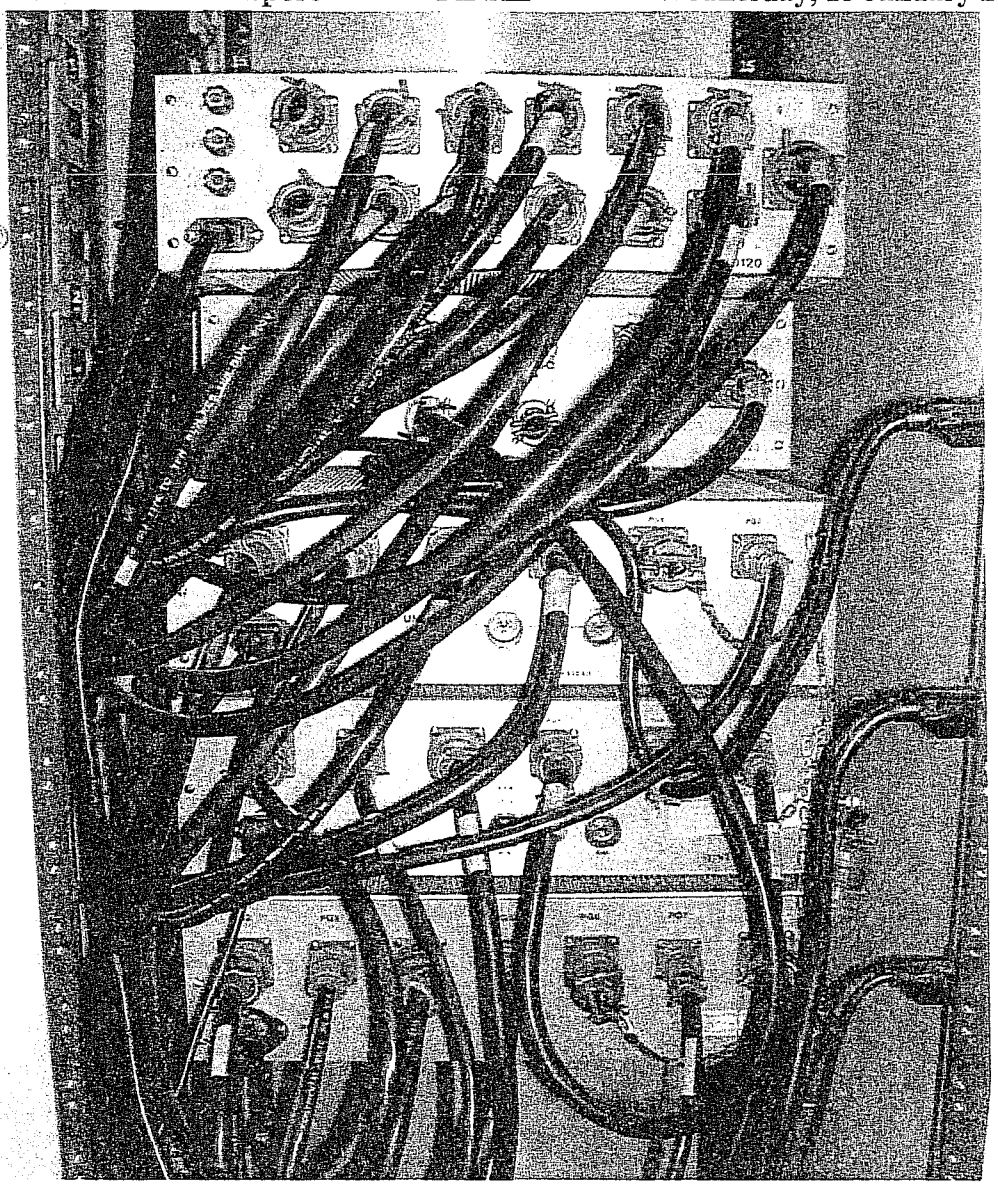


Figure 2: Picture of the rear of the sector 7 RSS equipment rack. The top unit is the ring summation chassis. The next unit down is the sector 7 summation chassis. An identical unit is located at each sector. Below this unit are the beamline 7.0.1, 7.3 and 7.3.3. RSS chassis. The test switches are located in the copper colored protective cups in the second and third units from the bottom. The bottom unit is an older chassis without test switches and requires disconnecting a cable and a test plug installed.

During this re-testing, EM1 observed '*everything dropping out back to sector 7*' at the ring summation chassis. This would have been a correct observation when a sector 7 beamline RSS chassis test switch was flipped. EM1 noticed the beamline 7.3 chassis was Off-Line, as it should be because of the BLC taking it Off-Line on December 23, 2005.

Note: The Beamline Summation test does not care if a beamline RSS chassis is On-Line or Off-Line and can be performed regardless. However a detected fault will trip the RF interlock as well as taking the beamline Off-Line. The Summation test cannot begin at step number one if this condition exists. Any fault preventing the start of the test must be investigated and corrected before testing can commence. No faults can exist while this test is being conducted.

EM1 interpreted this beamline 7.3 Off-Line condition as a fault requiring the control room operator to reset the chassis by key enabling it. This indicates that the EM did not understand what the RSS indicator lamps were telling him. It also indicates a lack of good judgment and training on the part of the EM. For had he perceived a fault, it should have been investigated, corrected and logged in the beamline logbook and the EM shop logbook. A note should have been added to the procedure as well. None of this was done.

EM1 called the control room to have the beamline 7.3 RSS chassis placed On-Line. The OP arrived and places beamline 7.3 RSS chassis On-Line at 1129. No check for a shielding change form or the beamline logbook was made and the key was not signed out which is normal when the key is kept in the sole possession of the operator.

Note: At this point there was a question of how many chassis were key enabled. EM1 said both 7.3 and 7.3.3 were key enabled while OP said only one chassis, 7.3, was key enabled. The Beamline 7.3.3 RSS chassis should have been On-Line already. Unfortunately, this beamline's status is not yet recorded by the event logger because it is a branch line. The branch line Equipment Protection System (EPS) is not directly connected to the Front End EPS which is logged. Therefore, it cannot be confirmed whether a fault occurred on 7.3.3's RSS. Two faults could have tripped the 7.3.3 RSS chassis; someone pressing the hutch emergency door release push button or someone accidentally disconnecting the 7.3.3 PSS cable. Both are highly unlikely because of the holiday weekend and not many people being in the building. A scan of key badges entries for the period indicated no workers being logged into the building who are associated with beamline 7.3.3. It is believed by the committee that no fault occurred for 7.3.3 and the Off-Line condition observed on 7.3 by EM1 triggered an erroneous assumption leading to the beamline being placed On-Line without a full key-enable.

EM1 continued to re-test sector 7 and left the beamline 7.3 RSS chassis On-Line upon completion.

EM2 applied administrative Lockout to the BTS B1 and B2 magnet power supplies at 1140 which is one of the last steps of the procedure. After that, he departs the building for home.

EM3 went to the EM shop. Interlock testing was completed at 1200. There are no log entries in either the beamline logbook or the EM shop logbook regarding the perceived fault at sector 7 or the missing procedure step for testing sector 7. There was no post-test review by the EM shop supervisor with the crew conducting the test.

The accelerator continued to be shutdown November 27 and 28. On Monday, November 29, Accelerator Maintenance commenced.

Note: Since conducting key-enable procedures for beamlines can take a bit of time, the BLC likes to get an early jump on them. By investigating and talking to the various beamline scientists early on during shutdown days, the BLC can find out what their progress is and when they may want to have their beamline inspected and the key-enable procedure performed.

During the mid morning of November 29, 2005 the BLC contacted ABLS as to when he may want to have his beamline key-enabled. They met at or near the beamline and during the meeting discovered the beamline was On-Line. The BLC switched the beamline RSS chassis to Off-Line at 1001 and notified ALS management.

On November 29, an audit of all open shielding change procedures was conducted before any beamline was allowed to come back On-Line. Another audit was conducted for all Off-Line beamlines to check and ensure they were in fact Off-Line.

On November 29 at 1550, beamline 7.3 was key-enabled On-Line after a key-enable procedure was performed for the beamline.

b. Root cause analysis

1. Time line with causal factors (indicated in red) and incident (indicated in red, underlined and labeled [incident])

1. RSS Summation interlock tests put on the shut down work list at the work planning meeting held 11/17/05. Test scheduled for 11/26/05.
2. EM2, who normally works the owl shift, was scheduled to work from 0400 to 1200 noon on 11/26/05 and assist with the RSS Summation interlock testing.
3. ALS scheduled for Accelerator Physics (AP) shift lasting 24 hours- 11/23/05
    a. Personnel Safety Shutters (PSS) are normally closed but can be opened for a specific beamline under controlled conditions.
4. AP shift commences-11/23/05, 0715
    a. All PSS closed and controlled by the control room.
5. Associate Beam Line Scientist (ABLS) requests from Beam Line Coordinator (BLC) to initiate an ALS shielding change form (ALS Shielding Control Procedure OP 02-04) to allow removal of a beamline exclusion zone in order to bake out a section of beamline 7.3. 11/23/05, 1000.
6. BLC switches 7.3 Off-line- 11/23/05, 1058
    a. Beamline 7.3 PSS closed.
7. ABLS removes exclusion zones for bake out.
8. ALS shut down for holidays - 11/24/05 and 11/25/05

a. Accelerator RSS interlocks remain intact.

9. RSS interlock testing commenced using the Beam Line Summation and Main Control Room Storage Ring Fill Procedure (EC 02-15, Rev. 13). 11/26/05, 0750
    a. The interlock test was conducted by the ALS' Electronic Maintenance (EM) shop personnel. EM1 was the lead tech supervising the test.
    b. The control room operator assisted from time to time by switching the RSS Run/Fill switch located in the control room when directed by EM1.
    c. EM1 and EM3 had performed the interlock test one time before as an assistant.
    d. EM2 had performed it two times before as an assistant.
    e. None had ever supervised the test.
    f. The previous EM shop supervisors have always personally supervised this test.
    g. EMs discovered some RF interlocks (not RSS) had to be completed before the RSS trip verification tests could be performed. This is not uncommon. These interlocks typically are vacuum, cavity water flow, etc.
10. RF interlocks were made up. 0814

Note: The following tests were performed by EM1 switching the BL 7.0 PSS control chassis test switches to the test position with the rear rack door unlocked. These tests required EM1 to be at the beamlines summation chassis in sector 7 while EM2 was stationed at the SR RF and EM3 was stationed at the BTS B1 and B2 power supplies.

    a. Testing commenced by starting with beamline summing chassis in sector 7. The BTS B1 and B2 interlock and the SR RF "A" and "B" chains tested at 0930 for BL 7.0 PSS1 by switching A and B test switches to test.
    b. BL 7.3 PSS1 tested in the same manner at 0941.
    c. BL 7.3.3 PSS1 tested at 0951 but the SR RF Pers Safety 2 interlock was not reset prior to the test. Therefore, there was no verification of this interlock trip.
    d. EM2 resets the SR RF at 0955
    e. EM2 and EM3 went then to the experimental area.
11. Testing continued with the control room fill request. 0955
12. The control room operator pushed the 'Fill" push button.
    a. This request should close all beamline PSS's.
13. Procedure indicated that an EM walked around the ring and observed the MCR Fill Request and PSS Closed lamps are lit on all PSS control chassis.
    a. Steps 5.4.1 [A],[1] through [A],[13] were conducted between 0955 and 1014.
    b. Procedural steps were initialed in Procedure EC 02-15
        i. Steps 5.4.1 [1]-[12] were lined through instead of individually initialed as having been completed
14. Testing continued in the Stored Beam mode. 1014
15. The control room operators pushed the 'Stored Beam" push button.
16. Procedure indicated that an EM walked around the ring, observed the MCR Fill Request lamps on all arc sector summing chassis are extinguished and the BTS B1 and B2 power supplies are interlocked off.
    a. Steps 5.4.2 [a]-[t] were conducted between 1014 and 1021.

b. Procedural steps were initialed in Procedure EC 02-15

17. Testing continued with the control room Beam Physics interlock test.
18. The control room operator turned and removed the Beam Physics Key.
    a. This should close all beamline PSS's.
19. Procedure indicated that an EM walked around the ring and observed the MCR Fill Request and PSS Closed lamps are lit on all PSS control chassis.
    a. Steps 5.4.3 [1] through [15] were conducted between 1021 and 1102.
    b. Procedural steps were initialed in Procedure EC 02-15
20. ALS card key access by EM3 (through ALS clean room) at 1028 and 1030
21. ALS card key access by EM1 (through sector 4 door) at 1040
22. ALS card key access by EM1 (through ALS clean room) at 1057
23. Testing continued at each beamline PSS control chassis, starting at sector 12.
    a. Steps in section 5.5 test requires the lead person to be stationed at the sector 7 summing chassis where all 12 arc sectors are summed.
    b. To execute the procedure properly also requires one person in the rear and one person in the front of the beamline safety racks where the PSS control chassis are located. The person in the rear operates test switches and the person in front verifies the test by observing indicator lamps on the front and at the arc sector summing chassis. At the same time, the lead person at sector 7 verifies the test by observing indicator lamps at that location.
24. Procedure indicates that the two EMs at the beamlines start at sector 12 and work their way around the ring in a counter clockwise direction.
    a. First step in section 5.5 started at 1102 and last step finished at 1124
    b. Procedural steps were initialed in Procedure EC 02-15
    c. Committee notes that 22 minutes for this part of the test is an unreasonably short time to complete the process for all steps (retesting conducted by RSS Engineer as leader on 12/13/2005 took 89 minutes)
    d. ALS event logger shows PERS SAFETY 1 trip occurred only 6 times during the period 1102 - 1124
    e. Proper execution of the procedure requires that 9 trips (one per sector minus sectors 7, 1, 2) should be logged on event logger.
        i. **Procedure improperly executed**
25. EMs note in procedure that there is nothing in procedure on how to test Sector 7
    a. Sector 7 is tested first in procedure
        i. **Indicates EMs did not understand procedures**
26. EMs decide to retest sector 7 without procedural guidance
    a. Not clear what steps were followed
        i. **Violates procedure**
    b. EM2 is at the rear of the equipment rack operating test switches and connecting testing plugs.
    c. EM1 is at the front of the equipment rack observing indicator lamps.
27. Retest sector 7 starts about 1124
    a. Time and date interpreted from event logger
28. EM1 witnesses 'everything dropping out back to the SR Sector Summing chassis' sector 7 indicator lamps.

a. Summation chassis should show sector 7-12 indicator lights turning off (i.e. 'dropping out').
b. Notices that the RSS chassis for 7.3 is off line
c. EM1 thinks that they tripped something that caused 7.3 to be off line

29. EM1 interprets the 7.3 off line status as being caused by a fault in the system that requires an OP to key back on line
    a. EMs should have investigated what caused the RSS chassis to be off line
        i. EMs do not understand what the RSS indicator lamps are telling them.
        ii. EMs do not understand how the RSS chassis and system functions.
30. EM1 calls operator in charge in control room to key on the RSS control chassis
31. OP brings a disputed number of key(s) (1 or 2) from the control room key locker
    a. OP does not log out key per ALS custom when key remains under direct control of operator for short time
    b. OP stated to the committee that OP brought one key
    c. EM1 stated that two beamlines needed to be brought On-Line which would require 2 keys
    d. EM2 stated only one beamline tripped off
    e. Archiver does not record RSS beamline status on 7.3.3
32. OP keys on 7.3 RSS chassis at 1129. [Incident]
    a. OP does not question reason for keying on chassis
    b. Operator does not check beamline log book before using RSS reset key.
    c. Archiver records BL 7.3 RSS chassis enabled
33. EM1 continues the re-test of sector 7 leaving both PSS control chassis On-Line.
34. EM2 went to apply an administrative lock to the BTS B1 and B2 power supplies.
35. EM3 went to the EM shop.
36. BTS B1 and B2 power supplies were turned off. 1140
37. EM2 ends shift and leaves ALS.
38. Interlock testing is completed 11/26/05, 1200
    a. No log entries in the EM log regarding the assumed SR RF trip at sector 7 or the incorrectly perceived missing section from the test procedure.
        i. Violates procedure
39. Accelerator continues to be in shutdown mode 11/27/2005
40. Accelerator maintenance day 11/29/05
41. BLC checks logs for all the beamlines that were Off-Line 11/29/2005, morning
42. BLC meets with the ABLS.
43. BLC and ABLS discussed bake out and when ABLS may want to have the beamline 7.3 PSS control chassis Key Enabled.
44. Chassis is found to be On-Line. 11/29/05, 1001
45. BLC switches the beamline to Off-Line
46. BLC notifies management, including DDD.
47. DDD requests an audit of all open shielding change procedures by Radiological Control Tech (RCT) and mandates verification of shielding by the RCT before any beamline was allowed to come back On-Line.
48. Audit was performed and all Off-Line beamlines were checked to ensure they were in fact Off-Line. 11/29/05

49. Beamline 7.3 key enabled following RCT verification 11/29/05, 1550
    a. After conducting a Key Enable Procedure

2. Root cause tree analysis (Text in italics is RSC subcommittee explanation for the specific choice in root cause path)

24fi. Procedure improperly executed
25ai Indicates EMs did not understand procedures
26ai. Violates procedure

- HUMAN PERFORMANCE DIFFICULTY
  - Was a mistake made while using a procedure?
    - PROCEDURES
      - Followed incorrectly
        - No checkoff
        - -- *No check of initial state of RSS chassis is required in procedure.*
        - Checkoff misused
        - -- *Not initialing individual steps as required.*
        - -- *Continued to recheck sector 7 with no procedure to follow.*
  - Were alarms or displays to recognize or to respond to a condition unavailable or misunderstood?
    - HUMAN ENGINEERING
      - Human machine interface
        - Displays NI
          - *RSS chassis indicator lights not understood. Training required.*
          - -- *No clear visual indication whether RSS Chassis is intentionally or accidentally Off-Line*
      - Complex system
        - Knowledge based decision required
        - -- *EMs should have investigated further before requesting to key chassis On-Line.*
        - -- *Further investigation would have included looking at log book for verification of initial beamline status, and other indicator lights.*
  - Did the person need more skill/knowledge to perform the job or to respond to conditions or to understand system response?
    - TRAINING
      - Understanding NI
        - instruction NI
        - -- *It appears that workers didn't understand the procedure*
        - Practice/repetition NI
        - -- *Procedure done once a year (once by leader, twice by one assistant and once by other).*
        - Continuing training NI
        - -- *Better training prior to executing the procedure without supervisor.*
    - WORK DIRECTION
      - Selection of worker NI

- Not qualified
  -- *Procedure done once a year (once by leader, twice by one assistant and once by other).*
  - Team selection NI
    -- *Team was led by EM who had never led the execution of the procedure before and only had done it once as assistant.*
    -- *Assistants had only done it once or twice as assistants.*
    -- *Team always had at least one very experienced member in the past (either shop supervisor or EM with multiple years of experience doing this test).*
- Supervision during work
  - No supervision
    -- *No EM supervisor onsite.*
    -- *Previous tests usually led by EM supervisor.*

29. EM1 interprets the 7.3 Off-Line status as being caused by a fault in the system that requires an OP to key back on line
29a_i EMs do not understand what the RSS indicator lights are telling them.
29a_ii EMs do not understand how the RSS chassis and system functions.

- HUMAN PERFORMANCE DIFFICULTY
  - HUMAN ENGINEERING
    - Human machine interface
      - Displays NI
        --*No clear visual indication whether RSS Chassis is intentionally or accidentally Off-Line*
    - Complex system
      - Knowledge based decision required
        -- *RF status interlock indicator on 7.3 RSS chassis would have shown if chassis is Off-Line because an RF trip had occurred.*
        -- *RF Interlock OK indicator light would not have been lit on beamline RSS chassis if a detectable fault had occurred.*
        -- *EMs should have investigated further before requesting to key chassis On-Line*
  - Was a mistake made while using a procedure?
    - PROCEDURES
      - Wrong
        - Situation not covered
          -- *No explicit instructions of what to do if RSS chassis has a detectable fault causing an RF trip.*
  - Were displays, alarms, controls, tools, or operated improperly?
    - HUMAN ENGINEERING
      - Human machine interface
        - Displays NI
          -- *RSS chassis indicator lights not understood. Training required.*
      - Complex system
        - Knowledge based decision required

-- RF status interlock indicator on 7.3 RSS chassis would have shown if chassis is Off-Line because an RF trip had occurred.
-- RF Interlock OK indicator light would not have been lit on beamline RSS chassis if a detectable fault had occurred.
-- EMs should have investigated further before requesting to key chassis On-Line

- Management System
  - Was a task performed in a hurry or a short-cut used?
    - MANAGEMENT SYSTEM
      - SPAC NOT USED
        - Enforcement NI

-- Supervisor should have re-enforced immediately that each step in procedure must be initialed

        - Communication of SPAC NI

-- Supervisor may not have communicated proper way to execute the procedure

32b. Operator does not check beamline log book or shielding change forms before using RSS reset key.

- HUMAN PERFORMANCE DIFFICULTY
  - Individual Performance
    - Should the person have had and used a written procedure but did not.
      - PROCEDURE
        - Not Used / Not Followed
          - no procedure

-- It is standard practice to key on a beamline without following complete key-enable procedure if the operator is satisfied that they understand the stated reason for an RSS chassis being Off-Line (e.g. at the request of an EM who was testing interlocks).

  - Management Systems
    - Were policies, admin. Controls, or procedures, not used, missing, or in need of improvement?
      - MANAGEMENT SYSTEM
        - SPAC NI
          - No SPAC

-- No defined policy for operator to key on a beamline when RSS chassis has tripped..
-- Key logging not used when OP remove keys.

3. Root cause summary table

Causal Factor	Paths through Root Cause Tree
24f_i Procedure improperly executed 25 a_i Indicates EMs did not understand procedures 26 a_i Violates procedure	• No checkoff • Checkoff misused • Displays NI • Knowledge based decision required • Instruction NI • Practice/repetition NI • Continuing training NI • Not qualified • Team selection NI • No supervision
29 EM1 interprets the 7.3 off line status as being caused by a fault in the system that requires an OP to key back on line 29ai EM does not understand meaning of indicator lights. 29aii EM does not understand system functions	• Displays NI • Knowledge based decision required • Situation not covered • SPAC not strict enough
32b Operator does not check beamline log book before using RSS reset key.	• No procedure • No SPAC

VII. SUMMARY

The ALS is a premier third generation light source with an excellent record of world-class science, innovations, and user service. The ALS continues to excel and generally operates safely thanks to a number of excellent, careful and knowledgeable people. The three incidents investigated in this report and their underlying root causes show that changes need to be made to ensure the continued safe environment and user operations of the ALS.

The incident on beamline 12.3.2 involved a commercial contractor removing radiation shielding from the 12.3.1 beamline when it was not properly taken Off-Line. The TapRooT® analysis determined several key root causes for this incident: Work Permit Needs Improvement, Accountability Needs Improvement, Employee Feedback Needs Improvement, and Corrective action not yet implemented. These all implicate a lack of a fully functioning work permit system, a procedure detailing when and how to use the work permit, and an empowered FC to carry it out. Despite detailed guidance from previous PIT reports about the FC position and the WP system, the FC did not implement such a system, and his supervisor, the DDD, did not hold the FC accountable to this task. This leads to a number of specific recommendations including a full overhaul of the work permit policy following the 2004 PIT recommendations, strengthening the FC position consistent with WP program, defining clear responsibilities and accountabilities for the FC, and improvement of the supervision and direction of the FC. A copy of a draft of the procedure entitled the "Maintenance and Installation Work at the Advanced Light Source-Use of the ALS Work List and the ALS Work Permit" is attached in Appendix V. This procedure was developed post-incident and represents a first step towards the development of a robust WP program.

The incident on beamline 4.2.2 involved removing shielding from the mono-chromator (mono) enclosure with the beamline key-enabled. In this incident everyone involved assumed someone else had taken the responsibility for ensuring the beamline was safely Off-Line. There are several root causes to this incident covering several areas. The specs for motors and other equipment located inside shielding need improvement, shielding accesses need trending to spot problems, beamline status displays need improvement, policies for when an OP becomes an acting BLC were confusing, and procedures for issuing the TPSR tool were not followed. These root causes led us to a number of detailed recommendations addressing the type of RSSD used for the 4.2.2 mono enclosure, the need for standards for frequency of shielding accesses for types of RSSD's and trending analysis to identify when access frequency does not match design expectations, a means of displaying status of all beamlines on the experimental floor and in the control room and archiving these statuses, clear roles and responsibilities for OPs and BLCs and a plan for establishing the appropriate kind and level of 24-hr coverage needed at the ALS, and tightening control of TPSR tools and improving related procedures.

The incident on beamline 7.3 involved keying On-Line a beamline that had previously been intentionally taken Off-Line for the purposes of removing a radiation protection exclusion zone to allow bake-out of beamline components. In this incident EMs performing a safety interlock system test thought that something they did had

caused a beamline RSS chassis to trip Off-Line, whereas it had in fact intentionally been taken Off-Line. Detailed analysis has again uncovered several root causes including the team selection for testing of safety systems needs improvement, RSS status and intended state displays need improvement, procedures and training need improvement, and when an OP becomes a BLC needs defining.

All three incidents have some root causes in common. In addition, during the course of our investigation overall organizational issues were illuminated. We recommend that the ALS implement a new organizational structure to accommodate the growth in users it services, correct the structural problems that we have identified and adjust the staffing levels where needed. We recommend that the organization returns to a line-management based structure with clear delineation of responsibility and accountability, and strengthen integrated safety management. We urge ALS to improve its relations with EH&S (and vice versa). When an incident occurs, we urge ALS to strengthen methods and techniques for fact finding, implementation of corrective actions, establishing lessons learned, and information dissemination.

We recommend that EH&S refocus its attention towards the ALS with the aim of helping the ALS ensure compliance. We recommend that EH&S and ALS jointly establish a clear separation between compliance and technical services provided to ALS. We also note that the levels of staffing in some areas at ALS and EH&S are inadequate. Within the ALS there are some personnel fits that may need to be reevaluated in light of a review of the positions and restructuring that we recommend. We have found in some cases that personnel are not performing at a sufficient level.

We believe that it is essential that all recommendations be properly addressed and implemented in a timely fashion to ensure the continued safe operation of the ALS. The RSC subcommittee members stand ready to work with the ALS, the RSC, EH&S and Laboratory management in the future.

VIII. RECOMMENDATIONS

The recommendations listed below are based on the root cause analysis for incidents 12.3.2, 4.2.2, 7.3, interviews, email suggestions and committee deliberations. The first column contains the recommendations, organized by type: (a) Management, (b) ALS ES&H and LBNL EH&S issues, (c) Administrative and engineering controls, and (d) Training and procedures. In the second column, level I means that the recommendation should be acted upon immediately, level II means that the ALS management must immediately put in place a plan of action that should be presented to the RSC and the RSC subcommittee for concurrence and level III is for items we consider to be at the discretion of the management.

The committee recognizes the excellent cooperation it has received from the management of ALS and all personnel interviewed during this investigation. Interviewees were open and forthcoming with information and suggestions. In addition valuable unsolicited suggestions were obtained from a number of ALS users and staff members. This is evidence of a strong commitment to safety within the ALS organization. None of the incidents involved any exposure to radiation or injury. This can be directly attributed to: (1) the high level of care that was taken during the design and construction of the facility; (2) the general care taken during the expansion and operation of the ALS, with regards to safety; (3) astute observations by well trained staff that something was wrong and immediate corrective actions taken to ensure safety. Most importantly, the ALS continues to excel and generally operate safely thanks to a number of excellent, careful and knowledgeable people ~~within the ALS~~ organization and those affiliated with it.

Recommendations	
Management	Level
1. **The ALS Division, assisted by the Laboratory Management, must enforce a line-management based structure with clear delineation of responsibility and accountability for ALS staff and users, in accordance with Integrated Safety Management.** The Deputy Division Director's present top-to-bottom style of decision making and problem solving for safety at the ALS has diluted "Work Ownership" attitude of group and section leaders. The impact of diluted work ownership affected the role some section leaders played in dealing with safety of the	II

personnel they supervise. For example, beamline coordinators go directly to Deputy Division Director for decisions on safety issues instead of their own direct supervisor, the ALS ES&H manager or EH&S. One key staff member felt marginalized with respect to safety and beamline coordination and another key staff was not informed of the 4.2.2 incident until the following week at the strategic management team meeting.	
2. **ALS organizational structures and staffing levels should be re-examined in light of the growth over the past decade in number of users that the ALS services and the new challenges that brings.** A study should be conducted that looks at management structures in other facilities that could serve as a basis for re-organizing the ALS. Proper balance needs to be obtained between accommodating user needs, facility operation and improvement, and overall safety. Note that whereas the number of users has grown by a factor 7 over the past 8 years, the overall staffing level at ALS has increased by less than 10%. Furthermore, the operator staffing level has reduced from 10 to 7 and the number of full time beamline coordinators decreased from 4 to 2 in the past 7 years. We recommend that ALS investigate what type of support skills should be present at the facility, what the level of support should be for the machine vs. the users, at what staffing level, should the support be physically present at the facility or on-call. Comparative studies with other facilities should be carried out to evaluate the best plan to accommodate the growing user population without compromising the need for machine support (operators, mechanical technicians, electrical maintenance). For example, at BNL there is 24 hour coverage by OPCO's (operation coordinator) that are knowledgeable and have a good awareness of what is happening on the experimental floor. Beamline coordinators and operators are currently in different branches in the organizational chart. The roles of OP and BLC must be clearly defined and well communicated to all employees and users. Responsibilities and accountability of personnel for safety of operations and the ALS building as a whole should be well defined and delineated. The committee is concerned about operators simultaneously acting as BLC and recommends that careful thought be given to splitting those functions to two different people on any given shift. Thought should be given to integration of coordinators and operators. If operators are to serve as coordinators then they must receive appropriate training and have proper technical	II

qualifications. We recommend that operators be encouraged to work with BLCs to get familiar with beamline related activities so that they can serve as watchdogs for beamlines. It also would serve as a stepping stone towards becoming a BLC if this is desirable.	
3. **The following staffing and performance issues need to be addressed** Four years ago the ALS lost the deputy for planning and two years ago it lost its Director. LBNL management needs to appoint a permanent Director of ALS. A fully empowered Director is needed to revisit the current organizational structure of the ALS and make the necessary and recommended changes. Upon departure of the deputy for planning, the Deputy Division Director has effectively assumed the role of deputy for planning in addition to all his other duties. Insufficient resources were allocated to fulfill all duties. All position descriptions need to be reviewed to ensure that the written description corresponds to the actual required responsibilities and duties, that the needed technical skills are properly defined and that they are matched to the job and are consistent within the same job classification. The committee has concerns with the skills and motivations of two EMs involved in the 7.3 incident. During our investigation we have concluded that personnel do not always follow documented procedures or proper protocol. Committee notes that a part of the test took only 22 minutes which is an unreasonably short time to complete the process for all steps (retesting conducted by RSS Engineer as leader on 12/13/2005 took 89 minutes). EMs did not follow procedures during execution of EC 02-15 and at least one other procedure (EC 02-64). Performance improvement plans need to be put in place. The EM supervisor will need to pay particular attention to their performance, to formation of experienced teams for testing interlocks, and to ensure that all procedures are understood and followed by his employees. The committee also has concerns about the motivation of the operations section leader to ensure proper training. Corrective action needs to be implemented to ensure 100% compliance with proper training. The responsibilities and functions assigned to the Facility Coordinator position need to be better defined and accountability must be enforced. We recommend that the position be strengthened and re-evaluated	II I I I

together with the entire organizational structure. For over a year, one of the primary roles of the FC was to implement an effective work permit system per recommendations from the 2004 PIT report. However, this was not in place and the lack of such a structured work permit program was found to be one of the root causes for the incident related to beamline 12.3.2, leading to the confusion in roles and responsibilities of personnel involved in the incident. For this reason, we are concerned with the present supervision and direction of the FC position by the DDD and the performance of the FC. We are concerned with the functionality, oversight and effectiveness (see also #8) of the ALS ES&H manager position. During the investigation and interview process the RSC sub-committee heard a number of comments questioning the ALS ES&H Manager's qualifications with regard to radiation safety, the large number of users formally supervised and the ability of this individual to effectively work with others within the ALS and LBNL's EH&S Division. As discussed under recommendations #7-9, we deem this position to be critical for the ALS and it should be strengthened. We also note that the ALS ES&H manager serves as Division Safety Coordinator and we were informed that, until recently, Labwide Division Safety Coordinator meetings were not attended in the past year by the ALS ES&H manager. The Laboratory Safety Coordinator Meeting is a main vehicle for discussing issues either coming down (either from DOE/UC/LBNL, etc.) or up (from the line divisions). As discussed below, the entire ALS safety group needs to be restructured to improve this critical function. It is possible that the issues above have placed additional demands and an undue burden on the DDD, who has in effect assumed many of the safety and facility coordination responsibilities.	I
4. **A fully overhauled work permit (WP) program following the 2004 PIT recommendations needs to be put in effect.** The WP program must be reviewed by the newly appointed standing safety committee for ALS (see Appendix W), including EH&S experts and members of the earlier PIT. The WP program needs to be computer based to enable up-to-date access to the current status of ongoing work at the ALS. All shielding modifications must involve HP during the writing of the WP and verification of the work after completion and before beamline is keyed back On-Line.	II

5. A robust investigation process needs to be implemented for all future events. We were dismayed by the fact that (1) upon the request of the DDD, the investigation of 12.3.2 was done by the same people involved in the incident, (2) the investigations were incomplete as evidenced, for example, by the fact that not all personnel involved were interviewed in the 4.2.2 incident, (3) initial communications with DOE by the Deputy Division Director and his staff on the incident with beamline 7.3 were premature and contained incorrect information. Employees were initially unjustifiably implicated as having made personal errors; this degraded the atmosphere in the facility and the morale of the personnel. This is damaging to the institution and needs to be avoided in the future. We recommend that when an incident happens, the newly formed ALS standing safety committee is immediately engaged, that proper investigation techniques are applied, and that EH&S and the Berkeley Site Office of DOE are informed that an incident has occurred and an investigation has started. We welcome the formation of a standing safety committee within the ALS to oversee investigations of incidents as they occur and ensure that corrective actions are implemented. Fact finding must start immediately and include interviewing all personnel directly involved in incident, securing electronic logs, log books, shielding change forms etc.. The ALS staff and LBNL management should immediately be informed about an incident having happened and that a thorough investigation has started. As soon as the fact finding phase is completed, details should be communicated in a timely manner to the staff for information and a final vetting. The lessons learned from a proper investigation based on root cause analysis and corrective actions determinations must also be communicated to ALS staff in a timely manner. We recommend that ALS provide the proper professional training in investigation methods (e.g. TapRooT®) to selected staff.	I
6. The ALS Director and DDD need to ensure that future PIT recommendations and those from other committees are tracked to completion, and that closure is communicated back to the recommenders. One of the mechanisms that the ALS has used in the past to deal with near miss incidents is by setting up Process Improvement Teams (PIT) that are tasked to come up with recommendations and corrective actions to be implemented by the ALS management. The PIT process seems to be an effective mechanism for analyzing and developing solutions when problems occur. The PIT process taps the	I

expertise and experience of the various groups and disciplines at the ALS and develops workable solutions. This process also has the direct benefit of engaging personnel in improving safety at work. PIT teams in 1999 and 2004 both recommended implementation of the work permit system and creation of the Accelerator Coordinator or Facility Coordinator (FC) position. In fact, it was referenced in the 2004 PIT report that the recommendations of the 1999 PIT report were not followed with respect to the implementation of the Work Permit System (WP) and creation of the Facility Coordinator (FC) position. In both cases the PIT team supplied detailed reports with a proposed WP system, and a position description for the FC. These recommendations were followed up in an unsatisfactory manner which left a perception with many of the employees of unresponsiveness of the management. The ALS Director and DDD are urged to ensure that future PIT recommendations and those from other committees are tracked to completion, and that closure be communicated back to the recommenders.	
ALS ES&H and LBNL EH&S issues	
7. **Laboratory management should clarify and enforce the safety roles and responsibilities of the ALS and EH&S.** Separation must be provided between a) compliance/oversight and b) EH&S Division tech support to facility/users and c) in-house ALS ES&H support. The function and role of the current ES&H group within the ALS organization must be revisited. For example, the proper function for the group would be to provide and coordinate user support from the vantage point of fabricating and implementing user systems safely and in accordance with rules and regulations (i.e., facilitate compliance with DOE, OSHA and LBNL rules). Facility oversight and enforcing compliance would not be part of this function but instead would entirely be the privy of EH&S proper. We note that compliance enforcement by EH&S is an essential function but must be strengthened with respect to the ALS as it has been weak in the past. We heard during the interview that the previous Radialogical Control Manager treated the ALS as an exception and did not require rigorous oversight by the RSC for all radiation related activities at the ALS.	II

Specifically we recommend that the RCT who is currently matrixed to the ALS must be paid for and managed by EH&S. It is noted that the current RCT arrangement is unique to the ALS and may impact the objectivity in the long run with respect to fulfilling safety responsibilities. The ALS-ES&H group needs to be led by a person with significant and demonstrated technical expertise in safe operation of complex research facilities and a strong appreciation for radiation safety and other significant hazards of a premier light source. The proper place of this group within the ALS organizational structure and its proper staffing should be determined. Although it is beyond the scope of this subcommittee we also note that laser safety needs considerable attention. During the course of the investigation we were informed about practices that may involve the use of class IV laser systems operating with partially covered beam paths at the ALS without room interlocks, that new class IV systems were being installed without proper supervision and oversight (physical presence) from the laser safety officer or facility coordinator. A complete review of all ALS laser systems and practices should be implemented.	
8. **The functionality of ALS-ES&H and LBNL EH&S within the ALS needs to be improved.** ALS-ES&H is generally perceived as weak and ineffective and the relationship between LBNL EH&S radiation safety personnel and ALS is significantly dysfunctional. Specifically, the interactions between the ALS-ES&H manager and the EH&S Health Physicist and Radiological Control Technician have been non-productive. This situation must be remedied and may include reassignment of personnel.	II
9. **To ensure that all shielding is properly installed and adequate, we recommend that annually a complete review of all shielding configurations on the ALS accompany the radiation survey, including all beamlines, be carried out to document changes and correct issues.** As part of the annual beamline review, all shield change forms from the previous year should be reviewed by the HP to re-evaluate that the shielding configuration is still adequate and matches what's on the floor.	I
10. **We recommend that the level of support in the area of radiation shielding design be increased.** We note that currently there is only one person at LBNL responsible for designing **and** reviewing shielding designs and shielding installation and use. We are concerned with the fact that the same person	II

carries out these two functions. The current process for implementing shielding configuration and its control is to rely on a single person for technical advice to the DDD for policy implementation. The SSC needs to become involved in this and provide oversight and ensure opinions are heard so that issues are resolved to the satisfaction of the ALS community. We have recommended that the current HP would be involved in implementing and interpreting trending analysis for shielding practices at ALS (see below). This added task again implies hiring an additional highly qualified individual.	
Administrative and engineering controls	
11. **The ALS shielding policy must be clearly communicated to ALS staff and regular RAT retraining must be enforced.** There has been considerable confusion recently regarding the definition of what constitutes beamline radiation shielding. The current definition is stated in the Radiation Awareness Training (RAT) document ALS5001 as "Beamline shielding includes bremsstrahlung shielding (BS), exclusion zones (EZ), leaded windows (LW), supplemental shielding (SS), X-ray shielding (XS), and any part of an enclosure designed to contain synchrotron radiation including hutches and beam pipes". This document clearly also states to contact the ALS RCT, BLC or ALS Control Room to take a beamline Off-Line for removal and modification of existing shielding. There are specific cases where a more detailed definition is needed for unique beamline components (for example, ion pumps, vacuum valves, ion gauges, turbo pumps and end stations in general), to ensure that the shielding is not compromised by inadvertent removal or modification of the component.	I
12. **Pending a complete review of BLC and operator functions, we recommend that key enable procedures only be performed by full time BLCs.** An RSS chassis RF interlock fault may be reset by control room operators provided the RSS chassis is put in the Off-Line state again immediately after the reset. To re-enable a beamline will then require a full time BLC to execute a full key-enable procedure.	I

13. Any TPSR tool can only be issued to a BLC by an operator, the TPSR tool check-out list needs to be immediately removed from the control room and the policy that only BLCs can check-out the TPSR tool needs to be enforced. Institutional practices have been discovered in the process of our investigation that effectively use a short cut to bypass the use of required procedures. Specifically, the use of a list containing names of personnel to which the TPSR tool can be checked out was in conflict with the actual procedure (BL 08-24) that states that the TPSR tool can only be checked out by the BLC. The original intent of the list was for BLCs to know who was properly trained to use the tool. Loss of sight of the original intent led to operators using the list to issue the tool directly to personnel on the list, without operators assuming the role of BLC as per procedure. The list was also not referenced in any procedure nor was its use documented anywhere. This inappropriate use of this list must be stopped immediately. Any list of persons authorized to perform specific work must be part of the procedure that describes the work (such as an appendix). ALS management must periodically evaluate facility operations for other instances where practice deviates from procedure. The BLC must escort the user to the beamline and ensure that the beamline is Off-Line, and all steps in procedure OP 02-04 are followed. For removal of mini-hutch fixed panels, following verification of the safe state of the beamline, the TPSR tool can be handed to the user by the BLC in accordance with BL 08-24. All other uses of the tool must follow procedure BL 08-25. To ensure that each TPSR tool is an ALS sanctioned tool, a special metal tag needs to be attached to each TPSR tool stating that "only authorized users can be in possession of the tool and if found must be returned to the CR".	I
14. The control of the TPSR tool needs to be reevaluated and the procedures need to be clarified and corrected where needed. Engineering controls should be implemented for securing and controlling shielding configuration whenever possible. For example, for each beamline, RSSD keys and unique tools could be physically linked to a key that is captured in an RSS chassis. Removal of the key from the chassis is needed to enable use of key/tool and causes beamline RSS to go Off-Line. To go back On-Line then requires a full key-enable procedure to be followed. Only personnel fully trained as a beamline coordinator can remove captured key and provide key/tool to the BLS.	II

15. Given the frequent access needs for the beam-line 4.2.2 mono-enclosure, all hinged panels need to be secured with a uniquely keyed lock (instead of tool) attached by welded ring to a second key that is captured in the RSS chassis.	I
16. All motors inside 4.2.2 mono-shielding enclosure need to be equipped with uninterruptible power supplies to avoid loss of encoder position.	I
17. Beamline 4.2.2 mono-enclosure and equipment needs to be reviewed by the newly ALS appointed standing safety committee (SSC) to look at radiation protection, equipment robustness and reliability and general operation practices, with a goal of reducing shielding access frequency.	I
18. Standards for frequency of access to equipment inside shielding need to be established by ALS in consultation with EH&S. For example, infrequent (frequent) access is less (more) than once a month. The RSSD used needs to be appropriate to the frequency of access. We recommend that the current RSSD use be reviewed by the SSC.	II
19. Trending and regular analysis of shielding access and reasons why should be implemented by appropriately trained individuals. Trending should be started immediately.	I
For the longer term, we recommend that the SSC consider the implementation of a Beamline Work Authorization (BWA) program. The approach would be that any beamline coming Off-Line must have a BWA approved and completed before it can be keyed on. The BWA would start with the key off signature and verification, followed by a brief description of work and appropriate required signatures before the form can be closed out and a key enabling allowed. No work by anyone can start until a BWA has been initiated and has two "Beamline Keyed Off" signatures. Each beamline could have a designated spot where an active BWA is posted so that anyone working on the beamline could see that there is one and it has the initial two signatures. Anyone doing work not listed on the BWA would have to either generate a new one or have the current one amended. Any beamline found Off-Line w/o BWA (since anyone can take a beamline Off-Line) or with work performed but not listed on the w/ no BWA would require a full key enable. ALL beamline work should require a BWA and all BWA's should require RCT inspection and signoff. (Beamline is defined as any part upstream of the endstation.) The RCT would simply be making	II

sure the beamline goes back to the configuration for which the results of the annual commissioning survey are still valid. This may also be part of a strong Work Permit system.	
20. Lessons learned from trending should be acted upon appropriately and immediately. Corrective action to minimize access should be implemented first. If this is deemed not sufficient then appropriate RSSDs need to be implemented that are commensurate with the frequency of access (e.g. building a hutch to enclose the systems in need of frequent access). This would include re-evaluating possible equipment and shielding improvements by an ALS appointed committee. The lessons should be shared with all ALS employees and users.	II
21. Means of clearly displaying and archiving beamline status in control room and at beamline needs to be implemented. Each beamline's ON/OFF status should be prominently displayed at the outer perimeter of building near each sector. For example, TV monitors could be used to show status of beamlines and whether or not they are intentionally Off-Line. Signage for each sector should be implemented near the display monitors that indicate the location of the RSS chassis and beamline log books.	II
22. Implement a secure method for ensuring that beamlines taken intentionally Off-Line are clearly marked as such and remain Off-Line. This process would enforce ownership of who took it Off-Line, and documents why and when it was taken Off-Line. For instance, a locking cover over the key-enable switch could be installed. The key to the locking cover would be kept in the control room key-locker and the cover would be tagged with the information who and when it was installed. Or another solution might be a suitable eye bolt installed above the RSS key enable lock cylinder that would allow the attachment of a durable LOTO type tag with the information who and when it was installed. This would be very similar to what is proscribed by OSHA for LOTO of energy sources.	I
23. All RSS state changes need to be electronically archived and preserved indefinitely for all beamlines. In general, electronic logging needs to be implemented for all safety related systems as soon as possible and extended to include as many system components as possible, including the beamlines. Event logger	II

data must include all safety related shutters and devices. Electronic logging is also needed to provide accurate On-Line status information of each beamline for display purposes. It should also be noted that the event logger data has been essential in reconstructing events related to the incidents under investigation.	
Training and procedures	
24. **Safety culture training and greater awareness of ISM needs to be instilled from top-down.** Management at all levels should be encouraged to walk around the facility and become familiar with the activities and look for safety issues. Training can be obtained in learning how to look for safety issues. For example the JGI recently hired a outside consultant to train all managers to spot a wide variety of safety concerns and they have reported that this program has been successful.	I/II
25. All procedures relating to shielding configuration control must be critically reviewed. A quick read through several procedures has uncovered areas of concern. For example,	I
- Procedures BL 08-25 and BL 08-16 Appendix 2 B need to be checked for consistency.	I
- Procedures BL-08-24, OP-11-01 need to be corrected and updated. Specifically, procedure BL-08-24, Rev. 4 section 5.3, step 2 must be a note (instead of a step), stating that "Removal of panels must be done in accordance with procedure OP 02-04, Shielding Control Procedure and requires first to contact the BLC"; in procedure OP11-01, Rev.4, the note in section 5.0 [2] should state that "other keys and tamper-proof screw tools can only be issued to BLCs trained in the appropriate procedures"	I
- Add a step in procedure EC 02-15 that requires noting and recording the status of RSS chassis for each beamline.	I
- Procedure OP 02-04 refers to BL 08-18 which is no longer existent on the procedure website (superseded by BL 08-26). Guideline restrictions in Section 5.1 [3] in that same procedure refer to a right hand column but should be the left hand column.	I
26. Supervisors must conduct a thorough review of ALS staff and user activities, ensure proper training and correct deficiencies.	I

Supervisors are directly responsible for ensuring that all personnel are properly trained in all relevant job specific procedures, and are to be held accountable if training deficiencies exist.	
27. The ALS needs to determine how to ensure that at any given time the responsibility for each beamline and its users is properly assigned, with clear responsibilities and accountabilities defined. A single person (ALS-ES&H safety manager) is currently listed as the supervisor for all visiting users to the ALS (between 500 and a 1000 at any given time), which we deem to be an untenable situation that must be corrected. In general, we note that the responsibility for beamline hardware lies with the beamline scientist, that the beamline scientist is a co-signer on the experimental system safety form but that the person responsible for beamline users is not well defined. The most logical approach would be to assign the responsibility for training and safety of users to beamline scientists and/or their deputy. Beamline scientists could act as the matrix supervisor responsible for the beamline specific safety training of the users assigned to that beamline. If a user moves to another beamline, the responsibility moves to the BLS of that beamline. This responsibility will include ensuring that a JHQ is filled out and that training requirements are met.	II
28. A JHQ-like system needs to be implemented to allow proper tracking of training and serve as a tool for accountability. For example, the current JHQ system could be used as a platform to specify and track required training for operators, BLCs, vacuum technicians, etc.	II
29. Training for essential Facility safety systems procedures (interlocks, EPS, vacuum, RF) should be done by dedicated instructor (e.g. supervisor, system expert/procedure author) and a formal examination process should be considered to accurately evaluate procedure proficiency for safety-significant procedures. While teaching procedures, an unequivocal statement must be included that procedures are to be strictly followed or a stop-work must be executed if procedural changes are deemed necessary, if a procedure is not understood, or an unanticipated event occurs. If cause for an event remains unclear, supervisors must be notified before proceeding. Supervisors must also be notified upon the completion of safety system	I

relevant procedures and debriefed on the work performed. Any irregularities must be noted and addressed immediately. Supervisors must then initial that procedure has been discussed with employee who completed it. Emphasis during training needs to be placed on *why* steps are performed, not just how. Particularly for radiation safety, training should include examples of the level of radiation at different machine systems and what the consequences are if safety is compromised.	
30. Teams carrying out safety significant procedures must be led by a qualified and highly experienced employee (e.g. EM supervisor). New team members must be supervised (i.e. watched) at all times by an additional experienced team member during the execution of the work to ensure compliance and proper training. A team with a new team leader must be supervised by a previous team leader or systems expert.	I
31. Formal hand-off procedure between shifts needs to be implemented to ensure that BLCs are properly informed of status of the beamlines and user activities, including a report on the status of all beamlines. This procedure would also establish who is BLC in charge. For example, a unique cell phone can be used as a baton to be passed from one BLC to the next. Users can contact BLCs through this cell phone and BLC on-duty is clearly identified. This cell phone can also be used as part of the system that automatically notifies BLCs of changes in state of a particular beamline.	I II
32. A system by which BLC is notified whenever a beamline RSS chassis changes state needs to be implemented. BLC on duty should then be required to investigate and document the reason and take appropriate measures for safe operation. This could be accomplished by the electronic event logger sending a page to a pager or cell phone, owned by the BLC, whenever a relevant Boolean is flipped.	II
33. The use of beamline log books by anyone affecting beamlines, including RSS chassis resets, needs to be standardized. All pertinent information pertaining to a particular beamline status, safety etc. should be located in a	I

central location for each sector, e.g., on the outer perimeter inside the building. Beamline log books that document maintenance need to be kept near the RSS chassis.	
34. Logging of beamline associated keys located in the control room key locker should include a note in the beamline coordinator log book, located in the control room, on how the key was used.	I
35. In addition to the ALS safety video and procedures, we recommend that a pamphlet be written, aimed at all ALS personnel (LBNL employees or not) working on beamlines. This pamphlet would educate about the various safety systems at the ALS. This would include brief descriptions of the RSS and EPS systems, how they communicate with each other, what gets key-enabled (RSS) and keyed-open (EPS), where various Off-Line and crash-off buttons are and what they do. This education will help empower ALS staff to take a beamline Off-Line anytime they feel something is potentially amiss, without fear that they're dumping the electron beam in the whole storage ring, and with the assurance that BLCs will promptly help to investigate and key-enable when safe.	III

IX. APPENDICES

Appendix A: Request from C. Donahue to RSC

Subject:
RSC Investigation
Date:
Tue, 22 Nov 2005 17:29:14 -0800
From:
Christine Donahue <CADonahue@lbl.gov>
To:
David K Shuh <DKShuh@lbl.gov>

David,

As acting Radiological Control Manager, I request that the Radiation Safety Committee (RSC) lead an investigation of the recent ALS shielding control procedure violations. The investigation should assess the effectiveness of current shielding control procedures, engineering controls, training, EH&S staff support and management oversight as needed to develop proposed corrective actions to prevent the likelihood of recurrence. I recommend that the investigation team be comprised of RSC members, at least one representative from the ALS user or engineering staff and, if possible, an individual who has served on an RSC investigation team in the past.

Thank you for your attention to this matter.

Christine Donahue

Appendix B: Charge letter from David Shuh to RSC subcommittee.

MEMORANDUM

TO: Warren Byrne (AFRD)
Robert Duarte (ENG)
David Kestell (EHS)
Wim Leemans (AFRD)
Michael Martin (ALS)
Art Ritchie (ALS)
David Robin (AFRD)

CC: Steven Chu, Director
Christine Donahue, Acting Radiological Control Manager
Ben Feinberg, Deputy Division Director, ALS
Janos Kirz, Acting Division Director, ALS
David McGraw, Chief Operating Officer
Phyllis Pei, Division Director, EHS
Radiation Safety Committee Members

FROM: David K. Shuh, Radiation Safety Committee Chair
DATE: 29 November 2005
SUBJECT: RSC Sub-committee to Investigate and Review ALS Shielding Control Procedures

Thank you for agreeing to serve on the Radiation Safety Committee (RSC) sub-committee to review and investigate the recent shielding control incidents at the Advanced Light Source (ALS). I have attached the charge from the Acting Radiological Control Manager, Christine Donahue, for the committee to review the ALS incidents. I ask the committee to submit its draft report for RSC review by 22 December 2005. The report will be discussed at a special meeting of the RSC in the first week of January 2006.

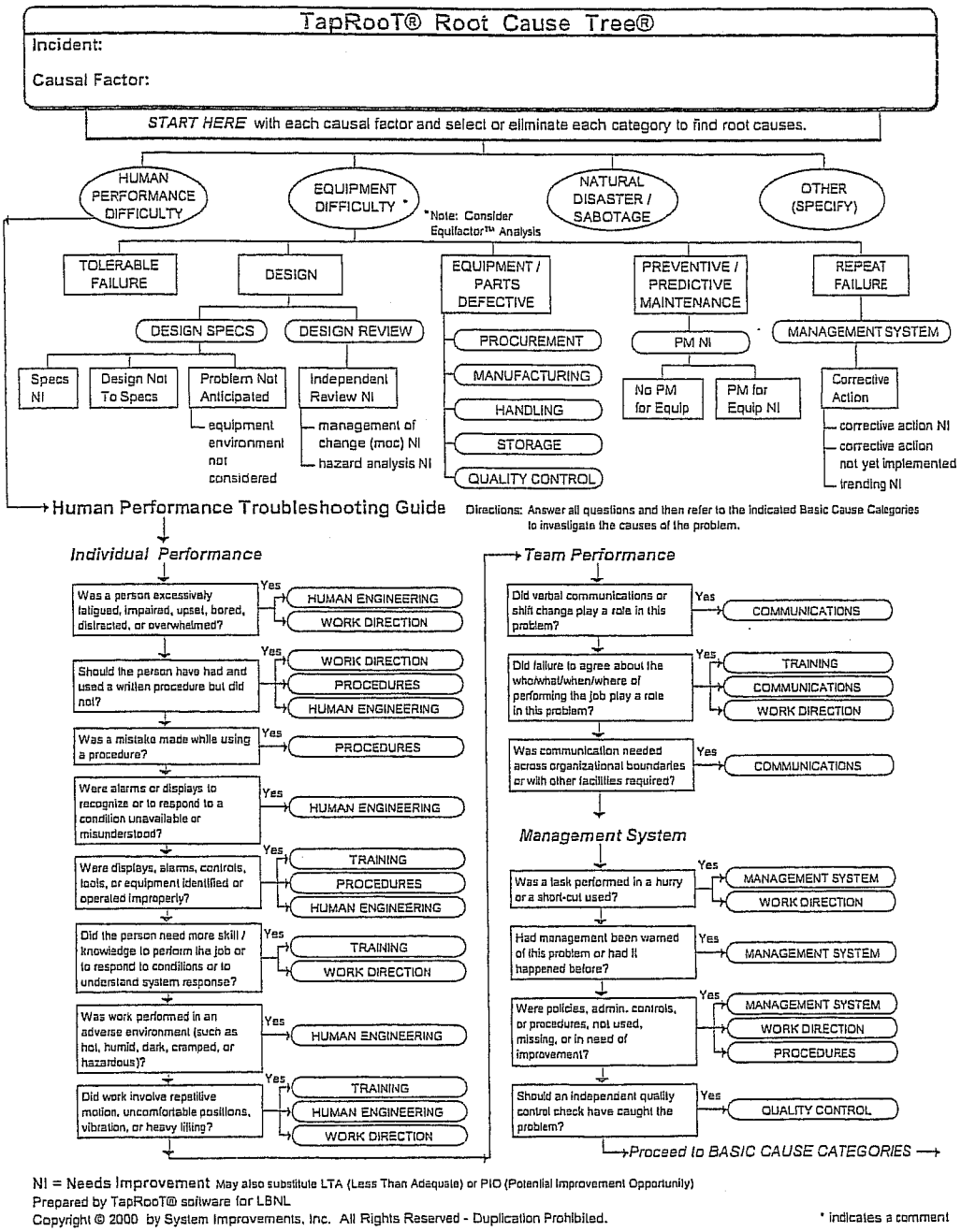
Since this is an RSC commissioned committee, I have asked Wim Leemans as an RSC member, to chair the committee and he has agreed. Ben Feinberg of the ALS will provide background documentation on the incidents as a starting point for your investigation. In addition to the review of the incidents, the final report should include a root cause analysis and suggested corrective actions.

I would like to personally thank each of you for agreeing to take your valuable time and review this situation. If I can be of any assistance during the process please do not hesitate to contact me.

David K. Shuh
Chair, LBNL Radiation Safety Committee

David K. Shuh <DKShuh@lbl.gov>
Senior Staff Scientist
Ernest O. Lawrence Berkeley National Laboratory
Chemical Sciences Division, TEL. 510.486.6937

Appendix C: TapRoot® Root Cause Tree®



NI = Needs Improvement May also substitute LTA (Less Than Adequate) or PIO (Potential Improvement Opportunity)

Prepared by TapRooT® software for LBNL

* indicates a comment

TapRooT® Root Cause Tree®

Incident: 1

Causal Factor: 01

BASIC CAUSE CATEGORIES

PROCEDURES

- Not Used / Not Followed
  - no procedure
  - procedure not available or inconvenient for use
  - procedure difficult to use
  - procedure use not required but should be
- Wrong
  - typo
  - sequence wrong
  - facts wrong
  - situation not covered
  - wrong revision used
  - second checker needed
- Followed Incorrectly
  - formal confusing
  - > 1 action / step
  - excess references
  - mult unit references
  - limits NI
  - details NI
  - data/computations wrong or incomplete
  - graphics NI
  - no checkoff
  - checkoff misused
  - misused second check
  - ambiguous instructions
  - equip identification NI

TRAINING

- No Training
  - task not analyzed
  - decided not to train
  - no learning objective
  - missed required training
- Understanding NI
  - learning objective NI
  - lesson plan NI
  - instruction NI
  - practice / repetition NI
  - testing NI
  - continuing training NI

QUALITY CONTROL

- No Inspection
  - inspection not required
  - no hold point
  - hold point not performed
- QC NI
  - inspection instructions NI
  - inspection techniques NI
  - foreign material exclusion during work NI

COMMUNICATIONS

- No Comm. or Not Timely
  - comm. system NI
  - late communication
- Turnover NI
  - no standard turnover process
  - turnover process not used
  - turnover process NI
- Misunderstood Verbal Comm.
  - standard terminology not used
  - standard terminology NI
  - repeat back not used
  - long message
  - noisy environment

MANAGEMENT SYSTEM

- Standards, Policies, or Admin Controls (SPAC) NI
  - no SPAC
  - not strict enough
  - confusing or incomplete
  - technical error
  - drawings / prints NI
- SPAC Not Used
  - comm. of SPAC NI
  - recently changed
  - enforcement NI
  - no way to implement
  - accountability NI
- Oversight / Employee Relations
  - infrequent audits & evaluations (a & e)
  - a & e lack depth
  - a & e not independent
  - employee communications NI
  - employee feedback NI
- Corrective Action
  - corrective action NI
  - corrective action not yet implemented
  - trending NI

HUMAN ENGINEERING

- Human - Machine Interface
  - labels NI
  - arrangement / placement
  - displays NI
  - controls NI
  - monitoring alertness NI
  - plant / unit differences
  - excessive lifting
  - tools / instruments NI
- Work Environment
  - housekeeping NI
  - hot / cold
  - wet / slick
  - lights NI
  - noisy
  - obstruction
  - cramped quarters
  - equipment guard NI
  - high radiation / contamination
- Complex System
  - knowledge-based decision required
  - monitoring too many items
- Non-Fault Tolerant System
  - errors not detectable
  - errors not recoverable

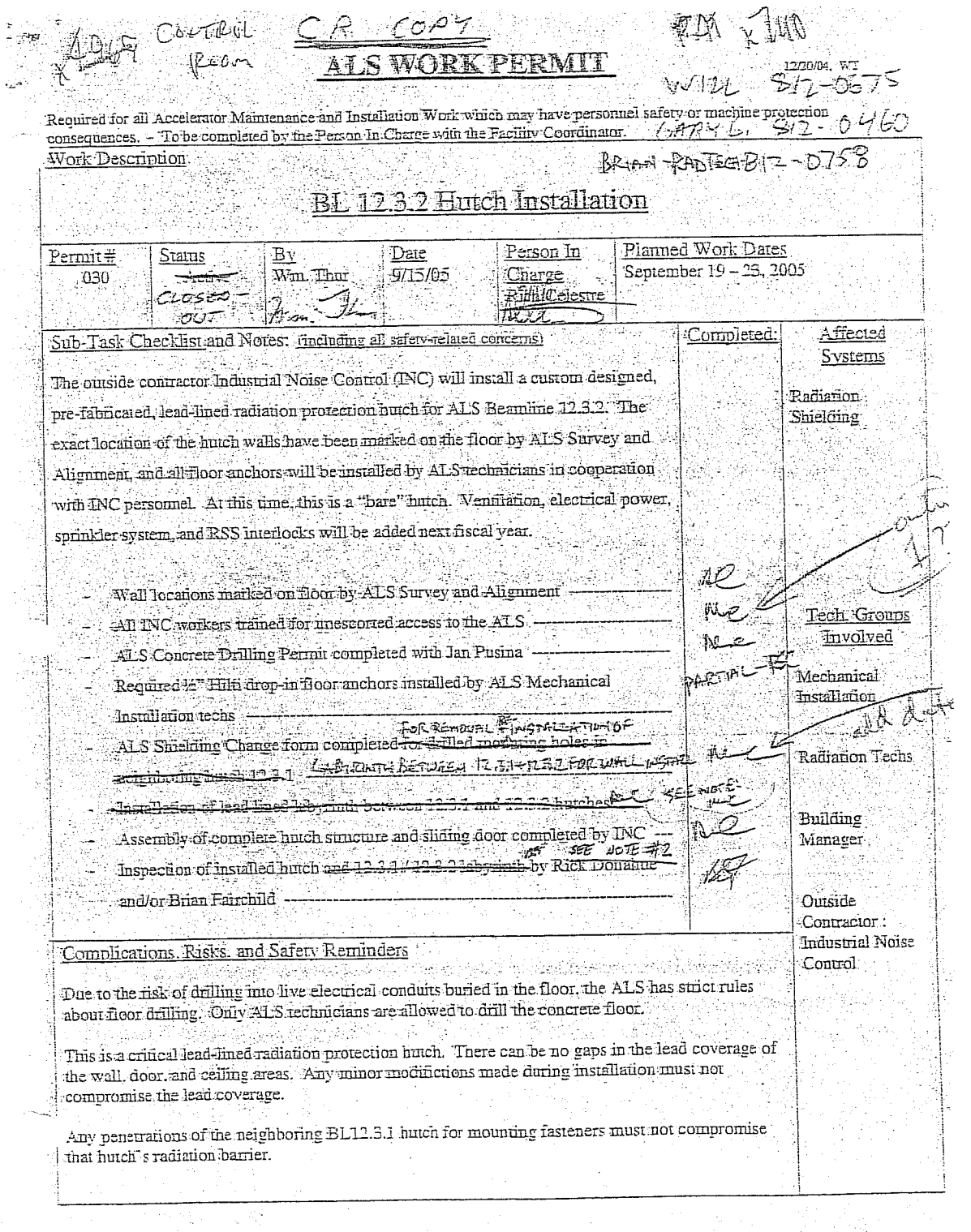
WORK DIRECTION

- Preparation
  - no preparation
  - work package/ permit NI
  - pre-job briefing NI
  - walk-thru NI
  - scheduling NI
  - lock out / tag out NI
  - fall protection NI
- Selection of Worker
  - not qualified
  - fatigued
  - upset
  - substance abuse
  - team selection NI
- Supervision During Work
  - no supervision
  - crew teamwork NI

NI = Needs Improvement May also substitute LTA (Less Than Adequate) or PIO (Potential Improvement Opportunity)

Prepared by TapRooT® software for LBNL

* indicates a comment



ADP Control Room C.R. COPY

ALS WORK PERMIT

12/20/04. WT

Required for all Accelerator Maintenance and Installation Work which may have personnel safety or machine protection consequences. – To be completed by the Person In Charge with the Facility Coordinator.

Work Description

BL 12.3.2 Hutch Installation

Permit #	Status	By	Date	Person In Charge	Planned Work Dates
030	~~Active~~ CLOSED - OUT	Wm. Thur	9/15/05	~~Rifili~~/Celestre	September 19 – 28, 2005

Sub-Task Checklist and Notes: (including all safety-related concerns)

The outside contractor Industrial Noise Control (INC) will install a custom designed, pre-fabricated, lead-lined radiation protection hutch for ALS Beamline 12.3.2. The exact location of the hutch walls have been marked on the floor by ALS Survey and Alignment, and all floor anchors will be installed by ALS technicians in cooperation with INC personnel. At this time, this is a "bare" hutch. Ventilation, electrical power, sprinkler system, and RSS interlocks will be added next fiscal year.

- Wall locations marked on floor by ALS Survey and Alignment ——— Completed:
- All INC workers trained for unescorted access to the ALS ———
- ALS Concrete Drilling Permit completed with Jan Pusina ———
- Required ½" Hilti drop-in floor anchors installed by ALS Mechanical Installation techs ———
- ALS Shielding Change form completed ~~for drilled mounting holes in neighboring hutch 12.3.1~~ FOR REMOVAL & INSTALLATION OF LABYRINTH BETWEEN 12.3.1 & 12.3.2 FOR WALL INSTAL ———
- ~~Installation of lead lined labyrinth between 12.3.1 and 12.3.2 hutches~~ SEE NOTE #1
- Assembly of complete hutch structure and sliding door completed by INC ———
- Inspection of installed hutch ~~and 12.3.1 / 12.3.2 labyrinth~~ by Rick Donahue and/or Brian Fairchild ——— SEE NOTE #2

Affected Systems: Radiation Shielding

Tech. Groups Involved: Mechanical Installation; Radiation Techs; Building Manager; Outside Contractor: Industrial Noise Control

Complications, Risks, and Safety Reminders

Due to the risk of drilling into live electrical conduits buried in the floor, the ALS has strict rules about floor drilling. Only ALS technicians are allowed to drill the concrete floor.

This is a critical lead-lined radiation protection hutch. There can be no gaps in the lead coverage of the wall, door, and ceiling areas. Any minor modifications made during installation must not compromise the lead coverage.

Any penetrations of the neighboring BL12.3.1 hutch for mounting fasteners must not compromise that hutch's radiation barrier.

References (J.O.s, Procedures, Dwgs, etc.)

BL 12.3.2 Radiation Hutch construction drawing by INC

Floor anchor calculations by Wm. Thur

Comments from Work Site – Complications, Concerns, Deviations from Plan, Advice for Next Time
(handwritten, attach sheet if necessary)

#1 LABYRINTH BETWEEN 12.3.1 + 12.3.2 HUTCHES REQUIRES ADDITION OF LEAD SHIELDING. (see A)

#2 Hutch panels are installed correctly by visual verification only. Top Labyrinth for air conditioning has Light visible around seams No Leaded glass windows are installed at this time. Labyrinth between BL12.3.1 & BL12.3.2 Hutch is not Lead-lined as required and must be installed with tamper-resistant bolts/screws prior to final review of hutch. B.E. Tanner 09/23/05

#3 Pb WINDOWS NOT SUPPLIED IAW CONTRACT, WILL NEED TO FOLLOW UP

(new win was installed)

Close-Out by Person in Charge

Signature: A. O'Neill

Date and Time: 26 SEP 05 0915

This work has been completed with due regard for all concerns noted above.
(Reminder: Always make appropriate Log entries.)

Follow-Up Tasks

- INC seismic calculations package and supporting calcs given to Will Thur
- Set of INC photographs of hutch wall internal lead construction given to Rick Donahue
- ~~Radiation survey of completed hutch using Americium sealed source~~ The radiation survey cannot be completed until all hutch construction is complete.
- ITEMS #1 & 3 FROM WORKSITE COMMENTS SECTION.

09/25/05

CONFIDENTIAL

RSC Sub-committee – Report **FINAL** **Wednesday, 18 January 2006**

Appendix E: ALS Shielding Change Form for 12.3.1

Location of change: BL12.3.1 (Beamline #, Sector #, BTS, LINAC) Person initiating form: BRIAN FAIRCHILD (Printed Name)

Reason for change:
- ☐ Remove/Replace existing shielding
- ☐ *Remove beam port plug for installation of beamline penetration (Work Permit Required)
- ☒ Permanent Removal/Modification of existing shielding (Work Permit Required)
- ☐ Add new shielding

All items require RCT Notification

Shielding affected: BL12.3.1 Hutch (Shielding #, Component #, RSSD #)

Description of work being performed: Removal of existing hutch labyrinth off 12.3.1 hutch to be replaced w/ Lead-Lined Labyrinth. ~~Penetration of [illegible]~~

Work performed by: Rich Celestre (Person-in-charge) x4263 ~~ARCHIVE doc~~ (Printed Name / Extension)

Start Date: 09/20/05 Estimated Completion Date: 09/21/05

1. ACCELERATOR and FRONT-END SHIELDING

ALS Contact: _____ Approved: _____ (ALS Operations) _____ (ALS RCT)

Restriction on beam operations: _____

2. BEAM PORT PLUGS

* ALS RCT must check the following shielding and initial before storage ring operation.

_____ PSS installed

_____ Transition wall shielding installed

_____ Front end shielding installed

3. BEAMLINE SHIELDING (Includes beam pipes and hutches)

Beamline offline: John Pfinney (Beamline Coordinator's Name)

Restriction on beam operations: Nonstructural Keyenable completed & RCT approval.

Beamline Coordinator's Initials (Needed for permanent removal/modification of existing shielding and/or add new shielding)

_____ Key-Enable Procedure Updated Or _____ Update Unnecessary

4. WORK COMPLETE (Complete for Sections 1, 2, and 3.)

End Date: 20 SEP 05 Work completed by: RICHARD CELESTRE (Printed Name) (Signature)

Verified by: BRIAN FAIRCHILD (Printed Name) (Signature)

ALS RCT completes the following section for beam port plug removal, permanent removal/modification of existing shielding and/or adding new shielding. This section not required for remove/replace existing shielding.

Radiation Survey Required? ☒ YES ☐ NO

Radiation Survey Complete _____ Initials

Appendix III of Search & Secure (OP 02-07) Updated N/A Initials

Comments: NO RAD DETECTED ON EXTERIOR OF HUTCH

5. OPERATIONAL APPROVAL

Accelerator/beamline may operate without restriction. Shielding work is complete. Initial below:

ALS RCT/Designee (NOT required for remove/replace existing shielding) _____ 09/20/05

Operations Group Leader/OIC (For Accelerator) _____

File original in ALS Control Room in the Shielding Change Binder

OP 02-04, Rev. E, Appendix

Appendix F: Badge entries into the ALS related to the 12.3.2 incident.

Badge Event Report
REPORT LIMITED BY DATE, EMPLOYEE ID, READER
18 entries were found matching your search criteria.

DATE/TIME	L NAME	F NAME	BADGE ID	EMPLOYEE ID	STATUS	DEPT	READER
09/19/2005 08:12:00	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-4-1:6-/80 DR
09/19/2005 09:14:27	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 09:23:54	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 09:36:57	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-7-0:6-1093A ROLLUP MAN DR
09/19/2005 12:28:10	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-5-0:6-WEST INTER DR,COL#17
09/19/2005 13:08:44	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 13:09:27	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 13:45:11	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 14:02:20	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-4-1:6-/80 DR
09/19/2005 14:56:52	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 15:08:25	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 16:31:47	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 16:54:47	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 08:22:07	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 09:06:51	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 10:06:00	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 10:22:50	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 12:54:42	THUR	G W.	151568069340	893425	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM

Badge Event Report
REPORT LIMITED BY DATE, EMPLOYEE ID, READER
4 entries were found matching your search criteria

4 entries were found matching your search criteria.

DATE/TIME	L NAME	F NAME	BADGE ID	EMPLOYEE ID	STATUS	DEPT	READER
09/20/2005 10:19:04	CELESTRE	RICHARD S.	155120385269	291901	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 12:47:43	CELESTRE	RICHARD S.	155120385269	291901	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 16:02:08	CELESTRE	RICHARD S.	155120385269	291901	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 17:13:10	CELESTRE	RICHARD S.	155120385269	291901	ACTIVE	ALS	1-1-1:6-LOBBY INTERIOR DR

Badge Event Report
REPORT LIMITED BY DATE, EMPLOYEE ID, READER
5 entries were found matching your search criteria.

DATE/TIME	L NAME	F NAME	BADGE ID	EMPLOYEE ID	STATUS	DEPT	READER
09/19/2005 10:53:59	MCKEAN	JOHN P.	151568025046	589870	ACTIVE	ALS	1-7-0:6-1093A ROLLUP MAN DR
09/19/2005 11:12:14	MCKEAN	JOHN P.	151568025046	589870	ACTIVE	ALS	1-3-0:6-/10 DR HIBAY
09/19/2005 12:58:51	MCKEAN	JOHN P.	151568025046	589870	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 14:09:13	MCKEAN	JOHN P.	151568025046	589870	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 08:29:26	MCKEAN	JOHN P.	151568025046	589870	ACTIVE	ALS	1-3-0:6-/10 DR HIBAY

Badge Event Report

12:37:12					expiration: 09/20/2006	USERS	HIBAY
09/20/2005 13:41:39	BURGESS	TRAVIS	155120386203	014604	ACTIVE expiration: 09/20/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY
09/20/2005 17:09:00	BURGESS	TRAVIS	155120386203	014604	ACTIVE expiration: 09/20/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY

Badge Event Report

Badge Event Report
REPORT LIMITED BY DATE, EMPLOYEE ID, READER
13 entries were found matching your search criteria.

DATE/TIME	L NAME	F NAME	BADGE ID	EMPLOYEE ID	STATUS	DEPT	READER
09/19/2005 09:23:48	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-1-1:6-LOBBY INTERIOR DR
09/19/2005 09:28:11	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 14:27:59	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 08:45:23	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 09:24:10	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 10:20:18	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-4-1:6-/80 DR
09/20/2005 13:18:06	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 13:33:57	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 15:30:42	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 15:36:58	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-4-1:6-/80 DR
09/20/2005 17:55:07	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 17:57:36	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 18:11:13	DONAHUE	RICHARD J.	154176429499	262901	ACTIVE	ALS	1-4-1:6-/80 DR

Badge Event Report

09/19/2005 13:42:26	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-1:6-/80 DR
09/19/2005 13:57:43	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
09/19/2005 13:59:57	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-7-0:6-1093A ROLLUP MAN DR
09/19/2005 14:38:24	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 14:59:53	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 15:13:30	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
09/19/2005 15:30:14	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-1:6-/80 DR
09/19/2005 15:39:57	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 16:05:53	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 07:42:00	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 07:54:35	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-7-0:6-1093A ROLLUP MAN DR
09/20/2005 07:57:03	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 09:01:13	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 09:34:51	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 09:39:02	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 10:27:06	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-7-0:6-1093A ROLLUP MAN DR
09/20/2005 10:57:22	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 11:22:06	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 11:44:25	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
09/20/2005 13:43:08	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
09/20/2005 14:16:35	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/20/2005 14:18:44	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-3-0:6-/10 DR HIBAY
09/20/2005 14:29:55	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-1:6-/80 DR
09/20/2005 14:38:57	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-7-0:6-1093A ROLLUP MAN DR
09/20/2005 14:48:20	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4

09/20/2005 15:03:40	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
09/20/2005 15:03:43	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
09/20/2005 15:03:45	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
09/20/2005 15:03:52	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4

Badge Event Report

REPORT LIMITED BY DATE, EMPLOYEE ID, READER

11 entries were found matching your search criteria.

DATE/TIME	L NAME	F NAME	BADGE ID	EMPLOYEE ID	STATUS	DEPT	READER
09/19/2005 09:00:13	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	1-7-0:6-1093A ROLLUP MAN DR
09/19/2005 10:27:50	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
09/19/2005 16:21:13	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 08:37:40	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 08:45:22	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	1-3-0:6-/10 DR HIBAY
09/20/2005 09:46:13	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 10:14:09	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 12:18:10	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	1-1-1:6-LOBBY INTERIOR DR
09/20/2005 17:50:22	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	39-6-1:6-1990 LOBBY ENTRY
09/20/2005 17:50:27	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	39-7-0:6-1993 HALLWAY ENTRY
09/20/2005 18:18:19	FRANKEL	KENNETH A.	154176430040	289750	ACTIVE	Unknown	1-1-1:6-LOBBY INTERIOR DR

Badge Event Report

REPORT LIMITED BY DATE, EMPLOYEE ID, READER

16 entries were found matching your search criteria.

DATE/TIME	L NAME	F NAME	BADGE ID	EMPLOYEE ID	STATUS	DEPT	READER
09/19/2005 12:49:35	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	39-7-0:6-1993 HALLWAY ENTRY
09/19/2005 13:22:31	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY
09/19/2005 13:22:47	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY
09/19/2005 13:36:10	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	39-7-0:6-1993 HALLWAY ENTRY
09/19/2005 14:03:58	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY
09/20/2005 07:29:55	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	39-6-1:6-1990 LOBBY ENTRY
09/20/2005 07:32:37	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	39-6-1:6-1990 LOBBY ENTRY
09/20/2005 07:32:40	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	39-6-1:6-1990 LOBBY ENTRY
09/20/2005 07:36:22	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	1-7-0:6-1093A ROLLUP MAN DR
09/20/2005 07:45:46	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY
09/20/2005 08:22:39	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY
09/20/2005 08:59:56	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY
09/20/2005 09:02:32	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY
09/20/2005 12:39:01	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY
09/20/2005 14:32:09	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	39-7-0:6-1993 HALLWAY ENTRY
09/20/2005 14:36:10	ALEKSIC	DAN	154176428906	007393	ACTIVE expiration: 09/19/2006	ALS-USERS	1-3-0:6-/10 DR HIBAY

Appendix G: Initial 12.3.2 incident report

9/21/05
Wm. Thur

September 20, 2005
Removal of BL 12.3.1 Cable Labyrinth Plate

Chronology

The outside contractor for the BL12.3.2 hutch, Industrial Noise Control, did not arrive at the ALS until mid-day on the September 19th one-day shutdown. The new 12.3.2 hutch components were available, and the INC crew consisted of Dan Aleksic, who is ALS-badged and has experience with previous hutch installations here, and his helper, Travis Burgess.
On the afternoon of September 19th, the goal was to get the hutch sill plates and the structural steel end-frame fully installed. The large and heavy structural steel end frame required help and equipment from the LBNL Riggers to manuever it into place.
There was a sense of urgency because the vibrations from hammer-drilling for floor anchors would upset experiment operations the following day. Travis Burgess, not yet ALS-badged, worked in an "escorted" status. Per our policy, the floor drilling and anchor installation was done by ALS techs Dennis Hull and Monroe Thomas, who stayed until about 4:30 to get the job done.

The 12.3.2 hutch installation was pre-planned, and is covered by ALS Work Permit 030, which was posted with supporting documents at the work site. The Person In Charge for this Work Permit is Rich Celestre. Rich had a long-planned vacation day on September 19th, and Pat McKean and Will Thur stood in for work supervision.

The next morning, Will Thur was checking on the installation work periodically. Dan and Travis aimed to install as many of the pre-fabricated lead lined steel wall panels as possible, starting with the wall immediately adjacent to the existing BL12.3.1 hutch. The panels were heavy and difficult to manuever, and some in-situ trimming and fitting was required. The work pace urgency of the previous day seemed to carry over to this morning. This wall contained an aperture for the existing cable labyrinth plate on the 12.3.1 hutch, but sliding the wall panels behind the structural frame required the temporary removal of the labyrinth plate. Dan Aleksic realized that this was a radiation shielding component, and he verbally enquired of the experimenter in the BL12.3.1 hutch whether access was permissable at that time. BL12.3.1 was not taking beam, the shutter was closed, and the quick answer was yes. Although Will Thur had been present earlier, he was not there at the time this was done. The panel fitting process was not straightforward, and the labyrinth plate was off for about half an hour when it became a concern to the experimenter who reported it to Beamline Coordinator John Pruyn, who summoned Radiation Techs Brian Fairchild and Rick Donahue. They were very concerned and immediately keyed off BL12.3.1 and initiated an ALS Shielding Change Form to document the process. Will Thur and Rich Celestre were both then present, and shared their concern; - not that there had been any possibility of radiation exposure in this

case, but that the Shielding Change Procedure and keying-off of the beamline had not been done as required.

Later in the morning, Will Thur escorted Travis Burgess to the ALS Users Office for his training and badging session, so that he would no longer require an escort. The rest of the hutch installation work is now proceeding steadily, with occaisional help from the ALS techs.

Recommendations to Ben from Georgeanna and Will on October 18th:

Last week Georgeanna and I talked at some length about what additional measures could be taken to prevent a re-occurance of the labyrinth plate removal that happened during the installation of the new BL 12.3.2 hutch on September 20th.

We agreed that this was a minor incident which happened as a result of compound oversights (some on my part). It could be taken as a wake up call, however, and we need to think seriously about how similar hazards can be prevented.

At a very basic level, the root of the situation is simply our practice of having outside contractor personnel working independently at the ALS. This is a natural mode of doing business, but it may be a mis-match for our mix of extremely high safety / environmental standards and the technical complexity of this busy accelerator facility. We require about an hour's worth of ALS training for contractor personnel, and this is important to give them a realistic idea of radiation hazards in terms of their own safety. However, this training cannot even come close to aquainting them with all of our Procedures, policies, and requirements for operational safety. Contractors are here to do a well-defined task, which they will invariably do by their own methods and with their own sense of urgency, and it is up to us to make sure that they don't run amok of any of our rules in the process.

What can be done? The first instinct is close supervision by ALS personnel. This is not always comfortable. I can recall times on this job when Pat McKean, Rich Celestre, and I were all standing around with our arms crossed watching these two contractors sweating hard to install the heavy lead lined hutch panels. Eventually the non-workers wandered away to let them get on with it, and that's when the labyrinth plate was removed and the lead sawdust fell on the floor. I think that a better solution would be to have our own technicians lined up to work with the contractor on installation projects. We have two very conscientious and hard-working techs in Dennis and Monroe, and they are very aware of the safety constraints at the ALS. If they were working side by side with the contractor, I'm sure that they would not be shy about pointing out and enforcing our rules.

This would require a minor attitude adjustment on the business side. We would have to accept that this manpower contribution is monetarily worthwhile for the added level of control over the work. I think that it is, and if it were presented to Dennis and Monroe in the right way, they would willingly take it on. And psychologically, it is much more workable than adding more policemen.

At a more literal level, Georgeanna and I also discussed labeling for the hutch labyrinth plates. The labyrinth plates are the one hutch component most likely to be accessed, modified, etc. to accomodate functional changes. A neat adhesive label with the following wording would be useful: "This labyrinth is a radiation barrier. It _must _not be removed or modified at any time without keying off the beamline and completing a Shielding Change form."

I know that some of us feel that written warnings can multiply to the point where they are generally ignored, but I think that these labels would be worthwhile and could potentially prevent a real accident. I would be happy to take on the project of getting these labels made and installed.

- Will

Appendix H: Badge entries into ALS related to incident 4.2.2

Angelic Pearson

DATE/TIME	L NAME	F NAME	BADGE ID	EMPLOYEE ID	STATUS	DEPT	READER
10/16/2005 11:28:03	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
10/16/2005 12:52:16	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/16/2005 13:01:39	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	39-6-1:6-1990 LOBBY ENTRY
10/16/2005 13:03:38	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-1-1:6-LOBBY INTERIOR DR

Ed Westbrook

DATE/TIME	L NAME	F NAME	BADGE ID	EMPLOYEE ID	STATUS	DEPT	READER
10/16/2005 09:05:38	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-0:6-1987 SECTOR #4
10/16/2005 09:10:25	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR
10/16/2005 09:12:24	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR
10/16/2005 09:13:38	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR
10/16/2005 09:22:59	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR
10/16/2005 13:43:38	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-6-1:6-80-107 ALS CLEAN ROOM
10/16/2005 13:57:10	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR
10/17/2005 09:34:58	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR
10/17/2005 09:38:06	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR

10/17/2005 11:08:49	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR
10/17/2005 11:50:52	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR
10/17/2005 12:16:02	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR
10/17/2005 13:05:10	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-1:6-/80 DR
10/17/2005 13:22:46	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-6-1:6-80-107 ALS CLEAN ROOM
10/17/2005 23:23:04	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-6-1:6-80-107 ALS CLEAN ROOM
10/17/2005 23:26:45	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-6-1:6-80-107 ALS CLEAN ROOM
10/17/2005 23:31:46	WESTBROOK	EDWIN	154176430170	000759	EXPIRED expiration: 10/18/2005	ALS-USERS	1-4-0:6-1987 SECTOR #4
10/18/2005 06:48:37	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 07:00:08	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-1:6-/80 DR
10/18/2005 08:04:07	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-1:6-/80 DR
10/18/2005 09:37:22	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-1:6-/80 DR
10/18/2005 10:13:50	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-1:6-/80 DR
10/18/2005 10:29:07	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-1:6-/80 DR
10/18/2005 13:08:07	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-0:6-1987 SECTOR #4
10/18/2005 14:23:06	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-1:6-/80 DR
10/18/2005 20:00:34	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 20:15:53	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-1:6-/80 DR

10/18/2005 21:55:05	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-0:6-1987 SECTOR #4
10/18/2005 22:23:43	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-0:6-1987 SECTOR #4
10/18/2005 23:39:46	WESTBROOK	EDWIN	154176430170	000759	ACTIVE expiration: 10/18/2006	ALS-USERS	1-4-0:6-1987 SECTOR #4

John Pruyn

DATE/TIME	L NAME	F NAME	BADGE ID	EMPLOYEE ID	STATUS	DEPT	READER
10/18/2005 08:13:38	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 08:19:33	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-1:6-/80 DR
10/18/2005 08:55:17	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-1:6-/80 DR
10/18/2005 09:02:35	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 09:38:28	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-1:6-/80 DR
10/18/2005 10:00:40	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-1:6-/80 DR
10/18/2005 10:09:07	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 10:12:17	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 10:17:56	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 10:20:22	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-1:6-/80 DR
10/18/2005 10:52:57	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
10/18/2005 10:57:01	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 10:59:27	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
10/18/2005 11:09:49	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 11:13:42	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
10/18/2005 11:22:18	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 11:26:12	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
10/18/2005 13:51:14	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
10/18/2005 13:57:25	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-1:6-/80 DR

10/18/2005 14:41:03	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 15:11:07	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-4-1:6-/80 DR
10/18/2005 15:34:56	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
10/18/2005 16:21:15	PRUYN	JOHN M.	155120152567	191051	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM

Appendix I: Tamper proof screw tool check out list from CR key locker

Ernest Orlando Lawrence
Berkeley National Laboratory

ADVANCED LIGHT SOURCE
Bldg. 60 • Room 160 • Ext. 7723

ALS Staff and Users trained in BL 08-24 – able to check out tamper proof screw tool

December 16, 2005

Bailey
Beaudrow
Borders
Byrne
Calais
Cork
Cornell
Coughlin
Dauz
DeCool
Dickert
Frankel
Gibson
Greensmith
Hamamoto
Henderson, RK
Holton
Krueger
MacGill
McDermott
Meyer
Miegs
Moroz
Nethisinghe
Nix
Pearson, A
Petros
Pruyn
Ralston
Rozales
Sherrell
Spear
Taylor
Thomas, M
Trame
Westbrook
Wilbur
Wong, Ed
Yang, L-B
Yegian
Zucca

CONFIDENTIAL

RSC Sub-committee – Report **FINAL** **Wednesday, 18 January 2006**

Appendix J: ALS Shielding Change Form for 4.2.2

This form completed 10-18-05 for request of Ben Feinberg.

ALS Shielding Change Form

Location of change: 4.2.2 (Beamline #, Sector #, BTS, LINAC) Person initiating form: John Pruyn (Printed Name)

Reason for change: ☒ Remove/Replace existing shielding

All items require RCT Notification:
- ☐ *Remove beam port plug for installation of beamline penetration (Work Permit Required)
- ☐ Permanent Removal/Modification of existing shielding (Work Permit Required)
- ☐ Add new shielding

Shielding affected: BL 4.2.2 Mono Doors (Shielding #, Components #, PSSD #)

Description of work being performed: Repairing Motor Motors

Work performed by: Ed Westbrook (Printed Name) 6652 (Extension)

Start Date: 10-15-05 Estimated Completion Date: 10-15-05

1. ACCELERATOR and FRONT-END SHIELDING

ALS Contact: _____ Approved: _____ (ALS Operations) _____ (ALS RCT)

Restriction on beam operations: _____

2. BEAM PORT PLUGS * ALS RCT must check the following shielding and initial before storage ring open

_____ PSS installed

_____ Transition wall shielding installed

_____ Front end shielding installed

3. BEAMLINE SHIELDING (Includes beam pipes and hutches)

Beamline offline Beam for Beamline (Beamline Coordinator's Name)

Restriction on beam operations: _____

Beamline Coordinator's initials (Needed for permanent removal/modification of existing shielding and/or add new shielding)

_____ Key-Enable Procedure Updated Or _____ Update Unnecessary

4. WORK COMPLETE (Complete for Sections 1, 2, and 3.)

End Date: 10-18-05 Work completed by Edwin Westbrook E.M. Westbrook

Verified by John Pruyn (Printed Name) (Signature)

ALS RCT completes the following section for beam port plug removal, permanent removal/modification of existing s and/or adding new shielding. This section not required for remove/replace existing shielding.

Radiation Survey Required? ☐ YES ☒ NO

Radiation Survey Complete N/A (Initials)

Appendix III of Search & Secure (OP 02-07) Updated N/A (Initials)

Comments: _____

5. OPERATIONAL APPROVAL

Accelerator/beamline may operate without restriction. Shielding work is complete. Initial below:

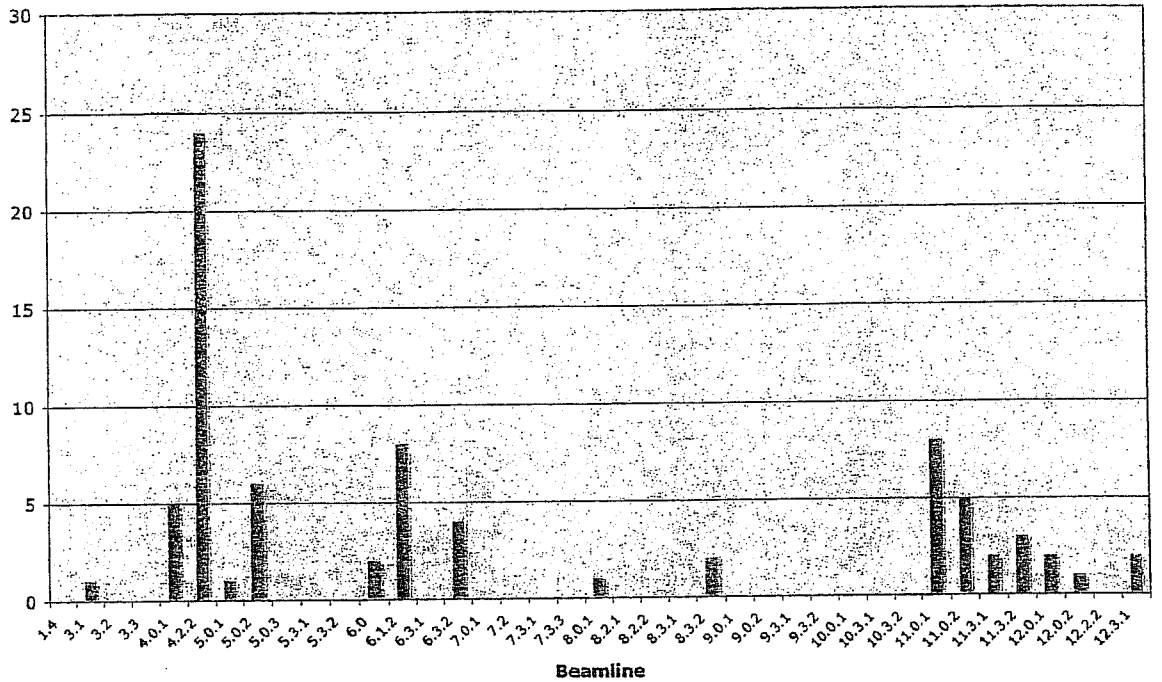
ALS RCT/Designee (NOT required for remove/replace existing shielding) N/A

Operations Group Leader/OIC (For Accelerator) _____

File original in ALS Control Room in the Shielding Change Binder OP 02-04, Rev. I

Appendix K: Trending of ALS Shielding Change Forms

Admin. control
Not engineering control



Ernest Orlando Lawrence
Berkeley National Laboratory

ADVANCED LIGHT SOURCE
Bldg. 80 • Room 228 • Ext. 7725

December 12, 2005

Memorandum

To: RSC Subcommittee

From: Ben Feinberg

Subj: History of Tamper Proof Screw Tool

We looked at the logbook for the release of the Tamper Proof Screw Removal (TPSR) tool during FY2005, and for the lifetime of Beamline 4.2.2, correlating the entries with entries in the Shielding Control log, and, as necessary, the key enable logs and the status of the beamlines.

During FY2005 we found 5 instances where the TPSR tool was checked out and no Shielding Control Form (SCF) was filled out.

On 2/23/05, during a machine startup shift (before beam operation began) the tool was checked out to adjust optics on a visible light diagnostics beamline. This is an area where there is no danger of radiation even if one were to reach in through the exposed hole in the shielding. As a precaution the cover was labeled shielding, and the staff member has been informed that a shielding change form was in order.

On 2/25/05 the TPSR tool was checked out. The best recollection by the person who checked it out is that this is when the container for the TPSR tool was replaced with a smaller container. No SCR required.

On 6/6/05 the TPSR tool was checked out, no SCF was filled out, but BL 8.2.1was taken offline, and brought back online the next day, after the TPSR tool was returned.

On 8/24/05 the TPSR tool was checked out for BL 4.2.2, an SCF was filled out for 8/23/05, and the beamline was taken offline and brought back online on 8/24. It's likely the date on the SCF was mistaken.

On 10/19/05 the TPSR tool was checked out for BL 12.3.2, under construction. No SCF is needed in this case, since the beamline had not yet been commissioned.

In the early history of BL 4.2.2 there were 70 instances where the TPSR tool was checked out.

On 10/29/03 the TPSR tool was checked out, and not returned until 10/31. The SCR was filled out and closed on 10/29, and the TPSR was returned before the beamline was key enabled on 10/31.

On 12/10/03 the TPSR tool was checked out, an SCF was filled out for 12/11/03, and the beamline was key enabled on 12/10/03. It's likely the date on the SCF was mistaken.

On 5/19/04 the TPSR tool was checked out, an SCF was filled out on 4/29 but the close date was written as 4/20. It's likely the date on the SCF should have been 5/20.

On 6/7/04 the TPSR tool was checked out, an SCF was filled out on 5/19, but the close date was not written down. The beamline was enabled on 6/11.

Appendix M: Initial report on incident 4.2.2. (from B. Feinberg)

Summary of 4.2.2 Mono Incident, Cause, and Action Items

4.2.2 Mono Hutch - Oct. 2005

- What happened?
  - Accelerator physics shift began (Sunday)
  - BL Scientist requested tamper-proof screw tool
    - Assumed BL already taken off line
    - Operator checked list, and gave him tool
    - Tool returned within an hour
  - Maintenance day began (Monday)
  - BL Scientist requested tool to complete job
    - Tool returned within an hour
  - Beam available for users (Monday night)
  - BL Scientist asked BL Coordinator to key on beamline (Tuesday morning)
    - BL Coord discovered BL already enabled
    - Checked condition of mono shielding
    - Alerted ALS management
    - Completed key-enable and shielding control form
  - No capability for x-rays while shielding removed
    - Accelerator physics and maintenance days
  - Shutter opened after independent verification of shielding

What did we do?

- Immediate measures:
  - All Operators reminded to verify beamline is offline and shielding control form filled out before releasing tamper proof tool
  - Separate log for Radiation Safety Security Devices
    - Tamper proof screw tool
    - Keys for RSSD locks

- Incident investigated by Operations Section Head and ES&H Program Manager

Action Items (under consideration)

- Engineering controls on mono shielding
  - Change fixed panels to locked panels
  - Welded ring connects panel key to RSS chassis key
    - Automatically takes beamline offline when removed
    - Requires key enable (and shielding check) before operation

- Clear, obvious indication of beamline status (for all beamlines)

- Do not release tamper proof screw tool to ALS users
  - Only release to designated ALS staff members

Ernest Orlando Lawrence
Berkeley National Laboratory

ADVANCED LIGHT SOURCE
Bldg. 80 • Room 228 • Ext. 7725

November 9, 2005

Memorandum

To: Karl Olson

From: Ben Feinberg

Subj: Incident at BL 4.2.2

Timeline:

Date	Time	Action	Comments
Sat. Oct. 15	3 pm	Power interruption suspended ALS operations and caused monochromator problems for BL 4.2.2	
Sun. Oct. 16	8:18 am	Accelerator Physics shifts begin, user beam disabled	A
Sun. Oct. 16	9:22 am	Beamline Scientist (LBNL guest) requested special tool to open mono shielding panels	
Sun. Oct. 16	9:22 am	Operator (Principal Accelerator Operator) checked that beamline scientist was on the list for the tool, and provided tool	B
Sun. Oct. 16	10:14 am	Beamline Scientist returned tool to Control Room	
Mon. Oct. 17	8 am	Maintenance shift begins, no beam in ALS storage ring	
Mon. Oct. 17	11:08 am	Beamline Scientist given tool to reinstall shielding panel	
Mon. Oct. 17	11:51 am	Beamline Scientist returned tool to Control Room	
Mon. Oct. 17	9:30 pm	Beam available for users	C
Tue. Oct. 18	8 am	Beamline Scientist asked Beamline coordinator (Engineering Technical Associate) to key-enable BL 4.2.2 (enable the beamline to receive x-rays)	
Tue. Oct. 18	8 am	Beamline Coordinator realized that beamline is already enabled, and verifies that mono shielding panels are properly installed	
Tue. Oct. 18	~8:15 am	Beamline Coordinator informs ALS management of problem, begins complete key-enable procedure and shielding control form	
Tue. Oct. 18	8:26 am	Shutter to BL 4.2.2 opened	D

Comments:

A) All user beamlines were disabled at this point.

B) The Operator followed the Accelerator Operations Logkeeping Procedure OP 11-01, which required the Operator to ensure that the requestor was trained in the appropriate procedures before receiving the special tool. Neither the Beamline Scientist nor the Operator acting as a Beamline Coordinator on the weekend, took the beamline off-line nor did either fill out the Shielding Change Form. Both of these actions are required by Shielding Control Procedure OP 02-04.

C) User beamlines were enabled at this point.

D) The beamline shutter was opened after shielding was verified to be in place.

cc: J. Chernowski
C. Donahue
G. Perdue

Appendix N: Copy of EC 02-15 used during 7.3 incident

Advanced Light Source

PROCEDURE	Page 1 of 37
Number: EC 02-15	
Revision: Rev. 13	
Issue Date: December 1, 2005	
Review Period: 3 years	
Supersedes Issues: EC 02-15, Rev. 12	

Title:
ALS Beamline Summation and Main Control Room Storage Ring Fill Radiation Interlock Testing Procedure

Section where used:
Electronic Maintenance Section

Prepared by	Date	Reviewed by	Date	Approved by	Date
Bob Mueller		Tim Kunell		Walter Barry	
		Max Vinco			

Revision Log:

Rev. No.	Effective Date	Pgs. Affected	Brief Description of Revision
1	11/8/93	6, 8-10,11-14	Pg. 5, Sec. 5.2.2[1], [c]-[e] reordered; Pg. 6, [2][a] revised; Pgs. 10-11, Sec. 5.3.3., Arc Sector 8 Tests, added; Pg. 14, Sec. 5.5.2[1] revised.
2	7/25/94	1*-20	Pgs. 11-20, Sec. 5.3.4, Sec. 5.3.5, and Sec. 5.4, Arc Sector 9 and Arc Sector 8 Tests added.
3	3/20/95	3, 6-10	Pg. 3, Sec. 4.0 [5] added; Pg. 6, Sec. 5.2.2 [4] revised; Pgs. 7-10, Sec. 5.3.* revised, Sec. 5.3.2 added, Sec. 5.3.3 revised, Sec. 5.3.4 revised; Pgs. 14-16, Sec. 5.4 revised; Pg. 17, above Sec. 5.5.2 NOTE added. Pg. 18, Sec. 6.0 added.
4	5/13/96	1-5, 6-8, 12 15-18	Pg. 1, new reviewer; Pgs. 1-2, Sec. 2.0 condensed; Pg. 3, Sec. 3.1.2 step [2] new, subsequent steps renumbered; Pgs. 3-4, NOTE in Sec. 5.2.1 new; Pg. 5, Preamble in Sec. 5.2.2 revised; Pg. 6, step [4] [a]; revised Pg. 7, Sec. 5.3 step [1] new; Pg. 8, Sec. 5.3.1 [1] [e] [f] revised; Pg. 12, Sec. 5.3.4 step [3] new; Pg. 15, Sec. 5.3.5 new; Pg. 16, Sec. 5.4.1 [2] [c] new, previous [c] now [d]; Pgs. 15-18, Secs. 5.4.1-5.4.3 revised to include BL 12.0; Pg. 18, Sec. 5.5, step [2] new.
5	11/25/96	3, 5, 7-16	Pg. 3, Sec. 4.0, step [3] added A and B chain, step [4] revised for staff handed and fast locations; Pg. 5, Sec. 5.2.1 step [7] NOTE added; Pg. 7-15, Sec. 5.3 revised to put sub-sections in order by BL number, correctly label lights; Pg. 16, Sec. 5.4 NOTE added.
6	6/10/97	3, 4, 6-23	Pg. 3, Sec. 3.0, Ref. [4] added; Pg. 4, Sec. 5.2.1 NOTE revised to add BL's 5.0, 5.0.2, 7.3, and 9.3.1, to identify BL's by PSS number; Pg. 5, Sec. 5.2.2 step [1] [i] new; Pp. 7- 23, Sec. 5.3.1 steps [4]-[5] new, [6] revised; Secs. 5.3 and 5.4, added BL's 5.0, 5.0.2, 7.3, and 9.3.1, revised BL numbers to include PSS.
7	12/10/98	3-5, 8, 11, *6, *9, 20, 23-25	Pg. 3, Sec. 5.1.* EM log replaces interlock log; Pg. 4, Sec. 5.2.1 NOTE, new BL's added; Pg. 5, Sec. 5.2.2 3rd parag. revised; Pg. 8, Sec. 5.3.2 new, subsequent secs. renumbered; Pg. **. Sec. 5.3.3 [3] new; Pg. 16, Sec. 5.3.7 BL nos. revised; Pp. 10-20, Secs. 5.3.8 and 5.3.9 new; Pp. 23-25, Sec. 5.4.1 [1], Sec. 5.4.2, Sec. 5.4.3 [1] steps added for new BL's.
8	7/12/99	*, 4, 7, 11, 13, 24, 28	Pg. 1, new approver; Pg. 4, Sec. 5.2.1 add BL 9.3.1; Pg. 7, Sec. 5.3.10 becomes 5.5, subsequent steps renumbered; Pg. 11, Sec. 5.4.1 [1] add BL 5.3.1; Pg. 13, Sec. 5.4.3 [1] add BL 5.3.1; Pg. 24, Sec. 5.5.3 [3] new m and BL 5.3.1; Pg. 28, 5.5. [1] moved to 5.4.3 [5].
9	8/14/00	4, 11, 13, 14, 27	Pg. 4, Sec. 5.2.* add BL 5.3.1; Pg. 11, Sec. 5.4.* ital. [h] new to add BL

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Revision Log, Cont.:

Rev. No.	Effective Date	Pgs. Affected	Brief Description of Revision
			5.3.1, subsequent steps relettered; Pg. 13-14,Sec. 5.4.2 [1] [g] new, subsequent steps relettered. Sec. 5.4.3 [1] [k], [l] new, subsequent steps relettered; Pg. 27, Sec. 5.5.7 [4] new.
10	3/7/01	1, 4, 8-11, 13, 14, 16-27	Pg. 1, Sec. 5.1.2 [1] six-month changes to yearly, Sec. 5.2.1 add BL's 3.3.1, 5.0.1, 5.0.2, 5.3.2, 8.5.1; Pg. 9- 10, Sec. 5.3 tests renumbered; Pg. 11, Sec. 5.4.1 revised format of step [2], add new BL's; Pg. 13, Sec. 5.4.2 [1] [l] new; Pg. 14, Sec. 5.4.3 revised format to add new steps for BL's 3.3.1, 5.0.1, 5.0.2, 5.3.2, 8.3.; Pg. 22; Pg. 16-27, Sec. 5.5.1-Sec. 5.5.9 steps revised to cover new toggle switches.
11	6/7/02	1, 4, 8, 12, 13, 15, 16, 22-26, 30, 33	Pg. 1, update signature block; Pg. 4, Sec. 5.2.1 NOTE add new BL's and fix nomenclature; Pg. 6, Sec. 5.2.1[8] add mini hutch key; Pg. 12-13, Sec. 5.4.1 [5] add NOTE, [7] reorder and delete steps, add NOTE [8] add NOTE; Pg. 15, Sec. 5.4.3 [5] add NOTE; Pg. 16, [7] reorder and delete steps, add NOTE, [8] add NOTE; Pg. 22, Sec. 5.5.4 [4] new; Pg. 23-25, Sec. 5.5.5 [3], [5], [7] nomenclature change; Pg. 25, Sec. 5.5.6 [4] new; Pg. 30, Sec. 5.5.7 [5] change switches to plugs; Pg. 33, Sec. 5.5.9 add NOTE, change nomenclature.
12	11/12/03	1, 4, 11-20, 27, 29, 34, 35	Pg. 1, update signature block; Pg. 4, Sec. 5.2.1 NOTE add new BL's; all additions below are new BL's since procedure last done; Pg. 11, Sec. 5.4.1 [2] [b] and [3] [c]; Pg. 12 [7] mid rack and [7]; Pg. 13 [11] [c]-[f]; Pg. 14 Sec. 5.4.2 [a], reletter subsq. steps. Pg. 15 Sec. 5.4.3 [2] [u] and [3] [c]; Pg. 16 [7] [f]; Pg. 17 [11] [c]-[f], Pg. 18-20, Sec. 5.5.1 [2]-[5], Pg. 27 Sec. 5.5.5 [5]; Pg. 29 Sec. 5.5.6 [4] revised ES test to use shorting plug; Pg. 35 Sec. 5.5.9 [2] and [3]; Pg. 36 Sec. 5.5.9 [1], subsequ. steps renumbered.
13	12/1/04	11, 20, 21, 26-28, 34	Pg. 11, Sec. 5.4.1 [3] [b] correct PSS no., Pg. 20-21, Sec. 5.5.2 [2] [a] and [3] [a] new, subsequent steps relettered; Pg. 25, Sec. 5.5.4 [4] [c] and [d] new; Pg. 26-28, Sec. 5.5.5 [3]-[8] renumber; Pg. 34, Sec. 5.5.8 [1] [b] [i] correct PSS no.

1.0 PURPOSE

To provide instructions and check lists enabling testing of the ALS beamline (BL) summation and main control room (MCR) storage ring (SR) fill radiation interlock system.

2.0 SCOPE

The ALS employs two types of experimental photon BL's; those with and without hutches. BL's are equipped with a safety shutter capable of shielding harmful radiation. All BL safety shutters are controlled indirectly via a BL Equipment Protection System (EPS), consisting of a programmable logic controller.

With the exception of BL 3.1, all BL safety shutters are closed by the MCR while filling the SR with the electron beam from the injection system (linac and booster). Transport of the electron beam from the injection system via the booster-to-SR transport line (BTS) is inhibited by turning off the BTS B1 and B2 bend magnet power supplies until all BL safety shutters are sensed to be in the closed position.

After the SR has been filled with the electron beam, the MCR relinquishes control of the safety shutters back to the BL user research group and reasserts the inhibit of

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2.0 SCOPE, Cont.

the BTS transport line by turning off the BTSB1 and B2 bend magnets. This prevents accidental transport of the electron beam via the BTS transport line while preparing for a refill of the SR at a later time when pre-tuning of the injection system with the safety shutters in an unknown position.

The "Fill" control chassis in the MCR also has a key switch called 'Beam Physics Key Switch'. At certain times the ALS operations staff will conduct beam studies. This type of operation may require all safety shutters to be closed with no possibility of the MCR operator relinquishing control of the safety shutter back to the BL user research group. During these periods of beam studies, the accelerator operations section leader or the MCR operator-in-charge (OIC), will remove the beam physics key and keep it in their possession. This action asserts a continuous close request to the BL safety shutter and cannot be over-ridden by the push button switch used normally to relinquish control of the safety shutters to the BL user research group.

Additional interlocks for the SR RF system are used for certain incompatible conditions detected in the beamline radiation safety system. Anytime a hutch's interlocked doors are open, the safety shutter should be closed. Should a hutch door be open while the SR RF is in a normal operate mode and a safety shutter becomes open, the SR RF will be turned off. Additionally,an emergency entrance or exit from the hutch using the emergency door release push button switches will turn off the SR RF. Activation of the switch will turn off the SR RF. A third "watch dog" interlock is in place that turns off the SR RF should the shutter open while the beamline is in the offline mode.

3.0 REFERENCES

[1] DOE Order 5280.2B, Safety of Accelerator Facilities, Part I.G
[2] LBL PUB-3000, Chapter 21
[3] LBL Prints:
  [a] 23W2545 Fill and Stored Beam Control System Drawing
  [b] 23W9375 Beamlines Interlock Summation System Drawing
  [c] 23W6535 SR Sectors 4 through 9 Interlock System Drawing
[4] Engineering Note, ALS Component Naming, October 30, 1994

4.0 REQUIRED MATERIALS, EQUIPMENT, SUPPLIES, TOOLS, AND MANPOWER

[1] Radiation safety rack shackleless padlock key
[2] Two-way radios or headset communication
[3] Arc sector summation chassis test dummy "A" and "B" chain shorting plugs
[4] Three people can execute this procedure, but five people can execute it much faster. The interlock chains are checked at B1, B2, RF, safety racks S0213, S0614 and each SR arc sector BL summation interlock chassis.
[5] Temporary Clip Accountability Sheet. Appendix from EC 02-02

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5.0 PROCEDURE

5.1 Introduction

5.1.1 Roles and Responsibilities

The ALS EM section supervisor, or his designee, is responsible for executing this procedure and maintaining the EM Log. All training required for this procedure will be supervised by the cognizant engineer for radiation safety.

5.1.2 Testing Schedules

[1] This test procedure shall be completed on a yearly basis thereafter. A grace period, not to exceed 30 days, is allowed depending on the commitment of resources available to conduct the six month test

[2] If the accelerator is not operational and six months has elapsed since the last interlock test, this procedure must be performed prior to operation.

[3] Testing shall be completed after any modification to the interlock chains.

[4] Tracking of the test dates and informing the EM section supervisor of expiration periods will be done by the ALS Procedure Center.

5.2 Documentation and Preparation

5.2.1 Documentation

NOTE: *This procedure includes the following BL's and branchlines:*

3.2_PSS101	*5.3_PSS101*	*8.2_PSS211*	*11.3_PSS201*
3.3_PSS101	*5.3_PSS201*	*8.3_PSS101*	*12.0 PSS1*
3.3_PSS201	*6.1.2 PSS1*	*8.3_PSS111*	*12.2_PSS201*
4.0_PSS002	*6.3.1 PSS1*	*8.3_PSS201*	*12.2_PSS211*
4.2_PSS201	*6.3.1 PSS2*	*9.0 PSS1*	*12.3_PSS101*
4.2_PSS211	*6.3.2 PSS1*	*9.3. PSS1*	*12.3_PSS111*
5.0_PSS001	*7.0 PSS1*	*9.3.1 PSS1*	
5.0_PSS101	*7.3 PSS1*	*9.3.1 PSS2*	
5.0_PSS111	*7.3.3 PSS1*	*10.0_PSS201*	
5.0_PSS2 11	*8.0 PSS1*	*10.3.1 PSS1*	
5.0_PSS201	*8.2_PSS101*	*10.3.2 PSS1*	
5.0_PSS301	*8.2_PSS111*	*11.0_PSS201*	
5.0_PSS311	*8.2_PSS201*	*11.3_PSS101*	

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5.0 PROCEDURE, Cont.

*If a BL has become operational and is not included in the list above, **STOP** and contact the ALS Personnel Safety System Engineer at Ext. 2919.*

Initials

[1] Inform the MCR OIC of the test and why it is being done for appropriate entry in the Operations log with initials and comments. MR

[2] All tests shall be entered in the Operations and EM logs with initials and comments, as appropriate. MR

[3] Persons performing the tests shall initial the steps in this procedure. MR

[4] Any errors, changes, or modifications found while performing this procedure must be reported to the cognizant radiation engineer, who will in turn inform the ALS Procedure Center. MR

[5] After procedure is completed, the original of the following checklist, used to perform the procedure, shall be filed in the ALS Procedure Center. MR

[6] Post signs at visitor sign-in logs, Bldg 80/6 entrance and Bldg. 6 lobby, that testing is being done and to ignore warning lights and sounds. MR

[7] Identification of Participants:

	Name printed	Signature	Initials
Tester, Position	PETE ROSADO		PR
Assistant	MICHAEL SWENSON		MS
Assistant	RONNY S. COLSTON		RSC
Assistant	Angelic L. Pearson		ALP
Assistant			
Assistant			

Time started 0750 Date started 26 NOV 05

Time finished 1203 Date finished 26 NOV 05

[8] Keys and test plugs received:

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5.0 PROCEDURE, Cont.

Initials

NOTE: *Archive search keys are available from the EM supervisor, or the OIC if the EM supervisor is unavailable.*

Type key(s)	Initial received
Safety rack shackleless padlock key	
Shorting plug for "A" chain arc sum chassis input	
Shorting plug for "B" chain arc sum chassis input	
Archive SR Search BTS Area key	
Archive SR Search RF Area key	
Archive SR Search SR 4-9 Area key	
Mini Hutch Box key	

[9] Person doing test makes announcement via the Bldg. 6 and 80 PA system that interlock testing is being done.

5.2.2 Preparation

While testing, certain BL interlocks will be intentionally bypassed using shorting plugs. Therefore, certain parts of the ALS accelerator must be disabled to prevent any hazardous conditions.

Two interlocks are to be tested and both are redundant. The first is the safety shutter interlock controlling the BTS B1 and B2 magnet power supplies. The second is the SR RF interlock.

[1] **Linac Disable Procedure**

[a] Disable the electron gun deck and high voltage power supply by locking out circuit breaker LI0117 CB8 (Hermosa control chassis P2).

[b] Remove and tag the 115 VAC supply plug for the high voltage power supply from its socket J3 on the rear of the Hermosa unit at LI0133.

[c] Switch the electron gun mode control chassis (23W1965) at LI0130 to the "HV Test" position and switch HV test chain switch from ILC to LOC.

[d] Switch the linac vacuum valve control panel LI0830 GTL VVR1 to local and close the valve by pressing the close push button switch.

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5.0 PROCEDURE, Cont.

Initials

[e] Remove the S band RF Modulator 1 and 2 HV enable keys at LI17 and LI20. These are to be retained by the Tester during the testing period.

[f] LOTO S0251 CB3 Klystron Drive Amp power.

[2] SR RF Disable Procedure

[a] If RF HV is on at S025026, then depress the HV off push-button at S025033. Wait for VVT to run down.

[b] Remove key A1 from the RF power supply crowbar control rack S025041 and insert it in the lock cylinder at SE0226 (crowbar cabinet) to release key A2. Remove key A2 and insert it in the grounding switch key cylinder at rear of SE0226 and move the ground bar to the down position. Remove the B2 key. Insert B2 key into S025041. B2 key is captured. Remove A3 key and keep in custody of the interlock testing party until interlock testing is complete.

[3] MCR Fill/Stored Beam Chassis CR1122

[a] Insert and turn the 'Beam Physics' key.

[b] Press the "Fill" push button switch.

[c] Turn control room SR search keys for sector 4 through 9, BTS, and SR RF to the operate position.

[4] Remove, if required, ADMIN locks and turn on the breakers on BTS-B1 and B2 power supplies.

[5] If necessary, reset all hutch emergency entry/exit push buttons and switch hutch beamline on line, then off line, to get SR RF permissive.

[6] SR Search and Secure

[a] List clamp #'s used on Temporary Clip Accountability Sheet, attached as Appendix.

[b] Ensure SR RF key is in "Operational" position @ S025723, RF System/Control and Interlock Master Interlock chassis.

[c] The tests in this procedure require a complete search

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5.0 PROCEDURE, Cont.

Initials

and secure of the SR Interlock system . Interlock chains must be complete at:

S101420 and S101426
S061421 and S061427
S021323 and S021324
B1 and B2 magnet power supplies radiation interlock complete
S026729 RF master interlocks PS1 and PS2

NOTE: *The linac and booster do not have to be searched and secured.*

5.3 Arc Sector 7 Tests

[1] Beamline 7.0 PSS1 Tests

[a] Verify shutter and SR RF chains **complete** at BL070123 and BL070120.

[b] Unlock the rear of rack BL0701. Switch both "A" and "B" test toggle switches on rear of BL070126 to the test position. Observe **Incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL070123 for BL 7.0 PSS1.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 7.

[c] Switch both "A" and "B" test toggle switches on rear of BL070126 to the run position.

[2] Beamline 7.3. PSS1 Tests

[a] Verify shutter and SR RF chains **complete** at BL070123 and BL070120.

[b] Unlock the rear of rack BL0701. Switch both "A" and "B" test toggle switches on rear of BL070129 to the test position. Observe **Incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL070123 for BL 7.3 PSS1.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 7.

[c] Switch both "A" and "B" test toggle switches on rear of BL070129 to the run position.

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5.0 **PROCEDURE, Cont.**

Initials

NOTE: *Use four people — one at BTS B1, one for BTS B2, SR RF and S0213, one at S0614, and one at BL 07.*

[3] **Beamline 7.3.3 PSS1 Tests**

[a] Verify shutter and SR RF chains **complete** at BL070123 and BL070120 (23W9345 summing chassis)
- [i] At S021323 and S021324 chain light panels.
- [ii] At S061421 and S061427 chain light panels.
- [iii] The "Radiation Interlock" at the BTS-B1 and BTS-B2 power supplies.
- [iv] The personnel safety #1 and #2 at the RF Master Interlock chassis at S026729.

[b] Disconnect the existing plug from BL070123 PG4. Observe **incomplete** chains "A" and "B", "Safety Shutter Closed", and "SR RF Intlks OK" lights at:
- [i] BL070123 for BL 7.3.3 PSS1.
- [ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 7.

[c] Observe **incomplete** chain "A" and "B" " chain lights at:
- [i] At S021323 and S021324 chain light panels.
- [ii] At S061421 and S061427 chain light panels.
- [iii] The "Radiation Interlock" at the BTS-B1 and BTS-B2 power supplies.
- [iv] The personnel safety #1 and #2 at the RF Master interlock chassis at S026729.

[d] Insert the 'A' chain shorting test plug in BL070123 PG4 and observe "A" chain **complete**, "B" chain **incomplete**, "Safety Shutter Closed" and "SR RF Intlks OK" lights at:
- [i] BL070123 for BL 7.3.3 PSS1.
- [ii] At the Beamlines SR Interlock Summing Chassis BL070120 for arc sector 7.

[e] Observe "A" chain **complete** and "B" chain **incomplete** lights at:
- [i] At S021323 and S021324 chain light panels.
- [ii] At S061421 and SC61427 chain light panels.
- [iii] Reset and ensure the personnel safety #2 at the RF Master Interlock chassis at S026729 incomplete.

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5.0 PROCEDURE, Cont.

Initials

[f] Attempt to reset the B1 and B2 power supplies. They should not reset and the "Radiation Interlock" for each should remain **incomplete.**

[g] Remove the "A" chain shorting plug and insert the "B" chain shorting test plug in BL070123 PG4 and observe "A" chain **incomplete**, "B" chain **complete**, "Safety Shutter Closed" and "SR RF Intlks OK" lights at:
[i] BL070123 for BL 7.3.3 PSS1.
[ii] At the Beamlines SR Interlock Summing Chassis BL070120 for arc sector 7.

[h] Observe "A" chain **incomplete** and "B" chain **complete** lights at:
[i] At S021323 and S021324 chain light panels.
[ii] At S061421 and S061427 chain light panels.
[iii] Reset and ensure the personnel safety #1 and #2 at the RF Master Interlock chassis at S026729 **incomplete.**

[i] Attempt to reset the B1 and B2 power supplies. They should not reset and the "Radiation Interlock" for each should remain **incomplete.**

[j] Remove the "B" chain shorting plug and re-connect the disconnected interlock cable into BL070123 PG4.

[k] Lock the rear of safety rack BL0701.

[l] Reset the B1 and B2 magnet power supplies.

5.4 MCR Fill and / BTS-B1 and BTS-B2 Magnet Interlocks

NOTE: *Use five people — one at BTS B1, one for BTS B2 and SR RF, one at CR1122, and two at the BL's.*

5.4.1 MCR Fill Request and BTS-B1 and BTS-B2 Interlock Tests

[A] MCR Fill/Stored Beam Tests from control chassis at CR1122

[1] At the MCR Fill/Stored Beam Control Chassis located at CR1122 press the "Fill" push button. Observe lighted lamps at:
[a] CR1122 'Fill Request'

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5.0 PROCEDURE, Cont.

Initials

[b] CR1122 "Shutters Closed"
[c] CR1122 "Hutches Closed"
[d] At CR 1122 beam physics key installed and turned

[2] At BL0301 rack, observe lighted lamps at:
[a] BL030123 "MCR Close Request"
[b] BL030123 BL 03.2_PSS101 "A and B Chains Shutters Closed"
[c] BL030123 BL 03.3_PSS201 "A and B Chains Shutters Closed"
[d] BL030123 BL 03.3_PSS101 "A and B Chains Shutters Closed"

[3] At BL0401 rack, observe lighted lamps at:
[a] BL040123 "MCR Close Request"
[b] BL040123 BL 04.0_PSS002 "A and B Chains Shutters Closed"
[c] BL040123 BL 04.2_PSS201 "A and B Chains Shutters

[4] At BL0501 and BL0502 racks, observe lighted lamps at:
[a] BL050123 "MCR Close Request"
[b] BL050123 BL 05.0_PSS001 "A and B Chains Shutters Closed"
[c] BL050123 BL 05.0_PSS101 "A and B Chains Shutters Closed"
[d] BL050123 BL 05.0_PSS111 "A and B Chains Shutters Closed"
[e] BL050123 BL 05.0 PSS201 "A and B Chains Shutters Closed"
[f] BL050123 BL 05.0_PSS211 "A and B Chains Shutters Closed"
[g] BL050123 BL 05.0.2_PSS "A and B Chains Shutters Closed"
[h] BL050223 "MCR Close Request"
[i] BL050223 BL 05.0 PSS301 "A and B Chains Shutters Closed"
[j] BL050223 BL 05.0_PSS311 "A and B Chains Shutters Closed"
[k] BL050223 BL 05.3 PSS101 "A and B Chains Shutters Closed"
[l] BL050223 BL 05.3_PSS201 "A and B Chains Shutters Closed"

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5.0 PROCEDURE, Cont.

Initials

[5] At BL0601 rack, observe lighted lamps at:
- [a] BL060123 "MCR Close Request"
- [b] BL060123 BL 6.1.2 PSS1 "A and B Chains Shutters Closed"
- [c] BL060123 BL 6.3.1 PSS1 "A and B Chains Shutters Closed"
- [d] BL060123 BL 6.3.2 PSS1 "A and B Chains Shutters Closed"

NOTE: *Beamline shutter for BL 6.3.1_PSS2 end-station does not have a "MCR Close Request" interlock. This interlock is jumpered at BL060123.*

[6] At BL0701 rack, observe lighted lamps at:
- [a] BL070120 "MCR Close Request"
- [b] BL070120 all sectors "A and B Chains Shutters Closed"
- [c] BL070123 "MCR Close Request"
- [d] BL070123 BL 7.0 PSS1 "A and B Chains Shutters Closed"
- [e] BL070123 BL 7.3 PSS1 "A and B Chains Shutters Closed"
- [f] BL070123 BL 7.3.3 PSS1 "A and B Chains Shutters Closed"

[7] At BL0801 and BL0802 racks, observe lighted lamps at:
- [a] BL080123 and BL080223 "MCR Close Request"
- [b] BL080123 BL 8.0 PSS1 "A and B Chains Shutters Closed"
- [c] BL080123 BL 8.2_PSS101 "A and B Chains Shutters Closed"
- [d] BL080123 BL 8.2_PSS201 "A and B Chains Shutters Closed"
- [e] BL080123 BL 8.3_PSS101 "A and B Chains Shutters Closed"
- [f] BL080223 BL 8.3_PSS201 "A and B Chains Shutters Closed"

NOTE: *Mini-batch beamline shutters BL 8.2_PSS111, BL 8.2_PSS211 and BL 8.3_PSS111 do not have a "MCR Close Request" interlock. This interlock is jumpered at BL080123 and BL080223.*

[8] At BL0901 rack, observe lighted lamps at:
- [a] BL090123 "MCR Close Request"

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[b] BL090123 BL 9.0 PSS1 "A and B Chains Shutters Closed" [illegible]
[c] BL090123 BL 9.3 PSS1 "A and B Chains Shutters Closed" [illegible]
[d] BL090123 BL 9.3.1 PSS1 "A and B Chains Shutters Closed" [illegible]

- NOTE: *Beamline shutter for BL 9.3.1_PSS2 end-station does not have a "MCR Close Request" interlock. This interlock is jumpered at BL090123.*

[9] At BL1001 rack, observe lighted lamps at:
[a] BL100123 "MCR Close Request" [illegible]
[b] BL100123 BL 10.3.1 PSS1 "A and B Chains Shutters Closed" [illegible]
[c] BL100123 BL 10.3.2 PSS1 "A and B Chains Shutters Closed" [illegible]
[d] BL100123 BL 10.0_PSS001 "A and B Chains Shutters Closed" [illegible]

[10] At BL1101 rack, observe lighted lamps at:
[a] BL110123 "MCR Close Request" [illegible]
[b] BL110123 BL 11.3_PSS201 "A and B Chains Shutters Closed" [illegible]
[c] BL110123 BL 11.3_PSS101 "A and B Chains Shutters Closed" [illegible]
[d] BL110123 BL 11.0_PSS201 "A and B Chains Shutters Closed" [illegible]

"B" LED OUT "A" SHUTTER B

[11] At BL1201 rack, observe lighted lamps at:
[a] BL120123 and BL120223 "MCR Close Request" [illegible]
[b] BL120123 BL 12.0 PSS1 "A and B Chains Shutters Closed" [illegible]
[c] BL120123 BL 12.2_PSS201 "A and B Chains Shutters Closed" [illegible]
[d] BL120123 BL 12.2_PSS211 "A and B Chains Shutters Closed" [illegible]
[e] BL120223 BL 12.3_PSS101 "A and B Chains Shutters Closed" [illegible]
[f] BL120223 BL 12.3_PSS111 "A and B Chains Shutters Closed" [illegible]

[12] At SR021323 and SR021324 racks, observe lighted lamps at:
[a] S021323 A "MCR Fill Intlk" **complete** [illegible]
[b] S021324 B "MCR Fill Intlk" **complete** [illegible]

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Initials

[13] After the various beamline PLC's have closed the safety shutters observe lighted lamps at:
- [a] S021323 Chain A "BL Safety Shutter Closed" **complete**
- [b] S021324 Chain B "BL Safety Shutter Closed" **complete**
- [c] Reset BTS B1 and BTS-B2
- [d] BTS B1 and BTS-B2 PS Radiation Intlk **complete**

5.4.2 MCR Stored Beam Request and BTS-B1 and BTS-B2 Interlock Tests

[1] At the MCR Fill/Stored Beam Control Chassis located at CR1122 press the "Stored Beam" push button. Observe **extinguished** lamps at:
- [a] CR1122 "Fill Request"
- [b] At CR1122 "Shutters Closed"
- [c] At CR1122 beam physics key installed and turned
- [d] BL030123 "MCR Close Request"
- [e] BL040123 "MCR Close Request"
- [f] BL050123 "MCR Close Request"
- [g] BL050223 "MCR Close Request"
- [h] BL060123 "MCR Close Request"
- [i] BL070120 "MCR Close Request"
- [j] BL070123 "MCR Close Request"
- [k] BL080123 "MCR Close Request"
- [l] BL080223 "MCR Close Request"
- [m] BL090123 "MCR Close Request"
- [n] BL100123 "MCR Close Request"
- [o] BL110123 "MCR Close Request"
- [p] BL120123 "MCR Close Request"
- [q] BL120223 "MCR Close Request"
- [r] S021323 Chain A "MCR Fill Intlk"
- [s] S021324 Chain B "MCR Fill Intlk"
- [t] BTS B1 and BTS B2 PS Radiation Intlk **incomplete**

5.4.3 MCR Beam Physics Key and BTS-B1 and BTS-B2 Interlock Tests

[1] At the MCR Fill/Stored Beam Control Chassis located at CR1122 remove the "Beam Physics Key" from its key switch. Observe lighted lamps at:
- [a] CR1122 "Fill Request"
- [b] CR1122 "Shutters Closed"

[2] At BL0301 rack, observe lighted lamps at:
- [a] BL030123 "MCR Close Request"

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Initials

[b] BL030123 BL 03.2_PSS101 "A and B Chains Shutters Closed" PGP
[c] BL030123 BL 03.3_PSS101 "A and B Chains Shutters Closed"
[d] BL030123 BL 03.3_PSS201 "A and B Chains Shutters Closed"

[3] At BL0401 rack, observe lighted lamps at:
[a] BL040123 "MCR Close Request"
[b] BL040123 BL 04.0_PSS201 "A and B Chains Shutters Closed"
[c] BL040123 BL 04.2 PSS201 "A and B Chains Shutters Closed"

[4] At BL0501 and BL0502 racks, observe lighted lamps at:
[a] BL050123 "MCR Close Request"
[b] BL050123 BL 05.0_PSS001 "A and B Chains Shutters Closed"
[c] BL050123 BL 05.0_PSS101 "A and B Chains Shutters Closed"
[d] BL050123 BL 05.0_PSS111 "A and B Chains Shutters Closed"
[e] BL050123 BL 05.0_PSS201 "A and B Chains Shutters Closed"
[f] BL050123 BL 05.0_PSS211 "A and B Chains Shutters Closed"
[g] BL050123 BL 05.0.2_PSS "A and B Chains Shutters Closed"
[h] BL050223 "MCR Close Request"
[i] BL050223 BL 05.0_PSS301 "A and B Chains Shutters Closed"
[j] BL050223 BL 05.0_PSS311 "A and B Chains Shutters Closed"
[k] BL050223 BL 05.3_PSS101 "A and B Chains Shutters Closed"
[l] BL050223 BL 05.3_PSS201 "A and B Chains Shutters Closed"

[5] At BL0601 rack, observe lighted lamps at:
[a] BL060123 "MCR Close Request"
[b] BL060123 BL 6.1.2 PSS1 "A and B Chains Shutters Closed"
[c] BL060123 BL 6.3.1 PSS1 "A and B Chains Shutters Closed"

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Initials

[d] BL060123 BL 6.3.2 PSS1 'A and B Chains Shutters Closed'

NOTE: *Beamline shutter for BL 6.3.1_PSS2 end-station does not have a "MCR Close Request" interlock. This interlock is jumpered at BL060123.*

[6] At BL0701 rack, observe lighted lamps at:
- [a] BL070120 "MCR Close Request"
- [b] BL070120 all sectors "A and B Chains Shutters Closed"
- [c] BL070123 "MCR Close Request"
- [d] BL070123 BL 7.0 PSS1 "A and B Chains Shutters Closed"
- [e] BL070123 BL 7.3 PSS1 "A and B Chains Shutters Closed"
- [f] BL070123 BL 7.3.3 PSS1 'A and B Chains Shutters Closed"

[7] At BL0801 and BL0802 racks, observe lighted lamps at:
- [a] BL080123 and BL080223 "MCR Close Request"
- [b] BL080123 BL 8.0 PSS1 'A and B Chains Shutters Closed"
- [c] BL080123 BL 8.2_PSS101 "A and B Chains Shutters Closed"
- [d] BL080123 BL 8.2_PSS201 "A and B Chains Shutters Closed"
- [e] BL080123 BL 8.3_PSS101 "A and B Chains Shutters Closed"
- [f] BL080223 BL 8.3_PSS201 "A and B Chains Shutters Closed"

NOTE: *Mini-hutch beamline shutters BL 8.2_PSS111 and BL 8.3_PSS111 do not have a "MCR Close Request" interlock. This interlock is jumpered at BL080123 and BL080223.*

[8] At BL0901 rack, observe lighted lamps at:
- [a] BL090123 "MCR Close Request"
- [b] BL090123 BL 9.0 PSS1 "A and B Chains Shutters Closed"
- [c] BL090123 BL 9.3 PSS1 "A and B Chains Shutters Closed"
- [d] BL090123 BL 9.3.1 PSS1 'A and B Chains Shutters Closed"

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Initials

NOTE: *Beamline shutter for BL 9.3.1_PSS2 end-station does not have a "MCR Close Request" interlock. This interlock is jumpered at BL090123.*

[9] At BL1001 rack, observe lighted lamps at:
- [a] BL100123 "MCR Close Request"
- [b] BL100123 BL 10.0_PSS201 "A and B Chains Shutters Closed"
- [c] BL100123 BL 10.3.1 PSS1 "A and B Chains Shutters Closed"
- [d] BL100123 BL 10.3.2 PSS1 "A and B Chains Shutters Closed"

[10] At BL1101 rack, observe lighted lamps at:
- [a] BL110123 "MCR Close Request"
- [b] BL110123 BL 11.0_PSS201 "A and B Chains Shutters Closed"
- [c] BL_110123 BL 11.3_PSS101 "A and B Chains Shutters Closed"
- [d] BL110123 BL 11.3_PSS201 "A and B Chains Shutters Closed"

[11] At BL1201 rack, observe lighted lamps at:
- [a] BL120123 and BL120223 "MCR Close Request"
- [b] BL120123 BL 12.0 PSS1 "A and B Chains Shutters Closed"
- [c] BL120123 BL 12.2_PSS201 "A and B Chains Shutters Closed"
- [d] BL120123 BL 12.2_PSS211 "A and B Chains Shutters Closed"
- [e] BL120223 BL 12.3 PSS101 "A and B Chains Shutters Closed"
- [f] BL120223 BL 12.3_PSS111 "A and B Chains Shutters Closed"

[12] After the various beamline PLC's have closed the safety shutters observe:
- [a] S021323 "MCR Fill Intlk" **incomplete**
- [b] S021324 MCR Fill Intlk" **incomplete**
- [c] Push, reset, and observe BTS-B1 and BTS-B2 PS Radiation Intlk **incomplete**

[13] At the MCR Fill/Stored Beam Control Chassis located at CR1122 with the "Beam Physics Key" removed, press the

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Initials

"Fill" push button. Observe:
- **[a]** S021323 Chain A "MCR Fill Intlk" and chain **complete** [initials]
- **[b]** S021324 Chain B "MCR Fill Intlk" and chain **complete**
- **[c]** Push, reset, and observe BTS-B1 and BTS-B2 PS Radiation Intlk **complete**

[14] Replace the "Beam Physics Key."

[15] Remove and account for all clamps used to complete SR search in section 5.2.2 [6] [a]. [initials]

5.5 Beamline Safety Shutter Tests

5.5.1 Arc Sector 12 Tests

NOTE: *Use three people for this part of the test, two at the BL under test and one at BL 07.*

[A] Beamline arc sector safety shutter and SR RF "A" chain interlocks
[B] Beamline arc sector safety shutter and SR RF "B" chain interlocks

[1] Beamline 12.0 PSS1 Tests

[a] Verify shutter and SR RF chains **complete** at BL120233, BL120123, and BL070120. [initials]

[b] Unlock the rear of rack BL1201. Switch both "A" and "B" test toggle switches on rear of BL120126 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
- **[i]** BL120123 for BL 12.0 PSS1. [initials]
- **[ii]** At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 12. [initials]

[c] Switch both "A" and "B" test toggle switches on rear of BL120126 to the run position. [initials]

[2] Beamline 12.2_PSS201 Tests

[a] Verify shutter and SR RF chains **complete** at BL120123 and BL070120. [initials]

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Initials

[b] Switch both "A" and "B" test toggle switches on rear of BL120135 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
- [i] BL120123 for BL 12.2_PSS201.
- [ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 12.

[c] Switch both "A" and "B" test toggle switches on rear of BL120135 to the run position.

[3] Beamline 12.2_PSS211 Tests

[a] Verify shutter and SR RF chains **complete** at BL120123 and BL070120.

[b] Switch both "A" and "B" test toggle switches on rear of BL120138 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
- [i] BL120123 for BL 12.2_PSS211.
- [ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 12.

[c] Switch both "A" and "B" test toggle switches on rear of BL120138 to the run position. Lock the rear of safety rack BL1201.

[4] Beamline 12.3 PSS101 Tests

[a] Verify shutter and SR RF chains **complete** at BL120223 and BL070120.

[b] Unlock the rear of rack BL1202. Switch both "A" and "B" test toggle switches on rear of BL120229 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
- [i] BL120223 for BL 12.3_PSS101.
- [ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 12.

[c] Switch both "A" and "B" test toggle switches on rear of BL120229 to the run position.

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Initials

[5] Beamline 12.3_PSS111 Tests

[a] Verify shutter and SR RF chains **complete** at BL120223 and BL070120.

[b] Switch both "A" and "B" test toggle switches on rear of BL120232 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL120223 for BL 12.3_PSS111.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 12.

[c] Switch both "A" and "B" test toggle switches on rear of BL120232 to the run position. Lock the rear of safety rack BL1202.

5.5.2 Arc Sector 11 Tests

[A] Beamline arc sector safety shutter and SR RF 'A' chain interlocks
[B] Beamline arc sector safety shutter and SR RF 'B' chain interlocks

[1] Beamline 11.3_PSS201 Tests

[a] Verify shutter and SR RF chains **complete** at BL110123 and BL070120

[b] Unlock the rear of rack BL1101. Switch both "A" and "B" test toggle switches on rear of BL110126 to the test position. Observe **incomplete** chains 'A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL110123 for BL 11.3 PSS201.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 11.

[c] Switch both "A" and "B" test toggle switches on rear of BL110126 to the run position.

[2] Beamline 11.3_PSS101 Tests

[a] Verify shutter and SR RF chains complete at BL110123 and BL070120.

[b] Switch both "A" and "B" test toggle switches on rear of BL110129 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF

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Initials

Intlk OK" lights at:
[i] BL110123 for BL 11.3 PSS101.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 11.

[c] Switch both "A" and "B" test toggle switches on rear of BL110129 to the run position.

[3] **Beamline 11.0_PSS201 Tests**

[a] Verify shutter and SR RF chains complete at BL110123 and BL070120.

[b] Switch both "A" and "B" test toggle switches on rear of BL110132 to the test position. Observe **incomplete** chains 'A', "B' "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL110123 for BL 11.0 PSS201.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 11.

[c] Switch both "A" and "B" test toggle switches on rear of BL110135 to the run position. Lock the rear of safety rack BL1101.

5.5.3 Arc Sector 10 Tests

[1] **Beamline 10.3.1 PSS1 Tests**

[a] Verify shutter and SR RF chains **complete** at BL100123 and BL070120 (23W9345 summing chassis).

[b] Unlock the rear of rack BL1001 and disconnect the existing plug from BL100123 PG2. Observe **incomplete** chains "A' and 'B', 'Safety Shutter Closed", and 'SR RF Intlks OK" lights at:
[i] BL100123 for BL10.3.1 PSS1.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 10.

[c] Insert the 'A' chain shorting test plug in BL100123 PG2 and observe "A' chain **complete** and 'B" chain **incomplete** "Safety Shutter Closed" and 'SR RF Intlks OK" lights at:
[i] BL100123 for BL 10.3.1 PSS1.
[ii] At the Beamlines SR Interlock Summing Chassis BL070120 for arc sector 10.

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Initials

[d] Remove the "A" chain shorting plug and insert the "B" chain shorting test plug in BL100123 PG2 and observe "A" chain **incomplete**, "B" chain **complete**, "Safety Shutter Closed", and "SR RF Intlks OK" lights at:
[i] BL100123 for BL 10.3.1 PSS1. _____
[ii] At the Beamlines SR Interlock Summing Chassis BL070120 for arc sector 10. _____

[e] Remove the "B" chain shorting plug and re-connect the disconnected interlock cable into BL100123 PG2. _____

[2] Beamline 10.3.2 PSS1 Tests

[a] Verify shutter and SR RF chains **complete** at BL100123 and BL070120 (23W9345 summing chassis). _____

[b] Disconnect the existing plug from BL100123 PG3. Observe **incomplete** chains "A" and "B", "Safety Shutter Closed", and "SR RF Intlks OK" lights at:
[i] BL100123 for BL10.3.2 PSS1. _____
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 10. _____

[c] Insert the "A" chain shorting test plug in BL100123 PG3 and observe "A" chain **complete**, "B" chain **incomplete**, "Safety Shutter Closed" and "SR RF Intlks OK" lights at:
[i] BL100123 for BL10.3.2 PSS1. _____
[ii] At the Beamlines SR Interlock Summing Chassis BL070120 for arc sector 10. _____

[d] Remove the "A" chain shorting plug and insert the "B" chain shorting test plug in BL100123 PG3 and observe "A" chain **incomplete**, "B" chain **complete**, "Safety Shutter Closed", and "SR RF Intlks OK" lights at:
[i] BL100123 for BL10.3.2 PSS1. _____
[ii] At the Beamlines SR Interlock Summing Chassis BL070120 for arc sector 10. _____

[e] Remove the "B" chain shorting plug and re-connect the disconnected interlock cable into BL100123 PG3. _____

[3] Beamline 10.0_PSS201 Tests

[a] Verify shutter and SR RF chains **complete** at BL100123 and BL070120 (23W9345 summing chassis). _____

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[b] Unlock the rear of rack BL1001. Switch both "A" and "B" test toggle switches on rear of BL100132 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL100123 for BL 10.0 PSS2D1. DAL
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 10. DAL

[c] Switch both "A" and "B" test toggle switches on rear of BL100132 to the run position. Lock the rear of safety rack BL1001. DAL

5.5.4 Arc Sector 9 Tests

[A] Beamline arc sector safety shutter and SR RF "A" chain interlocks
[B] Beamline arc sector safety shutter and SR RF "B" chain interlocks

[1] Beamline 9.0 PSS1 Tests

[a] Verify shutter and SR RF chains **complete** at BL090123 and BL070120. DAL

[b] Unlock the rear of rack BL0901. Switch both "A" and "B" test toggle switches on rear of BL090126 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL090123 for BL 9.0 PSS1. DAL
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 9. DAL

[c] Switch both "A" and "B" test toggle switches on rear of BL090126 to the run position. DAL

[2] Beamline 9.3 PSS1 Tests

[a] Verify shutter and SR RF chains **complete** at BL090123 and BL070120. DAL

[b] Unlock the rear of rack BL0901. Switch both "A" and "B" test toggle switches on rear of BL090129 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL090123 for BL 9.3 PSS1. DAL
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 9. DAL

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Initials

[c] Switch both "A" and "B" test toggle switches on rear of BL090129 to the run position. PJR

[3] **Beamline 9.3.1 PSS1 Tests**

[a] Verify shutter and SR RF chains **complete** at BL090123 and BL070120. PJR

[b] Disconnect the existing plug from BL090123 PG4. Observe **incomplete** chains "A" and "B", "Safety Shutter Closed", and "SR RF Intlks OK" lights at:
[i] BL090123 for BL 9.3.1 PSS1. PJR
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 9. PJR

[c] Insert the "A" chain shorting test plug in BL090123 PG4 and observe "A" chain **complete**, "B" chain **incomplete**, "Safety Shutter Closed", and "SR RF Intlks OK" lights at:
[i] BL090123 for BL 9.3.1 PSS1. PJR
[ii] At the Beamlines SR Interlock Summing Chassis BL070120 for arc sector 9. PJR

[d] Remove the "A" chain shorting plug and insert the "B" chain shorting test plug in BL090123 PG4 and observe "A" chain **incomplete**, "B" chain **complete**, "Safety Shutter Closed", and "SR RF Intlks OK" lights at:
[i] BL090123 for BL 9.3.1 PSS1. PJR
[ii] At the Beamlines SR Interlock Summing Chassis BL070120 for arc sector 9. PJR

[e] Remove the "B" chain shorting plug and reconnect the disconnected interlock cable into BL090123 PG4. PJR

[f] Lock the rear of safety rack BL0901. PJR

[4] **Beamline 9.3.1 PSS2 End-Station Tests**

[a] Verify shutter and SR RF chains **complete** at BL090123 and BL070120. PJR

[b] Unlock the rear of BL0902. Switch both "A" and "B" test toggle switches on rear of BL090238 to the test position. Observe **incomplete** chains "A" and "B" and "SR RF Intlks OK" lights at:

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initials

[i] BL090123 for BL 9.3.1 PSS2 end-station.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 9.

[c] Switch both "A" and "B" test toggle switches on rear of BL0901238 to the run position.

[d] Lock the rear of safety rack BL0902.

5.5.5 Arc Sector 8 Tests

[A] Beamline arc sector safety shutter and SR RF "A" chain interlocks
[B] Beamline arc sector safety shutter and SR RF "B" chain interlocks

[1] Beamline 8.0_PSS1 Tests

[a] Verify shutter and SR RF chains **complete** at BL080123 and BL070120 (23W9345 summing chassis).

[b] Unlock the rear of rack BL0801. Switch both "A" and "B" test toggle switches on rear of BL080126 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL080123 for BL 8.0 PSS1.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 8.

[c] Switch both "A" and "B" test toggle switches on rear of BL080126 to the run position.

[2] Beamline 8.2_PSS101 Tests

[a] Verify shutter and SR RF chains **complete** at BL080123 and BL070120 (23W9345 summing chassis).

[b] Switch both "A" and "B" test toggle switches on rear of BL080123 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL080123 for BL 8.2 PSS101.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 8.

[c] Switch both "A" and "B" test toggle switches on rear of BL080129 to the run position.

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5.0 PROCEDURE, Cont.

Initials

[3] Beamline 8.2_PSS201 Tests

[a] Verify shutter and SR RF chains **complete** at BL080123 and BL070120 (23W9345 summing chassis). DJL

[b] Switch both "A" and "B" test toggle switches on rear of BL080132 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL080123 for BL 8.2 PSS201. DJL
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 8. DJL

[c] Switch both "A" and "B" test toggle switches on rear of BL080132 to the run position. DJL

[4] Beamline 8.3_PSS101 Tests

[a] Verify shutter and SR RF chains **complete** at BL080123 and BL070120 (23W9345 summing chassis). DJL

[b] Switch both "A" and "B" test toggle switches on rear of BL080135 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL080123 for BL 8.3 PSS101. DJL
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 8. DJL

[c] Switch both "A" and "B" test toggle switches on rear of BL080135 to the run position. Lock the rear of safety rack BL0801. DJL

[5] Beamline 8.3_PSS201 Tests

[a] Verify shutter and SR RF chains **complete** at BL080223 and BL070120 (23W9345 summing chassis). DJL

[b] Unlock the rear of rack BL0802. Switch both "A" and "B" test toggle switches on rear of BL080232 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL080223 for BL 8.3_PSS201. DJL
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 8. DJL

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5.0 PROCEDURE, Cont.

Initials

[c] Switch both "A" and "B" test toggle switches on rear of BL080232 to the run position. Lock the rear of safety rack BL0802. _____

[6] Beamline 8.2_PSS111 Mini Hutch Tests

[a] Verify shutter and SR RF chains **complete** at BL080123 and BL070120 (23W9345 summing chassis). _____

[b] At the beamline 8.2.1 mini hutch interlock control chassis, open the interlock control chassis using the PSS Control Box Key and switch both "A" and "B" test toggle switches to the test position. Observe **incomplete** chains "A", "B" and "SR RF Intlk OK" lights at:
[i] BL080123 for BL 8.2_PSS111 mini hutch. _____
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 8. _____

[c] Switch both "A" and "B" test toggle switches in the mini-hutch control box to the run position. Close and lock the mini-hutch interlock control chassis. _____

[7] Beamline 8.2_PSS211 Mini Hutch Tests

[a] Verify shutter and SR RF chains **complete** at BL080123 and BL070120 (23W9345 summing chassis). _____

[b] At the beamline 8.2.2 mini hutch interlock control chassis, open the interlock control chassis using the PSS Control Box Key and switch both "A" and "B" test toggle switches to the test position. Observe **incomplete** chains "A", "B" and "SR RF Intlk OK" lights at:
[i] BL080123 for BL 8.2_PSS211. _____
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 8. _____

[c] Switch both "A" and "B" test toggle switches in the mini-hutch control box to the run position. Close and lock the mini-hutch interlock control chassis. _____

[8] Beamline 8.3_PSS111 Mini Hutch Tests

[a] Verify shutter and SR RF chains **complete** at BL080223 and BL070120 (23W9345 summing chassis). _____

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5.0 PROCEDURE, Cont.

Initials

[b] At the beamline 6.3.1 mini hutch interlock control chassis, open the interlock control chassis using the PSS Control Box Key and switch both "A" and "B" test toggle switches to the test position. Observe **incomplete** chains 'A", 'B" and 'SR RF Intlk OK" lights at:
[i] BL060223 for BL 6.3_PSS111 mini hutch.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 6.

[c] Switch both "A" and "B" test toggle switches in the mini-hutch control box to the run position. Close and lock the mini-hutch interlock control chassis.

5.5.6 Arc Sector 6 Tests

[A] Beamline arc sector safety shutter and SR RF "A" chain interlocks
[B] Beamline arc sector safety shutter and SR RF "B" chain interlocks

[1] Beamline 6.1.2 PSS1 Tests

[a] Verify shutter and SR RF chains **complete** at BL060123 and BL070120.

[b] Unlock the rear of rack BL0601. Switch both "A" and "B" test toggle switches on rear of BL060126 to the test position. Observe **incomplete** chains "A", "B" 'Safety Shutter Closed", and "SR RF Intlk OK' lights at:
[i] BL060123 for BL 6.1.2 PSS1.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 6.

[c] Switch both "A" and "B" test toggle switches on rear of BL060126 to the run position.

[2] Beamline 6.3.2 PSS1 Tests

[a] Verify shutter and SR RF chains **complete** at BL060123 and BL070120.

[b] Unlock the rear of rack BL0601. Switch both "A" and "B" test toggle switches on rear of BL060129 to the test position. Observe **incomplete** chains 'A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL060123 for BL 6.3.2 PSS1.

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5.0 PROCEDURE, Cont.

Initials

[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 6. PJL

[c] Switch both "A" and "B" test toggle switches on rear of BL060129 to the run position. PJL

[3] Beamline 6.3.1 PSS1 Tests

[a] Verify shutter and SR RF chains **complete** at BL060123 and BL070120. PJL

[b] Unlock the rear of rack BL0601. Switch both "A" and "B" test toggle switches on rear of BL060132 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL060123 for BL 6.3.1 PSS1. PJL
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 6. PJL

[c] Switch both "A" and "B" test toggle switches on rear of BL060132 to the run position. PJL

[4] Beamline 6.3.1 PSS2 End-StationTests

[a] Verify shutter and SR RF chains **complete** at BL060123 and BL070120 (23W9345 Summing Chassis). PJL

[b] Unlock the rear of rack BL 0601 and disconnect the existing plug or cable from BL060123 PG5. Observe **incomplete** chains "A" and "B," "Safety Shutter Closed," "SR RF Intlk OK" lights at:
[i] BL060123 for BL 6.3.1 PSS2 End Station PJL
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 6. PJL

[c] Insert the "A" chain shorting plug in BL060123 PG5 and observe "A" chain **complete** and "B" chain **incomplete**, "Safety Shutter Closed," and "SR RF Intlk OK" lights at:
[i] BL060123 for BL 6.3.1 PSS2 End Station PJL
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 6. PJL

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5.0 PROCEDURE, Cont.

Initials

[d] Remove the "A" chain shorting plug and insert the "B" chain shorting test plug in BL060123 PG5 and observe "A" chain **complete** and "B" chain **incomplete**, "Safety Shutter Closed," and "SR RF Intlk OK" lights at:
[i] BL060123 for BL 6.3.1 PSS2 End Station
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 6.

[e] Remove the "B" chain shorting plug and reconnect the disconnected interlock cable in BL060123.

5.5.7 Arc Sector 5 Tests

[A] Beamline arc sector safety shutter and SR RF "A" chain interlocks
[B] Beamline arc sector safety shutter and SR RF "B" chain interlocks

[1] Beamline 05.0_PSS001 Tests

[a] Verify shutter and SR RF chains **complete** at BL050123 and BL070120.

[b] Unlock the rear of rack BL0501. Switch both "A" and "B" test toggle switches on rear of BL050125 to the test position. Observe **incomplete** chains 'A', "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL050123 for BL 5.0_PSS001.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 5.

[c] Switch both "A" and "B" test toggle switches on rear of BL050126 to the run position.

[2] Beamline 05.0_PSS101 Tests

[a] Verify shutter and SR RF chains **complete** at BL050123 and BL070120.

[b] Switch both "A" and "B" test toggle switches on rear of BL050129 to the test position. Observe **incomplete** chains "A", "B" 'Safety Shutter Closed', and 'SR RF Intlk OK' lights at:
[i] BL050123 for BL 5.0_PSS101.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 5.

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5.0 PROCEDURE, Cont.

Initials

[c] Switch both "A" and "B" test toggle switches on rear of BL050129 to the run position. PJO

[3] **Beamline 05.0_PSS111 Tests**

[a] Verify shutter and SR RF chains **complete** at BL050123 and BL070120. PJO

[b] Switch both "A" and "B" test toggle switches on rear of BL050132 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK' lights at:
[i] BL050123 for BL 5.0_PSS111. PJO
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 5. PJO

[c] Switch both "A" and "B" test toggle switches on rear of BL050132 to the run position. PJO

[4] **Beamline 05.0_PSS201 Tests**

[a] Verify shutter and SR RF chains **complete** at BL050123 and BL070120. PJO

[b] Switch both "A" and "B" test toggle switches on rear of BL050135 to the test position. Observe **incomplete** chains "A", "B" 'Safety Shutter Closed', and "SR RF Intlk OK" lights at:
[i] BL050123 for BL 5.0_PSS201. PJO
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 5. PJO

[c] Switch both "A" and "B" test toggle switches on rear of BL050135 to the run position. PJO

[5] **Beamline 05.0_PSS211 Tests**

[a] Verify shutter and SR RF chains **complete** at BL050123 and BL070120. PJO

[b] Disconnect the existing plug from BL050123 FG6. Observe **incomplete** chains "A' and "B", 'Safety Shutter Closed", and "SR RF Intlks OK' lights at:
[i] BL050123 for BL 5.0_PSS211. PJO

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5.0 PROCEDURE, Cont.

Initials

[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 5. DJL

[c] Insert the "A" chain shorting test plug in BL050123 PG6 and observe 'A" chain **complete**, "B" chain **incomplete**, 'Safety Shutter Closed", and "SR RF Intlks OK" lights at:
[i] BL050123 for BL 5.0_PSS211. DJL
[ii] At the Beamlines SR Interlock Summing Chassis BL070120 for arc sector 5. DJL

[d] Remove the "A" chain shorting plug and insert the "B" chain shorting test plug in BL050123 PG6 and observe "A" chain **incomplete**, "B" chain **complete**, "Safety Shutter Closed', and "SR RF Intlks OK" lights at:
[i] BL050123 for BL 5.0_PSS211. DJL
[ii] At the Beamlines SR Interlock Summing Chassis BL070120 for arc sector 5. DJL

[e] Remove the "B" chain shorting plug and reconnect the disconnected interlock cable into BL050123 PG6. DJL

[6] **Beamline 05.0_PSS301 Tests**

[a] Verify shutter and SR RF chains **complete** at BL050223 and BL070120. DJL

[b] Switch both "A" and "B" test toggle switches on rear of BL050141 to the test position. Observe **incomplete** chains "A", "B" 'Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL050223 for BL 5.0_PSS301. DJL
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 5. DJL

[c] Switch both "A" and "B" test toggle switches on rear of BL050141 to the run position. DJL

[7] **Beamline 05.0 PSS311 Tests**

[a] Verify shutter and SR RF chains **complete** at BL050223 and BL070120. DJL

[b] Switch both "A" and "B" test toggle switches on rear

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5.0 PROCEDURE, Cont.

Initials

of BL050144 to the test position. Observe **incomplete** chains "A", "B" 'Safety Shutter Closed", and "SR RF Intlk OK' lights at:
[i] BL050223 for BL 5.0_PSS311.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 5.

[c] Switch both "A" and "B" test toggle switches on rear of BL050144 to the run position.

[8] Beamline 05.3_PSS101 Tests

[a] Verify shutter and SR RF chains **complete** at BL050223 and BL070120.

[b] Unlock the rear of rack BL0502. Switch both "A" and "B" test toggle switches on rear of BL050226 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and 'SR RF Intlk OK' lights at:
[i] BL050223 for BL 5.3_PSS101.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 5.

[c] Switch both "A" and "B" test toggle switches on rear of BL050226 to the run position.

[9] Beamline 05.3_PSS201 Tests

[a] Verify shutter and SR RF chains **complete** at BL050223 and BL070120.

[b] Switch both "A" and "B" test toggle switches on rear of BL050229 to the test position. Observe **incomplete** chains "A", "B" 'Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL050223 for BL 5.3_PSS201.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 5.

[c] Switch both "A" and "B" test toggle switches on rear of BL050229 to the run position. Lock the rear of safety racks BL0501 and BL0502.

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5.0 PROCEDURE, Cont.

Initials

5.5.8 Arc Sector 4 Tests

[A] Beamline arc sector safety shutter and SR RF "A" chain interlocks
[B] Beamline arc sector safety shutter and SR RF "B" chain interlocks

[1] Beamline 04.0_PSS002 Tests

[a] Verify shutter and SR RF chains **complete** at BL040123 and BL070120.

[b] Unlock the rear of rack BL0401. Switch both "A" and "B" test toggle switches on rear of BL040129 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL040123 for BL 4.0_PSS201.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 4.

[c] Switch both "A" and "B" test toggle switches on rear of BL040126 to the run position.

[2] Beamline 04.2_PSS201 Tests

[a] Verify shutter and SR RF chains **complete** at BL040123 and BL070120.

[b] Switch both "A" and "B" test toggle switches on rear of BL040135 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL040123 for BL 4.2_PSS201.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 4.

[c] Switch both "A" and "B" test toggle switches on rear of BL040135 to the run position. Lock the rear of safety rack BL0401

[3] Beamline 4.2_PSS211 Mini Hutch Tests

[a] Verify shutter and SR RF chains **complete** at BL040123 and BL070120 (23W9345 summing chassis).

[b] At the beamline 4.2.2. mini hutch interlock control

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5.0 PROCEDURE, Cont.

Initials

chassis, open the interlock control chassis using the PSS Control Box Key and switch both "A" and "B" test toggle switches to the test position. Observe **incomplete** chains 'A', "B" and 'SR RF Intlk OK" lights at:

[i] BL040123 for BL 4.2_PSS211 mini hutch.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 4.

[c] Switch both "A" and "B" test toggle switches in the mini-hutch control box to the run position. Close and lock the mini-hutch interlock control chassis.

5.5.9 Arc Sector 3 Tests

[A] Beamline arc sector safety shutter and SR RF "A" chain interlocks
[B] Beamline arc sector safety shutter and SR RF "B" chain interlocks

NOTE: *BL 3.1 PSS1 is not in this system and is not tested.*

[1] Beamline 03.2_PSS101 Tests

[a] Verify shutter and SR RF chains **complete** at BL030123 and BL070120.

[b] Unlock the rear of rack BL0301. Switch both "A" and "B" test toggle switches on rear of BL030135 to the test position. Observe **incomplete** chains "A', "B" "Safety Shutter Closed', and "SR RF Intlk OK" lights at:
[i] BL030123 for BL 3.2_PSS101.
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 3.

[c] Switch both "A" and "B" test toggle switches on rear of BL030135 to the run position.

[2] Beamline 03.3_PSS101 Tests

[a] Verify shutter and SR RF chains **complete** at BL030123 and BL070120.

[b] Switch both "A" and "B" test toggle switches on rear of BL030132 to the test position. Observe **incomplete** chains "A', 'B' "Safety Shutter Closed", and 'SR RF Intlk OK" lights at:

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[i] BL030123 for BL 3.3_PSS101. DJR
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 3. DJR

[c] Switch both "A" and "B" test toggle switches on rear of BL030132 to the run position. DJR

[3] Beamline 03.3_PSS201 Tests

[a] Verify shutter and SR RF chains complete at BL030123 and BL070120. DJR

[b] Switch both "A" and "B" test toggle switches on rear of BL030129 to the test position. Observe **incomplete** chains "A", "B" "Safety Shutter Closed", and "SR RF Intlk OK" lights at:
[i] BL030123 for BL 3.3_PSS201. DJR
[ii] At the Beamlines SR Interlock Summing Chassis at BL070120 for arc sector 3. DJR

[c] Switch both "A" and "B" test toggle switches on rear of BL030129 to the run position. Look the rear of safety rack BL0301 DJR

5.6 Restore Systems

[1] Turn off and ADMIN lock BTS-B1 and B2 power supplies. DJR

[2] Remove testing signs at visitor sign-in logs. DJR

5.6.1 Restore Linac Systems

[1] Remove tag from the 115 VAC supply plug for the high voltage power supply and restore plug to its socket J3 on the rear of the Hermosa unit at LI0133. DJR

[2] Restore the electron gun deck and high voltage power supply by removing circuit breaker tag LI0117 CB8 (Hermosa control chassis) P2 lockout. DJR

[3] Switch the electron gun mode control chassis at LI0130 out of the "HV Test" position and switch HV test chain switch from LOC to LC. DJR

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5.0 PROCEDURE, Cont.

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[4] At control panel LI0830 and switch the control panel to remote control and request the control room to open GTL VVR1.

[5] Return the S band RF Modulator 1 and Modulator 2 Operate keys to the respective key switches.

[6] Remove LOTO at S0251 CB3 Klystron Drive Amp.

5.6.2 Restore SR RF Systems

NOTE: *If one of the A3 keys has been removed for RF work, simply insert the A3 key into the key cylinder at S025041 key cache. Otherwise, complete step [1] below.*

[1] Insert key A3 into the key cylinder at S025041 key cache. Turn A3 and remove B2 key. Insert B2 at the rear of RF power supply crowbar cabinet SE0226 and turn it to release the ground bar. Move the ground bar to the up position and remove key A2. Insert key A2 into the crowbar cabinet SE0226 and remove key A1. Return key A1 to the RF crowbar control rack S025041.

5.6.3 Control of Keys and Test Plugs

Type key(s)	Initial returned
Safety rack shackleless padlock key	
Shorting plug for "A" chain arc sum chassis input	
Shorting plug for "B" chain arc sum chassis input	
Archive SR Search BTS Area key	
Archive SR Search RF Area key	
Archive SR Search SR 4-9 Area key	
Mini Hutch Box key	

6.0 APPENDIX

Temporary Clip Accountability Sheet, from EC 02-02

December 15, 2005

EC 02-15 Test History

Below is the entire test history of procedure EC 02-15, "ALS Beamline Summation and Main Control Room Storage Ring Fill Radiation Interlock Testing Procedure." **The supervisor, if involved, is noted in boldface type.** The test was performed every 6 months until 2001, when EC 02-15A, a functional test (based on the larger "full" test), was created — once a year EC 02-15 is performed, followed 6 months later by EC 02-15A. The interlock system was designed by Art Ritchie. The history below is ordered from last test done to first test done.

Test Date	Lead Tester	Assistant Testers
11/26/05	Rosado	Colston, Sawada, Pearson
11/1/04	Vinco	Rogoff, Holzer, Kozy, Sawada, **Kuneli**
10/6/03	**Kuneli**	Rogoff, Colston, Rosado, Vinco
9/30/02	**Gregor**	Kuneli, Foster, Nhan
7/30/01	**Gregor**	Colston, Vinco, Holzer, Cole, Sippio
8/14/00	**Gregor**	Mueller, Nomura, Gregoire, Jefferson
1/18/00	**Gregor**	Mueller, Jefferson, Kuneli
7/6/99	**Gregor**	Mueller, Dwinell, Nomura, Slater
12/7/98	**Gregor**	Mueller, Nomura, Casey
6/22/98	**Gregor**	Bolin, Casey
12/15/97	**Gregor**	Bolin, Mueller
5/2/97	**Gregor**	Bolin, Samuelson, Jones
11/19/96	**Gregor**	Mueller, Casey, Bolin
5/13/96	**Gregor**	Bishop, Wolfe, Ybarra
10/18/95	Photos	Pusina, Jones, Wolfe
3/20/95	Stricklin	Ritchie
10/3/94	**Gregor**	Mueller, Ackerman, Linder,
6/13/94	Stricklin	Linder, Ritchie
4/11/94	**Gregor**	Linder, Ritchie, Stricklin
11/18/93	Rogoff	Stricklin, Linder, Ritchie
10/14/93	Stricklin	Hauck, Burch
9/23/93	Stricklin	Hauck, Collins

Note: 1993 and 1994 have tests done more frequently than every 6 months; the ALS was still commissioning the machine at that time.

Researched by Rita Jones, ALS Procedure Center Manager. All original tests are in my office, Bldg. 80, Rm. 160.

Appendix P: Badge entries into ALS related to incident 7.3

Badge Event Report
REPORT LIMITED BY DATE, READER
81 entries were found matching your search criteria.

DATE/TIME	L NAME	F NAME	BADGE ID	EMP L ID	STATUS	DEPT	READER
11/26/2005 00:00:25	RICHARDSON	DAVID	155120303799	000220	ACTIVE	ENGINEERING	39-7-0:6-1993 HALLWAY ENTRY
11/26/2005 00:08:43	RICHARDSON	DAVID	155120303799	000220	ACTIVE	ENGINEERING	1-4-0:6-1987 SECTOR #4
11/26/2005 00:15:48	WANG	FENG	155120386506	006383	ACTIVE expiration: 08/31/2006	Unknown	39-6-1:6-1990 LOBBY ENTRY
11/26/2005 00:33:18	POLMAN	JOS	155120052814	710382	ACTIVE expiration: 03/09/2006	ALS	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 00:40:57	WANG	FENG	155120386506	006383	ACTIVE expiration: 08/31/2006	Unknown	39-6-1:6-1990 LOBBY ENTRY
11/26/2005 01:35:53	RICHARDSON	DAVID	155120303799	000220	ACTIVE	ENGINEERING	1-4-0:6-1987 SECTOR #4
11/26/2005 02:03:43	POLMAN	JOS	155120052814	710382	ACTIVE expiration: 03/09/2006	ALS	1-4-1:6-/80 DR
11/26/2005 02:33:05	WANG	FENG	155120386506	006383	ACTIVE expiration: 08/31/2006	Unknown	39-6-1:6-1990 LOBBY ENTRY
11/26/2005 04:44:30	COLSTON	RONNY A.	152480014414	003843	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM

11/26/2005 05:07:51	RICHARDSON	DAVID	155120303799	000220	ACTIVE	ENGINEERING	1-3-1:6-/10 DR, COL #21
11/26/2005 05:11:57	RICHARDSON	DAVID	155120303799	000220	ACTIVE	ENGINEERING	1-1-0:6-LOBBY EXTERIOR DR
11/26/2005 05:12:00	RICHARDSON	DAVID	155120303799	000220	ACTIVE	ENGINEERING	1-1-0:6-LOBBY EXTERIOR DR
11/26/2005 05:15:35	RICHARDSON	DAVID	155120303799	000220	ACTIVE	ENGINEERING	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 05:17:42	RICHARDSON	DAVID	155120303799	000220	ACTIVE	ENGINEERING	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 07:36:37	KETTELER	GUIDO	155120303111	011171	ACTIVE expiration: 02/20/2006	Unknown	39-6-1:6-1990 LOBBY ENTRY
11/26/2005 07:36:55	KETTELER	GUIDO	155120303111	011171	ACTIVE expiration: 02/20/2006	Unknown	1-2-1:6-SOUTH DR, COL #3
11/26/2005 07:51:36	ROSADO	PETER J.	151696112370	215751	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 08:07:50	ROTENBERG	ELI	154128226716	275451	ACTIVE	ALS	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 08:23:31	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 08:26:18	MARCUS	MATTHEW	152544058879	004251	ACTIVE	Unknown	1-7-0:6-1093A ROLLUP MAN DR
11/26/2005 08:40:31	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN

							CLEAN ROOM
11/26/2005 08:54:14	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 08:55:24	LE GROS	MARK	152480015508	588803	ACTIVE	ALS-USERS	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 09:25:46	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-4-1:6-/80 DR
11/26/2005 09:27:53	KETTELER	GUIDO	155120303111	011171	ACTIVE expiration : 02/20/2006	Unknown	1-3-0:6-/10 DR HIBAY
11/26/2005 09:28:57	ADANIYA	HIDEHITO	155120386370	009576	ACTIVE	Unknown	1-5-1:6-WEST EXTER DR,COL# 17
11/26/2005 09:56:21	MARCUS	MATTHEW	152544058879	004251	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 10:28:35	SAWADA	MICHAEL T.	151664062829	284751	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 10:30:06	SAWADA	MICHAEL T.	151664062829	284751	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 10:39:56	ROSADO	PETER J.	151696112370	215751	ACTIVE	Unknown	1-4-0:6-1987 SECTOR #4
11/26/2005 10:54:50	LE GROS	MARK	152480015508	588803	ACTIVE	ALS-USERS	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005	ROSADO	PETER J.	151696112370	215751	ACTIVE	Unknown	1-6-1:6-80-107 ALS

							ALS CLEAN ROOM
11/26/2005 11:26:54	LARABELL	CAROLYN A.	155120052313	228551	ACTIVE	ALS	1-5-1:6-WEST EXTER DR,COL# 17
11/26/2005 11:28:27	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-4-1:6-/80 DR
11/26/2005 11:42:50	ZHANG	YANFENG	154112282526	010725	ACTIVE expiration: 01/03/2006	Unknown	1-1-0:6-LOBBY EXTERIOR DR
11/26/2005 11:43:02	ZHANG	YANFENG	154112282526	010725	ACTIVE expiration: 01/03/2006	Unknown	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 11:43:06	ZHANG	YANFENG	154112282526	010725	ACTIVE expiration: 01/03/2006	Unknown	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 11:43:09	ZHANG	YANFENG	154112282526	010725	ACTIVE expiration: 01/03/2006	Unknown	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 11:46:55	FEDOROV	ALEXEI	154112271336	003522	ACTIVE	ALS-USERS	1-2-1:6-SOUTH DR, COL #3
11/26/2005 11:50:54	COLSTON	RONNY A.	152480014414	003843	ACTIVE	Unknown	1-3-1:6-/10 DR, COL #21
11/26/2005 11:57:52	KIRZ	JANOS	155120052318	666076	ACTIVE expiration: 06/30/2006	ALS-USERS	1-5-1:6-WEST EXTER DR,COL# 17
11/26/2005 12:09:40	ADANIYA	HIDEHITO	155120386370	009576	ACTIVE	Unknown	1-5-1:6-WEST EXTER DR,COL# 17
11/26/2005 12:52:31	DONG	CHUNGLI	154128223203	008367	ACTIVE expiration: 11/19/200	ALS-USERS	1-1-1:6-LOBBY INTERIO

					11/19/2006		R DR
11/26/2005 12:55:04	DONG	CHUNGLI	154128223203	008367	ACTIVE expiration: 11/19/2006	ALS-USERS	1-4-1:6-/80 DR
11/26/2005 12:58:55	LARABELL	CAROLYN A.	155120052313	228551	ACTIVE	ALS	1-5-1:6-WEST EXTER DR,COL# 17
11/26/2005 12:59:07	LE GROS	MARK	152480015508	588803	ACTIVE	ALS-USERS	1-5-0:6-WEST INTER DR,COL# 17
11/26/2005 13:13:16	DONG	CHUNGLI	154128223203	008367	ACTIVE expiration: 11/19/2006	ALS-USERS	1-1-1:6-LOBBY INTERIO R DR
11/26/2005 13:43:15	LE GROS	MARK	152480015508	588803	ACTIVE	ALS-USERS	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 13:51:06	SHUH	DAVID K.	155120152989	302951	ACTIVE	ALS	1-7-0:6-1093A ROLLUP MAN DR
11/26/2005 14:02:15	SHUH	DAVID K.	155120152989	302951	ACTIVE	ALS	1-5-0:6-WEST INTER DR,COL# 17
11/26/2005 14:38:31	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 15:16:00	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-4-1:6-/80 DR
11/26/2005 15:18:24	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-4-1:6-/80 DR
11/26/2005 15:22:08	TANAKA	KIYOHISA	152688125047	006735	ACTIVE expiration: 04/30/2006	Unknown	1-1-0:6-LOBBY EXTERIO R DR

11/26/2005 15:24:18	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 15:29:10	TANAKA	KIYOHISA	152688125047	006735	ACTIVE expiration: 04/30/2006	Unknown	1-2-1:6-SOUTH DR, COL #3
11/26/2005 15:33:22	PEARSON	ANGELIC L.	154112272765	800672	ACTIVE	Unknown	39-7-0:6-1993 HALLWAY ENTRY
11/26/2005 15:39:08	TANAKA	KIYOHISA	152688125047	006735	ACTIVE expiration: 04/30/2006	Unknown	1-7-0:6-1093A ROLLUP MAN DR
11/26/2005 16:24:40	SIPPIO	ANTHONY	154112271479	005194	ACTIVE	Unknown	1-4-1:6-/80 DR
11/26/2005 16:44:35	SIPPIO	ANTHONY	154112271479	005194	ACTIVE	Unknown	1-3-1:6-/10 DR, COL #21
11/26/2005 17:27:00	ELLIS	GREGORY W.	154176429533	010334	ACTIVE expiration: 12/31/2005	Unknown	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 17:33:28	ELLIS	GREGORY W.	154176429533	010334	ACTIVE expiration: 12/31/2005	Unknown	1-4-1:6-/80 DR
11/26/2005 17:41:11	FAKRA	SIRINE	155120051235	002227	ACTIVE	Unknown	39-6-1:6-1990 LOBBY ENTRY
11/26/2005 17:41:30	FAKRA	SIRINE	155120051235	002227	ACTIVE	Unknown	1-2-1:6-SOUTH DR, COL #3
11/26/2005 17:42:19	ARAKI	TOHRU	152688122215	006339	ACTIVE expiration: 11/14/2006	Unknown	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 17:44:19	ARAKI	TOHRU	152688122215	006339	ACTIVE expiration: 11/14/2006	Unknown	1-4-1:6-/80 DR

					6		
11/26/2005 17:52:32	RUDE	BRUCE S.	155120267660	770232	ACTIVE	ALS	1-2-1:6-SOUTH DR, COL #3
11/26/2005 18:33:11	SIPPIO	ANTHONY	154112271479	005194	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 19:03:25	KOUPRINE	ALEXANDRE P.	155120386302	009349	ACTIVE expiration: 09/30/2006	Unknown	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 19:07:57	DONG	CHUNGLI	154128223203	008367	ACTIVE expiration: 11/19/2006	ALS-USERS	1-1-1:6-LOBBY INTERIOR DR
11/26/2005 19:12:16	KOUPRINE	ALEXANDRE P.	155120386302	009349	ACTIVE expiration: 09/30/2006	Unknown	1-4-1:6-/80 DR
11/26/2005 19:24:47	RUDE	BRUCE S.	155120267660	770232	ACTIVE	ALS	1-2-1:6-SOUTH DR, COL #3
11/26/2005 20:44:51	FEDOROV	ALEXEI	154112271336	003522	ACTIVE	ALS-USERS	39-6-1:6-1990 LOBBY ENTRY
11/26/2005 21:10:03	FEDOROV	ALEXEI	154112271336	003522	ACTIVE	ALS-USERS	1-2-1:6-SOUTH DR, COL #3
11/26/2005 21:32:11	SIPPIO	ANTHONY	154112271479	005194	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 21:34:03	SIPPIO	ANTHONY	154112271479	005194	ACTIVE	Unknown	1-3-1:6-/10 DR, COL #21
11/26/2005 23:07:30	PETERKA	DARCY S.	154176428668	507203	ACTIVE	ALS	1-1-1:6-LOBBY INTERIOR DR
					ACTIVE expiration		1-1-1:6-

23:13:46		RE P.	02	9	expiration : 09/30/2006		LOBBY INTERIOR DR
11/26/2005 23:14:52	KOUPRINE	ALEXANDRE P.	155120386302	009349	ACTIVE expiration : 09/30/2006	Unknown	1-4-1:6-/80 DR
11/26/2005 23:17:08	SIPPIO	ANTHONY	154112271479	005194	ACTIVE	Unknown	1-6-1:6-80-107 ALS CLEAN ROOM
11/26/2005 23:18:36	SIPPIO	ANTHONY	154112271479	005194	ACTIVE	Unknown	1-3-1:6-/10 DR, COL #21

Appendix Q: ALS Event Logger data related to incident 7.3

20051126 14:48:52	252	1	0	SR12C___RFPERM_BM12	RF_PERM_OK
20051126 14:48:52	252	1	0	SR09C___RFPERM_BM13	RF_PERM_OK
20051126 14:48:52	252	1	0	SR09C___FEVACS_BM14	FE_VAC_SUM
20051126 14:48:52	252	1	0	SR08C___FEVACS_BM14	FE_VAC_SUM
20051126 14:48:52	252	1	0	SR07C___RFPERM_BM13	RF_PERM_OK
20051126 14:48:52	140	1	0	ICS_B08_RSS_RUN_MODE	coil - PV_01027
20051126 14:48:52	140	1	0	SR07C___FEVACS_BM14	FE_VAC_SUM
20051126 14:48:52	140	1	0	SR06C___FEVACS_BM14	FE_VAC_SUM
20051126 14:48:52	139	1	0	ICS_BL08_BPS_RUN_PMT	coil - PV_01026
20051126 14:48:52	139	1	0	SR05C___RFPERM_BM13	RF_PERM_OK
20051126 14:48:52	139	1	0	SR05C___FEVACS_BM14	FE_VAC_SUM
20051126 14:48:52	139	1	0	SR04C___RFPERM_BM13	RF_PERM_OK
20051126 14:48:52	139	1	0	SR04C___FEVACS_BM14	FE_VAC_SUM
20051126 14:48:52	139	1	0	SR03S___VACSUM_BM18	SEC 2 COMPLETE
20051126 14:48:52	139	1	0	SR03S___VACSUM_BM16	SEC 4 COMPLETE
20051126 14:48:52	139	1	0	SR03S___VACSUM_BM13	SEC 7 COMPLETE
20051126 14:48:52	139	1	0	SR03S___VACSUM_BM11	SEC 9 COMPLETE
20051126 14:48:52	139	1	0	SR03S___VACSUM_BM09	SEC 11 COMPLETE
20051126 14:48:52	139	1	0	SR03S___VACSUM_BM08	SEC 12 COMPLETE
20051126 14:48:52	137	1	0	ICS_BL08_SR_RF_PMT coil - PV_01025	
20051126 14:48:52	137	1	0	SR03S___VACSUM_BM15	SEC 5 COMPLETE
20051126 14:48:52	137	1	0	SR12C___FEVACS_BM14	FE_VAC_SUM
20051126 14:48:52	137	1	0	SR11C___RFPERM_BM12	RF_PERM_OK
20051126 14:48:52	137	1	0	SR11C___FEVACS_BM14	FE_VAC_SUM
20051126 14:48:52	135	1	0	SR10C___FEVACS_BM14	FE_VAC_SUM
20051126 14:48:51	960	1	0	SR02C___RFPERM_BM12	RF_PERM_OK
20051126 14:48:51	959	1	0	SR03C___FEVACS_BM14	FE_VAC_SUM
20051126 14:48:51	959	1	0	SR02S___PINGRA_BM19	PINGER_AIR
20051126 14:48:51	958	1	0	SR01C___FEVACS_BM14	FE_VAC_SUM SR OPENED?
20051126 14:48:46	130	1	0	SR12U___IG1____BM03	ION GAUGE1 ON
20051126 14:46:32	111	1	0	SR03S___C2TEMP_BM18	CAV 2 HTR ON
20051126 14:46:30	110	1	0	SR03S___C1TEMP_BM18	CAV 1 HTR ON
20051126 14:41:37	154	1	0	LTB_____BS_____BM05	PS_READY_MON
20051126 14:41:37	154	1	0	LTB_____BS_____BM02	SAFETY_CHAIN
20051126 14:41:37	153	1	0	LTB_____B1_____BM08	PS_READY_MON
20051126 14:41:37	153	1	0	LTB_____B1_____BM07	B1_MAG_INTLK
20051126 14:41:37	153	1	0	LTB_____B1_____BM05	PS_CNTRL_PWR_MON
20051126 14:38:03	938	0	1	SR04H___IG1____BM01	ION GAUGE1 ON
20051126 14:37:55	952	1	0	SR04U___IG1____BM01	ION GAUGE1 ON
20051126 14:16:11	110	1	0	SR03S___PSINT__BM01	HVPS VVT FAN/AIR
20051126 14:16:10	113	0	1	SR03S___PSINT__BM01	HVPS VVT FAN/AIR
20051126 14:32:50	037	0	1	ICS_BL082_IG101_OK coil - PV_01107	
20051126 14:32:48	505	1	0	ICS_BL082_IG101_OK coil - PV_01107	
20051126 14:31:14	113	1	0	SR03S___MSTINT_BM09	PERS SAFETY 1
20051126 14:31:10	136	1	0	LN_____MD2INT_BM19	P.SAFETY A MON.
20051126 14:31:10	135	1	0	LN_____MD1INT_BM19	P.SAFETY CHAIN A
20051126 14:31:08	132	1	0	EG_____HV_____BM09	GUN_OPERATNL_BM2
20051126 14:31:08	131	1	0	EG_____HTR____BM08	HEATER_RDY
20051126 14:31:08	131	1	0	EG_____HTR____BM03	RF_TEST_OFF
20051126 14:31:08	131	1	0	EG_____HTR____BM02	HV_TEST_OFF_BM
20051126 14:31:08	131	0	1	EG_____AUX____BM10	RF_TEST_BM
20051126 14:31:08	131	1	0	EG_____AUX____BM10	GUN_OPERATNL_BM1
20051126 14:31:08	130	0	1	LN_____MD2_RF_BM02	RF TEST ON
20051126 14:31:08	129	0	1	LN_____MD1_RF_BM02	RF TEST ON
20051126 14:30:54	926	1	0	LTB_____TV6LIT_BM13	TV6 LAMP ON

20051126 14:30:54	052	1	0	LTB____TV6LIT_BC20	TV6 LAMP ON/OFF
20051126 14:29:04	103	0	1	SR10S___VVR1___BM04	VVR1_CLSD
20051126 14:28:56	924	0	1	SR03S___VVR2___BM09	VVR2_CLSD
20051126 14:28:56	105	0	1	SR08S___VVR1___BM04	VVR1_CLSD
20051126 14:28:56	104	0	1	SR06S___VVR2___BM04	VVR1_CLSD
20051126 14:28:51	107	1	0	SR08S___VACSUM_BM10	SEC 10 COMPLETE
20051126 14:28:51	106	1	0	SR10S___VVR1___BM03	VVR1_OPN
20051126 14:28:51	106	1	0	SR10C___RFPERM_BM13	RF_PERM_OK
20051126 14:28:49	778	1	0	SR10S___VVR1___BC20	VVR1_DR
20051126 14:28:48	922	0	1	SR03S___VVR1___BM04	VVR1_CLSD
20051126 14:28:46	920	0	1	SR01S___VVR2___BM09	VVR2_CLSD
20051126 14:28:46	106	1	0	SR08S___VVR1___BM03	VVR1_OPN
20051126 14:28:46	106	1	0	SR08C___RFPERM_BM13	RF_PERM_OK
20051126 14:28:46	105	1	0	SR08S___VACSUM_BM12	SEC 8 COMPLETE
20051126 14:28:45	781	1	0	SR08S___VVR1___BC20	VVR1_DR
20051126 14:28:44	099	1	0	SR06S___VVR2___BM03	VVR1_OPN
20051126 14:28:44	098	1	0	SR06C___RFPERM_BM13	RF_PERM_OK
20051126 14:28:44	098	1	0	SR03S___VACSUM_BM14	SEC 6 COMPLETE
20051126 14:28:43	280	1	0	SR06S___VVR1___BC20	VVR1_DR
20051126 14:28:41	920	1	0	SR03S___VVR2___BM08	VVR2_OPN
20051126 14:28:40	787	1	0	SR03S___VVR2___BC21	VVR2_DR
20051126 14:28:39	922	0	1	SR01S___VVR1___BM04	VVR1_CLSD
20051126 14:28:39	099	1	0	SR03S___VACSUM_BM17	SEC 3 COMPLETE
20051126 14:28:38	924	1	0	SR03C___RFPERM_BM13	RF_PERM_OK
20051126 14:28:38	923	1	0	SR03S___VVR1___BM03	VVR1_OPN
20051126 14:28:38	287	1	0	SR03S___VVR1___BC20	VVR1_DR
20051126 14:28:35	922	1	0	SR01S___VVR2___BM08	VVR2_OPN
20051126 14:28:35	289	1	0	SR01S___VVR2___BC21	VVR2_DR
20051126 14:28:32	098	1	0	SR03S___VACSUM_BM19	SEC 1 COMPLETE
20051126 14:28:32	098	1	0	SR03S___VACSUM_BM07	SEC VAC SUM CH 1
20051126 14:28:32	098	1	0	SR03S___VACSUM_BM03	BEAM PROTECT 1
20051126 14:28:32	098	1	0	SR03S___VACSUM_BM02	BEAM PROTECT 2
20051126 14:28:32	097	1	0	SR05S___VACSUM_BM06	SEC VAC SUM CH 2
20051126 14:28:32	097	1	0	SR05S___VACSUM_BM05	FAST RF TRIP 1
20051126 14:28:32	097	1	0	SR05S___VACSUM_BM04	FAST RF TRIP 2
20051126 14:28:31	921	1	0	SR01C___RFPERM_BM12	RF_PERM_OK
20051126 14:28:31	920	1	0	SR01S___VVR1___BM03	VVR1_OPN
20051126 14:28:31	031	1	0	SR01S___VVR1___BC20	VVR1_DR SR VALVES CLOSED
20051126 14:18:59	903	0	1	SR04U___IG1____BM01	ION GAUGE1 ON
20051126 14:18:52	909	1	0	SR04U___IG1____BM01	ION GAUGE1 ON
20051126 14:13:42	085	0	1	SR05W___IG1____BM03	ION GAUGE1 ON
20051126 14:13:36	086	1	0	SR05W___IG1____BM03	ION GAUGE1 ON
20051126 13:57:18	864	0	1	BR1_____KI_____BM05 THYRATHRON READY	
20051126 13:57:18	864	0	1	BR1_____KI_____BM04 CATHODE TEMP OK	
20051126 13:57:17	861	1	0	BR1_____KI_____BM05 THYRATHRON READY	
20051126 13:57:17	861	1	0	BR1_____KI_____BM04 CATHODE TEMP OK	
20051126 13:49:40	054	0	1	SR07U___IG1____BM03	ION GAUGE1 ON
20051126 13:49:35	046	1	0	SR07J___IG1____BM03	ION GAUGE1 ON
20051126 13:17:38	007	0	1	SR08U___IG1____BM03	ION GAUGE1 ON
20051126 13:17:33	014	1	0	SR08U___IG1____BM03	ION GAUGE1 ON
20051126 13:07:44	008	0	1	SR12U___IG1____BM03	ION GAUGE1 ON
20051126 13:07:39	002	1	0	SR12U___IG1____BM03	ION GAUGE1 ON
20051126 12:53:21	977	0	1	SR10U___IG1____BM03	ION GAUGE1 ON
20051126 12:53:17	975	1	0	SR10U___IG1____BM03	ION GAUGE1 ON
20051126 12:47:21	975	0	1	SR09U___IG1____BM03	ION GAUGE1 ON

20051126 12:47:16	977	1	0	SR09U__IG1___BM03	ION GAUGE1 ON	
20051126 12:45:07	442	1	0	SR07C__HCSD1__BM00	PS_INTLK_OK	
20051126 12:45:03	977	0	1	SR10U__IG1___BM03	ION GAUGE1 ON	
20051126 12:44:59	979	1	0	SR10U__IG1___BM03	ION GAUGE1 ON	
20051126 12:07:00	926	0	1	SR08U__IG1___BM03	ION GAUGE1 ON	
20051126 12:06:55	925	1	0	SR08U__IG1___BM03	ION GAUGE1 ON	
20051126 11:49:14	899	0	1	SR09U__IG1___BM03	ION GAUGE1 ON	
20051126 11:49:09	898	1	0	SR09U__IG1___BM03	ION GAUGE1 ON	— TEST ENDED ?
20051126 11:47:58	966	1	0	GTL____VVR1__BM11	VALVE IN LOCAL	
20051126 11:47:57	964	0	1	GTL____VVR1__BM14	GTL VVR1 RDY	
20051126 11:46:11	887	0	1	SR03S__LBLBKR_BM09	KEY INTRLK COMP	
20051126 11:46:11	887	0	1	SR03S__LBLBKR_BM07	LBL BREAKER RDY	
20051126 11:43:08	959	0	1	EG____HTR____BM08	HEATER RDY	
20051126 11:43:08	959	1	0	EG____AUX____BM13	RF_TEST_BM	
20051126 11:43:08	959	0	1	EG____AUX____BM10	GUN_OPERATNL_BM1	
20051126 11:43:08	958	1	0	LN____MD1_RF_BM02	RF TEST ON	
20051126 11:43:07	958	0	1	EG____HV_____BM09	GUN_OPERATNL_BM2	
20051126 11:43:07	957	0	1	EG____HTR____BM05	RF_TEST_OFF	
20051126 11:43:07	957	0	1	EG____HTR____BM02	HV_TEST_OFF_BM	
20051126 11:43:07	956	1	0	LN____MD2_RF_BM02	RF TEST ON	
20051126 11:43:07	956	0	1	LN____MD2INT_BM19	P.SAFETY A MON.	
20051126 11:43:07	955	0	1	LN____MD1INT_BM19	P.SAFETY CHAIN A	
20051126 11:42:28	888	1	0	BTS____B2____BM00	CNTRL_PWR_ON_MON	
20051126 11:42:27	889	1	0	BTS____B2____BM09	AIR_FLO	
20051126 11:42:27	889	1	0	BTS____B2____BM15	LEM_O/T	
20051126 11:42:27	889	1	0	BTS____B2____BM14	AC_OVER_CURRENT	
20051126 11:42:27	889	1	0	BTS____B2____BM13	AC_PHASE_LOSS	
20051126 11:42:27	889	1	0	BTS____B2____BM11	LOCAL OFF	
20051126 11:42:27	889	1	0	BTS____B2____BM10	SCR_O/T	
20051126 11:42:27	889	1	0	BTS____B2____BM08	GND_FAULT_RELAY	
20051126 11:42:27	889	1	0	BTS____B2____BM07	MAGNET_WATER_FLO	
20051126 11:42:27	889	1	0	BTS____B2____BM06	SMOKE_DETC_ALARM	
20051126 11:42:27	889	1	0	BTS____B2____BM05	DC_OVER_CURRENT	
20051126 11:42:27	889	1	0	BTS____B2____BM04	SAFETY_INTLKS	
20051126 11:42:27	889	1	0	BTS____B2____BM03	DOOR_INTLK	
20051126 11:42:27	889	1	0	BTS____B2____BM02	MAGNET_O/T	
20051126 11:42:22	887	1	0	BTS____B2____BM01	REMOTE_CNTRL_ON	
20051126 11:40:15	959	1	0	BTS____B1____BM13	AC_PHASE_LOSS	
20051126 11:40:15	959	1	0	BTS____B1____BM11	LOCAL OFF	[illegible]
20051126 11:40:15	959	1	0	BTS____B1____BM15	LEM_O/T	[illegible]
20051126 11:40:15	959	1	0	BTS____B1____BM14	AC_OVER_CURRENT	[illegible]
20051126 11:40:15	959	1	0	BTS____B1____BM10	SCR_O/T	[illegible]
20051126 11:40:15	959	1	0	BTS____B1____BM09	AIR_FLO	
20051126 11:40:15	959	1	0	BTS____B1____BM08	GND_FAULT_RELAY	
20051126 11:40:15	959	1	0	BTS____B1____BM07	MAGNET_WATER_FLO	
20051126 11:40:15	958	1	0	BTS____B1____BM06	SMOKE_DETC_ALARM	
20051126 11:40:15	958	1	0	BTS____B1____BM05	DC_OVER_CURRENT	
20051126 11:40:15	958	1	0	BTS____B1____BM04	SAFETY_INTLK	
20051126 11:40:15	958		0	BTS____B1____BM03	DOOR_INTLK	
20051126 11:40:15	958		0	BTS____B1____BM02	MAGNET_O/T	
20051126 11:40:15	958	1	0	BTS____B1____BM00	CNTRL_PWR_ON_MON	
20051126 11:40:08	965	1	0	BTS____B1____BM01	REMOTE_CNTRL_ON	B1 & B2 TRIP

20051126 11:18:27	350	0	1	SR07C__HCSD1__BM00	PS_INTLK_OK	
20051126 11:37:19	886	0	1	SR03S__MSTINT_BM09	PERS SAFETY 1	TEST
20051126 11:35:51	891	1	0	SR03S__MSTINT_BM09	PERS SAFETY 1	
20051126 11:35:21	890	0	1	SR03S__MSTINT_BM09	PERS SAFETY 1	
20051126 11:33:30	889	1	0	SR03S__MSTINT_BM09	PERS SAFETY 1	TEST
20051126 11:32:41	876	0	1	SR03S__MSTINT_BM09	PERS SAFETY 1	
20051126 11:29:44	334	0	1	B073_PSS1_RSS_RUN_PMT	call - PV_00188 7.3 KEYED ONLINE	
20051126 11:24:02	874	1	0	SR03S__MSTINT_BM09	PERS SAFETY 1	TEST
20051126 11:21:55	874	0	1	SR03S__MSTINT_BM09	PERS SAFETY 1	
20051126 11:20:58	855	0	1	SR09U__IG1___BM03	ION GAUGE1 ON	
20051126 11:20:53	860	1	0	SR09U__IG1___BM03	ION GAUGE1 ON	
20051126 11:19:56	872	1	0	SR03S__MSTINT_BM09	PERS SAFETY 1	TEST
20051126 11:19:17	857	0	1	SR03S__MSTINT_BM09	PERS SAFETY 1	
20051126 11:16:53	857	1	0	SR03S__MSTINT_BM09	PERS SAFETY 1	TEST
20051126 11:14:01	852	0	1	SR03S__MSTINT_BM09	PERS SAFETY 1	
20051126 11:09:47	858	1	0	SR03S__MSTINT_BM09	PERS SAFETY 1	TEST
20051126 11:09:03	846	0	1	SR03S__MSTINT_BM09	PERS SAFETY 1	
20051126 11:07:18	842	1	0	SR03S__MSTINT_BM09	PERS SAFETY 1	TEST
20051126 11:05:30	842	0	1	SR03S__MSTINT_BM09	PERS SAFETY 1	
20051126 11:02:07	838	1	0	SR03S__RFMODE_BM12	SRRF MODE RDY	
20051126 11:02:07	838	1	0	SR03S__MSTILK_BM12	CAV 1&2 VAC INT	
20051126 11:02:07	838	1	0	SR03S__MSTILK_BM12	PULLDOWN CABLE	
20051126 11:02:07	838	1	0	SR03S__MSTILK_BM11	PERMIT RF	
20051126 11:02:06	837	1	0	SR03S__RFCONT_BM14	SRRF RF RDY MON.	
20051126 11:02:06	837	1	0	SR03S__MSTINT_BM09	PERS SAFETY 1	– 1st trip after last RF reset
20051126 11:02:06	837	1	0	SR03S__MSTINT_BM08	PERS SAFETY 2	
20051126 11:02:06	837	1	0	SR03S__MSTINT_BM07	BEAM PROTECT 1	
20051126 11:02:06	837	1	0	SR03S__MSTINT_BM06	BEAM PROTECT 2	
20051126 11:02:06	837	1	0	SR03S__MSTINT_BM05	RF SAFETY 1	
20051126 11:02:06	837	1	0	SR03S__MSTINT_BM04	RF SAFETY 2	
20051126 11:02:06	837	1	0	SR03S__MSTINT_BM03	FDR RF INT	
20051126 11:02:06	837	1	0	SR03S__MSTINT_BM02	FDR COOLING INT	
20051126 11:02:06	836	1	0	SR03S__MSTILK_BM15	CAV1 COOLING INT	
20051126 11:02:06	836	1	0	SR03S__MSTILK_BM14	CAV2 COOLING INT	REAL TRIP?
20051126 10:59:32	830	0	1	SR05W__IG1___BM03	ION GAUGE1 ON	
20051126 10:59:26	834	1	0	SR05W__IG1___BM03	ION GAUGE1 ON	
20051126 10:46:15	826	0	1	SR09U__IG1___BM03	ION GAUGE1 ON	
20051126 10:46:10	820	1	0	SR09U__IG1___BM03	ION GAUGE1 ON	
20051126 10:42:04	823	0	1	SR05W__IG1___BM03	ION GAUGE1 ON	
20051126 10:41:59	823	1	0	SR05W__IG1___BM03	ION GAUGE1 ON	
20051126 10:27:18	790	0	1	SR08U__IG1___BM03	ION GAUGE1 ON	
20051126 10:27:13	792	1	0	SR08U__IG1___BM03	ION GAUGE1 ON	
20051126 10:21:18	782	0	1	SR12U__IG1___BM03	ION GAUGE1 ON	
20051126 10:21:15	784	1	0	SR12U__IG1___BM03	ION GAUGE1 ON	
20051126 10:21:06	493	0	1	ICS_BL083_PSS101_RSS_TRLY_CL	NOTE: FILL MODE (below) call - PV_01043	

RE-TEST OF SECT 7 ?

22 MINUTES

20051126 10:21:05	946	0	1	B09_3_PSS1_RSS_TRLY_CLSD coil - PV_00141
20051126 10:21:05	286	0	1	ICS_BL12_2_PSS201_RSS_TRLY_C coil - PV_01279
20051126 10:21:05	278	0	1	ICS_BL12_3_PSS101_RSS_TRLY_C coil - PV_01243
20051126 10:21:05	275	0	1	B040_FV001_RF_DUMP_INHBT_OUT coil - PV_00709
20051126 10:21:04	970	0	1	ICS_BL082_PSS201_RSS_TRLY_CL coil - PV_01079
20051126 10:21:04	968	0	1	B095_PS1_CLSD
20051126 10:21:04	965	0	1	ICS_BL082_PSS101_RSS_TRLY_CL coil - PV_01067
20051126 10:21:04	955	0	1	ICS_BL0801_PSS1_RSS_TRLY_CLS coil - PV_01028
20051126 10:21:04	916	0	1	B063_PS1_CLSD coil - PV_00396
20051126 10:21:04	796	0	1	B061_PS1_CLSD coil - PV_00332
20051126 10:21:04	790	0	1	BLBR_B08_01_NONVAC_CLSD coil - PV_00754
20051126 10:21:04	752	0	1	BL10_3_PS1_CLSD
20051126 10:21:04	511	0	1	BLBR_B0632_PSS1_TRLY_OPN coil - PV_01021
20051126 10:21:04	397	1	0	BLBR_B09_32_PS1_TRLY_OPN
20051126 10:21:04	100	1	0	B09_3_PSS1_RSS_TRLY_OPN
20051126 10:21:03	924	0	1	BR3_B040_PSS002_TRLY_CLSD_O coil - PV_00780
20051126 10:21:03	921	1	0	BR2_B040_FE_PASS_BEAM_OUT coil - PV_00776
20051126 10:21:03	919	0	1	BR1_B040_PSS002_TRLY_CLSD_O coil - PV_00772
20051126 10:21:03	907	0	1	B050_PSS001_RSS_TRLY_CLSD coil - PV_00155
20051126 10:21:03	847	0	1	B0632_PSS1_RSS_TRLY_CLSD coil - PV_00415
20051126 10:21:03	663	0	1	B093_FV1_RF_DUMP_INH_OUT
20051126 10:21:03	454	0	1	B040_PSS002_RSS_TRLY_CLSD coil - PV_00125
20051126 10:21:03	255	0	1	BL10_3_FV1_RF_DUMP_INHBT_OUT
20051126 10:21:03	226	1	0	ICS_B03_STORED_BEAM_MODE coil - PV_00854
20051126 10:21:03	128	0	1	ICS_B040_PSS002_TRLY_CLSD
20051126 10:21:03	126	0	1	B063_FV1_RF_DUMP_INH_OUT coil - PV_00934
20051126 10:21:03	121	1	0	B063_PS1_OPN_CMD_OUT coil - PV_00936
20051126 10:21:03	113	0	1	B061_FV1_RF_DUMP_INH_OUT coil - PV_00902
20051126 10:21:03	108	1	0	B061_PS1_OPN_CMD_OUT coil - PV_00898
20051126 10:21:03	086	1	0	B095_PS1_OPN
20051126 10:21:02	946	0	1	B050_PS001_CLSD coil - PV_00100
20051126 10:21:02	944	1	0	B050_PS001_OPN coil - PV_00099
20051126 10:21:02	772	1	0	ICS_BL0801_PSS1_RSS_TRLY_OPN coil - PV_01027
20051126 10:21:02	752	1	0	BL10_3_PS1_OPN
20051126 10:21:02	627	1	0	BLBR_B08_01_BRFE_PASS_BEAM coil - PV_00759
20051126 10:21:02	624	1	0	BLBR_B08_01_PSS1_TRLY_OPN coil - PV_00757
20051126 10:21:03	621	1	0	B08_01_PSS1_EPS_OPN_PMT_OUT coil - PV_00707
20051126 10:21:02	539	1	0	B063_PS1_OPN coil - PV_00395
20051126 10:21:02	539	1	0	B061_PS1_OPN coil - PV_00351
20051126 10:21:02	539	1	0	B050_BR_BRFE_PASS_BEAM_O coil - PV_00773
20051126 10:21:02	539	0	1	ICS_BL082_PS201_TRLY_CLSD coil - PV_01129
20051126 10:21:02	539	0	1	ICS_BL082_PS201_CLSD coil - PV_01117
20051126 10:21:02	539	0	1	ICS_BL083_PS101_TRLY_CLSD coil - PV_01095
20051126 10:21:02	539	1	0	ICS_BL12_22_FE_PASS_BEAM coil - PV_01331
20051126 10:21:02	539	1	0	ICS_BL12_2_PSS201_EPS_OPN_PM coil - PV_01329
20051126 10:21:02	539	1	0	ICS_BL12_31_FE_PASS_BEAM coil - PV_01325
20051126 10:21:02	539	1	0	ICS_BL12_3_PSS101_EPS_OPN_PM coil - PV_01321
20051126 10:21:02	539	1	0	ICS_BL12_2_PSS201_RSS_TRLY_O coil - PV_01278
20051126 10:21:02	539	1	0	ICS_BL12_3_PSS101_RSS_TRLY_O coil - PV_01242
20051126 10:21:03	539	1	0	ICS_BL12_RSS_MCR_OPN_PMT coil - PV_01225
20051126 10:21:02	192	1	0	B050_PSS001_EPS_OPN_PMT_O coil - PV_00707
20051126 10:21:02	175	0	1	ICS_BL083_PS101_CLSD coil - PV_01079
20051126 10:21:02	171	0	1	ICS_BL080_PS1_TRLY_CLSD coil - PV_01069
20051126 10:21:02	166	0	1	ICS_BL080_PS1_CLSD coil - PV_01057
20051126 10:21:02	160	1	0	ICS_BL080_PS1_OPN coil - PV_01056
20051126 10:21:02	085	1	0	B050_VVR002_PASS_BEAM coil - PV_00373
20051126 10:21:02	085	1	0	B050_PSS001_PASS_BEAM coil - PV_00359
20051126 10:21:02	085	1	0	B050_PSS001_EPS_OPN_PMT coil - PV_00355
20051126 10:21:01	999	1	0	BR3_B040_PSS002_TRLY_OPN_O

FLL

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20051126 10:21:01   995   1   0   0R1_B040_PSS002_TRLY_OPN_O
20051126 10:21:0.   992   1   0   B040_PSS002 EPS OPN PMT O
20051126 10:21:01   980   1   0   B10_RSS_OPN_PMT     coil - PV_00114
20051126 10:21:03   923   1   0   B08_RSS_NONVAC_PMT      input stat - PV_10002
20051126 10:21:01   787   1   0   ICS_BL0822_FE_PASS_BEAM   coil - PV_01131
20051126 10:21:01   785   1   0   ICS_BL082_PSS201_EPS_OPN_PMT     coil - PV_01129
20051126 10:21:01   782   1   0   ICS_BL082_PSS101_EPS_OPN_PMT     coil - PV_01128
20051126 10:21:01   779   1   0   ICS_BL0831_FE_PASS_BEAM   coil - PV_01125
20051126 10:21:01   777   1   0   ICS_BL0801_FE_PASS_BEAM   coil - PV_01124
20051126 10:21:01   775   1   0   ICS_BL083_PSS101_EPS_OPN_PMT     coil - PV_01121
20051126 10:21:01   773   1   0   ICS_BL0801_PSS1_EPS_OPN_PMT     coil - PV_01118
20051126 10:21:01   686   1   0   BL10_3_PS1_OPN_CMD_OUT
20051126 10:21:01   684   1   0   BLBR_B0632_VVR1_TRLY_CLSD
20051126 10:21:01   675   1   0   B050_PSS001_RSS_TRLY_OPN  coil - PV_00152
20051126 10:21:01   674   1   0   BLBR_B0631_BRFE_PASS_BEAM     coil - PV_01015
20051126 10:21:01   674   1   0   B05_RSS_OPN_PMT     coil - PV_00146
20051126 10:21:01   581   1   0   ICS_B10_STORED_BEAM_MODE     coil - PV_01056
20051126 10:21:01   563   1   0   ICS_BL082_PSS201_RSS_TRLY_OP     coil - PV_01078
20051126 10:21:01   551   1   0   ICS_BL082_PSS101_RSS_TRLY_OP     coil - PV_01066
20051126 10:21:01   545   1   0   ICS_BL083_PSS101_RSS_TRLY_OP     coil - PV_01042
20051126 10:21:01   540   1   0   ICS_BL08_RSS_MCR_OPN_PMT     coil - PV_01025
20051126 10:21:0.   513   1   0   B040_PSS002_RSS_TRLY_OPN  coil - PV_00124
20051126 10:21:0.   510   1   0   B04_SR_STORED_BEAM
20051126 10:21:0.   485   1   0   B0632_PSS1_EPS_OPN_PMT_OUT     coil - PV_00955
20051126 10:21:01   389   1   0   BLBR_B08_01_NONVAC_OPN  coil - PV_00751
20051126 10:21:01   388   1   0   B11_SR_STORED_BEAM
20051126 10:21:01   186   1   0   ICS_B040_PSS002_TRLY_OPN
20051126 10:21:01   116   1   0   B0632_PSS1_RSS_TRLY_OPN   coil - PV_00414
20051126 10:21:01   060   1   0   B03_RSS_MCR_OPN_PMT     coil - PV_00514
20051126 10:21:01   025   1   0   ICS_BL082_PS201_TRLY_OPN  coil - PV_01128
20051126 10:21:01   014   1   0   ICS_BL082_PS201_OPN coil - PV_01116
20051126 10:21:01   007   1   0   ICS_BL083_PS101_TRLY_OPN  coil - PV_01096
20051126 10:21:00   948   1   0   B07_RSS_OPN_PMT     coil - PV_00114
20051126 10:21:00   934   1   0   ICS_BL083_PS101_OPN coil - PV_01078
20051126 10:21:00   930   1   0   ICS_BL080_PS1_TRLY_OPN     coil - PV_01068
20051126 10:21:00   929   1   0   B09_STORED_BEAM
20051126 10:21:00   918   1   0   ICS_B11_STORED_BEAM_MODE     coil - PV_01079
20051126 10:21:00   761   1   0   BL12_RSS_OPN_PMT_IN     input stat - PV_10002
20051126 10:21:00   708   1   0   B06_RSS_OPN_PMT     coil - PV_00514
20051126 10:21:00   645   1   0   B093_PS1_OPN_CMD_OUT
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FILL

NOTE: FILL MODE (above)

ECOL-11 C4.3 Beam Physics Key Parameters

NOTE: STORED BEAM MODE (below)

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20051126 10:14:13   100   1   0   B093_PS1_CLSD
20051126 10:14:13   097   0   1   B093_PS1_OPN
20051126 10:14:12   619   0   1   B09_5_PSS1_RSS_TRLY_OPN
20051126 10:14:12   170   1   0   B093_FV1_RF_DUMP_INH_OUT
20051126 10:14:12   168   0   1   B093_PS1_OPN_CMD_OUT
20051126 10:14:11   949   0   1   ICS_BL0822_FE_PASS_BEAM   coil - PV_01131
20051126 10:14:11   787   0   .   ICS_BL082_PSS101_RSS_TRLY_OP     coil - PV_01069
20051126 10:14:11   485   0   1   BLBR_B09_32_PS1_TRLY_OPN
20051126 10:14:11   259   .   0   ICS_BL082_PS201_TRLY_CLSD coil - PV_01129
20051126 10:14:11   256   0   1   ICS_BL082_PS201_TRLY_OPN  coil - PV_01128
20051126 10:14:11   251   1   0   ICS_BL082_PS201_CLSD     coil - PV_01117
20051126 10:14:11   249   0   1   ICS_BL082_PS201_OPN coil - PV_01116
20051126 10:14:11   140   0.  1   BR3_B040_PSS002_TRLY_OPN_O
20051126 10:14:11   137   0   1   BR._B040_PSS002_TRLY_OPN_O
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20051126 10:14:10	986	0	1	ICS_BL12_22_FE_PASS_BEAM coil - PV_01131
20051126 10:14:10	983	0	1	ICS_BL12_51_FE_PASS_BEAM coil - PV_01125
20051126 10:14:10	788	0	1	ICS_BL12_2_PSS201_RSS_TRLY_O coil - PV_01278
20051126 10:14:10	655	0	1	B040_PSS002_RSS_TRLY_OPN coil - PV_00124
20051126 10:14:10	554	0	1	ICS_BL082_PSS201_RSS_TRLY_OP coil - PV_01078
20051126 10:14:10	485	0	1	B063_PS1_OPN coil - PV_00395
20051126 10:14:10	483	0	1	B050_PS001_OPN coil - PV_00099
20051126 10:14:10	394	0	1	BLBR_B08_01_NONVAC_OPN coil - PV_00753
20051126 10:14:10	269	0	1	ICS_B040_PSS002_TRLY_OPN
20051126 10:14:10	099	0	1	BLBR_B0652_VVR1_TRLY_CLSD
20051126 10:14:10	091	0	1	BLBR_B0651_BRFE_PASS_BEAM coil - PV_01015
20051126 10:14:10	080	1	0	ICS_BL083_PS101_TRLY_CLSD coil - PV_01095
20051126 10:14:10	078	0	1	ICS_BL083_PS101_TRLY_OPN coil - PV_01094
20051126 10:14:09	948	1	0	ICS_BL083_PS101_CLSD coil - PV_01079
20051126 10:14:09	946	0	1	ICS_BL083_PS101_OPN coil - PV_01078
20051126 10:14:09	941	0	1	ICS_BL080_PS1_TRLY_OPN coil - PV_01068
20051126 10:14:09	936	1	0	ICS_BL080_PS1_CLSD coil - PV_01057
20051126 10:14:09	935	0	1	ICS_BL080_PS1_OPN coil - PV_01056
20051126 10:14:09	878	0	1	B050_BR_BRFE_PASS_BEAM_O coil - PV_00773
20051126 10:14:09	620	0	1	BL10_3_PS1_OPN
20051126 10:14:09	616	0	1	B050_VVR002_PASS_BEAM coil - PV_00073
20051126 10:14:09	613	0	1	B050_PSS001_PASS_BEAM coil - PV_00059
20051126 10:14:09	548	0	1	ICS_BL0831_FE_PASS_BEAM coil - PV_01125
20051126 10:14:09	546	0	1	ICS_BL0801_FE_PASS_BEAM coil - PV_01124
20051126 10:14:09	471	0	1	B0632_PSS1_RSS_TRLY_OPN coil - PV_00414
20051126 10:14:09	385	0	1	ICS_BL083_PSS101_RSS_TRLY_OP coil - PV_01042
20051126 10:14:09	378	0	1	ICS_BL0801_PSS1_RSS_TRLY_OPN coil - PV_01027
20051126 10:14:09	233	0	1	BLBR_B08_01_BRFE_PASS_BEAM coil - PV_00759
20051126 10:14:09	232	0	1	ICS_BL12_3_PSS101_RSS_TRLY_O coil - PV_01242
20051126 10:14:09	231	0	1	BLBR_B08_01_PSS1_TRLY_OPN coil - PV_00757
20051126 10:14:09	228	0	1	B050_PSS001_RSS_TRLY_OPN coil - PV_00152
20051126 10:14:09	133	1	0	BR2_B040_PSS002_TRLY_CLSD_O coil - PV_00780
20051126 10:14:09	130	0	1	BR2_B040_FE_PASS_BEAM_OUT coil - PV_00776
20051126 10:14:09	128	1	0	BR1_B040_PSS002_TRLY_CLSD_O coil - PV_00772
20051126 10:14:09	124	0	1	B040_PSS002_EPS_OPN_PMT_O
20051126 10:14:09	097	0	1	B06_RSS_OPN_PMT coil - PV_00314
20051126 10:14:08	852	1	0	ICS_BL080_PS1_TRLY_CLSD coil - PV_01069
20051126 10:14:08	796	0	1	B03_RSS_MCR_OPN_PMT coil - PV_00314
20051126 10:14:08	697	1	0	B063_FV1_RF_DUMP_INH_OUT coil - PV_00934
20051126 10:14:08	692	0	1	B063_PS1_OPN_CMD_OUT coil - PV_00930
20051126 10:14:08	685	1	0	B061_FV1_RF_DUMP_INH_OUT coil - PV_00902
20051126 10:14:08	680	0	1	B061_PS1_OPN_CMD_OUT coil - PV_00898
20051126 10:14:08	646	1	0	B040_PSS002_RSS_TRLY_CLSD coil - PV_00125
20051126 10:14:08	643	0	1	B04_SR_STORED_BEAM
20051126 10:14:08	398	0	1	ICS_B10_STORED_BEAM_MODE coil - PV_01056
20051126 10:14:08	319	1	0	ICS_B040_PSS002_TRLY_CLSD
20051126 10:14:08	255	1	0	B050_PS001_CLSD coil - PV_00150
20051126 10:14:08	096	1	0	B063_PS1_CLSD coil - PV_00396
20051126 10:14:08	094	0	1	ICS_B03_STORED_BEAM_MODE coil - PV_00854
20051126 10:14:08	088	0	1	BL12_RSS_OPN_PMT_IN input stat - PV_10002
20051126 10:14:08	076	1	0	B040_FV001_RF_DUMP_INHBT_OUT coil - PV_00709
20051126 10:14:08	004	1	0	BL10_3_PS1_CLSD
20051126 10:14:07	959	1	0	B061_PS1_CLSD coil - PV_00352
20051126 10:14:07	954	0	1	B061_PS1_OPN coil - PV_00351
20051126 10:14:07	951	0	1	ICS_BL12_2_PSS201_EPS_OPN_PM coil - PV_01229
20051126 10:14:07	948	0	1	ICS_BL12_5_PSS101_EPS_OPN_PM coil - PV_01321
20051126 10:14:07	898	0	1	B07_RSS_OPN_PMT coil - PV_00114
20051126 10:14:07	897	0	1	B050_PSS001_EPS_OPN_PMT_O coil - PV_00707
20051126 10:14:07	797	1	0	ICS_BL082_PSS201_RSS_TRLY_CL coil - PV_01079

STD'ED BEAM

20051126 10:14:07	793	1	0	ICS_BL0B3_PSS101_RSS_TRLY_CL	coil - PV_01067
20051126 10:14:07	786	1	0	ICS_BL0B3_PSS101_RSS_TRLY_CL	coil - PV_01043
20051126 10:14:07	779	1	0	ICS_BL0801_PSS1_RSS_TRLY_CLS	coil - PV_01025
20051126 10:14:07	777	0	1	ICS_BL08_RSS_MCR_OPN_PMT	coil - PV_01025
20051126 10:14:07	762	0	1	B050_PSS001_EPS_OPN_PMT	coil - PV_00355
20051126 10:14:07	758	1	0	ICS_BL12_2_PSS201_RSS_TRLY_C	coil - PV_01279
20051126 10:14:07	751	1	0	ICS_BL12_2_PSS101_RSS_TRLY_C	coil - PV_01245
20051126 10:14:07	746	0	1	ICS_BL12_RSS_MCR_OPN_PMT	coil - PV_01225
20051126 10:14:07	739	1	0	B09_3_PSS1_RSS_TRLY_CLSD	coil - PV_00141
20051126 10:14:07	681	1	0	BLBR_B0632_PSS1_TRLY_OPN	coil - PV_01021
20051126 10:14:07	630	1	0	BLBR_B08_01_NONVAC_CLSD	coil - PV_00754
20051126 10:14:07	628	0	1	B08_01_PSS1_EPS_OPN_PMT_OUT	coil - PV_00767
20051126 10:14:07	615	0	1	B11_SR_STORED_BEAM	
20051126 10:14:07	569	0	1	B09_STORED_BEAM	
20051126 10:14:07	426	0	1	B0632_PSS1_EPS_OPN_PMT_OUT	coil - PV_00955
20051126 10:14:07	379	1	0	B050_PSS001_RSS_TRLY_CLSD	coil - PV_00153
20051126 10:14:07	377	0	1	B05_RSS_OPN_PMT	coil - PV_00146
20051126 10:14:07	249	0	1	ICS_B11_STORED_BEAM_MODE	coil - PV_01079
20051126 10:14:07	180	0	1	B10_RSS_OPN_PMT	coil - PV_00114
20051126 10:14:07	005	1	0	B0632_PSS1_RSS_TRLY_CLSD	coil - PV_00415
20051126 10:14:06	993	0	1	B08_RSS_NONVAC_PMT	input stat - PV_10002
20051126 10:14:06	889	1	0	BL10_3_EV1_RF_DUMP_INHIBT	OUT
20051126 10:14:06	887	0	1	BL10_3_PS1_OPN_CMD_OUT	
20051126 10:14:06	887	1	0	BTS____B1____BM17	PS_READY_MON
20051126 10:14:06	887	1	0	BTS____B1____BM16	INTLKS_OK
20051126 10:14:06	887	1	0	BTS____B1____BM12	RAD INTLK OK
20051126 10:14:06	855	0	1	ICS_BL0B2_PSS201_EPS_OPN_PMT	coil - PV_01129
20051126 10:14:06	851	0	1	ICS_BL0B2_PSS101_EPS_OPN_PMT	coil - PV_01128
20051126 10:14:06	848	0	1	ICS_BL0B3_PSS101_EPS_OPN_PMT	coil - PV_01121
20051126 10:14:06	845	0	1	ICS_BL0801_PSS1_EPS_OPN_PMT	coil - PV_01118

NOTE: STORED BEAM MODE (above)

20051126 10:14:06	777	1	0	BTS____B2____BM17	PS_READY_MON
20051126 10:14:06	777	1	0	BTS____B2____BM16	INTLKS_OK
20051126 10:14:06	777	1	0	BTS____B2____BM12	RAD INTLK OK
20051126 10:12:54	781	0	1	SR10U___IG1____BM03	ION GAUGE1 ON
20051126 10:12:31	784	1	0	SR10U___IG1____BM03	ION GAUGE1 ON
20051126 10:09:49	426	0	1	SR04U___IG2____BM01	ION GAUGE2 ON
20051126 10:03:42	429	1	0	SR04U___IG2____BM01	ION GAUGE2 ON
20051126 09:59:42	756	0	1	SR08U___IG1____BM03	ION GAUGE1 ON
20051126 09:59:37	757	1	0	SR08U___IG1____BM03	ION GAUGE1 ON
20051126 09:56:43	764	0	1	BTS____B2____BM17	PS_READY_MON
20051126 09:56:43	764	0	1	BTS____B2____BM16	INTLKS_OK
20051126 09:56:43	764	0	1	BTS____B2____BM12	RAD INTLK OK
20051126 09:55:47	752	0	1	SR03S___RFMODE_BM12	SRRF MODE RDY
20051126 09:55:47	752	0	1	SR03S___RFCONT_BM14	SRRF RF RDY MON.
20051126 09:55:47	752	0	1	SR03S___MSTINT_BM08	PERS SAFETY 2
20051126 09:55:47	752	0	1	SR03S___MSTINT_BM07	BEAM PROTECT 1
20051126 09:55:47	752	0	1	SR03S___MSTINT_BM06	BEAM PROTECT 2
20051126 09:55:47	752	0	1	SR03S___MSTINT_BM05	RF SAFETY 1
20051126 09:55:47	752	0	1	SR03S___MSTINT_BM04	RF SAFETY 2
20051126 09:55:47	752	0	1	SR03S___MSTINT_BM03	FDR RF INT
20051126 09:55:47	752	0	1	SR03S___MSTINT_BM02	FDR COOLING INT

20051126 09:55:47	750	0	1	SR03S___MSTILK_BM15	CAV1 COOLING INT	
20051126 09:55:47	750	0	1	SR03S___MSTILK_BM14	CAV2 COOLING INT	
20051126 09:55:47	750	0	1	SR03S___MSTILK_BM13	CAV 1&2 VAC INT	
20051126 09:55:47	750	0	1	SR03S___MSTILK_BM12	PULLDOWN CABLE	
20051126 09:55:47	750	0	1	SR03S___MSTILK_BM11	PERMIT RF	
20051126 09:55:46	865	0	1	BTS____B1____BM17	PS_READY_MON	
20051126 09:55:46	865	0	1	BTS____B1____BM16	INTLKS_OK	
20051126 09:55:46	865	0	1	BTS____B1____BM12	RAD INTLK OK	
20051126 09:55:46	752	0	1	SR03S___MSTINT_BM09	PERS SAFETY 1	RESET RF INTLK
20051126 09:52:32	405	0	1	SR04U___IG2____BM01	ION GAUGE2 ON	
20051126 09:52:25	405	1	0	SR04U___IG2____BM01	ION GAUGE2 ON	
20051126 09:51:08	744	1	0	SR03S___MSTINT_BM09	PERS SAFETY 1	TEST
20051126 09:45:50	740	0	1	SR03S___FDR_R_BM19	FEEDER RESET RDY	
20051126 09:45:50	740	1	0	SR03S___FDR_R_BM18	FEEDER RESET ON	
20051126 09:45:49	741	1	0	SR03S___FDR_R_BM19	FEEDER RESET RDY	
20051126 09:45:49	741	0	1	SR03S___FDR_R_BM18	FEEDER RESET ON	
20051126 09:44:50	824	0	1	SR03S___MSTINT_BM09	PERS SAFETY 1	RESET
20051126 09:41:47	854	1	0	BTS____B1____BM17	PS_READY_MON	
20051126 09:41:47	854	1	0	BTS____B1____BM16	INTLKS_OK	
20051126 09:41:47	854	1	0	BTS____B1____BM12	RAD INTLK OK	
20051126 09:41:47	729	1	0	SR03S___RFMODE_BM12	SRRF MODE RDY	
20051126 09:41:47	729	1	0	SR03S___RFCONT_BM14	SRRF RF RDY MON.	
20051126 09:41:47	729	1	0	SR03S___MSTINT_BM09	PERS SAFETY 1	
20051126 09:41:47	729	1	0	SR03S___MSTINT_BM08	PERS SAFETY 2	
20051126 09:41:47	729	1	0	SR03S___MSTINT_BM07	BEAM PROTECT 1	
20051126 09:41:47	729	1	0	SR03S___MSTINT_BM06	BEAM PROTECT 2	
20051126 09:41:47	729	1	0	SR03S___MSTINT_BM05	RF SAFETY 1	
20051126 09:41:47	729	1	0	SR03S___MSTINT_BM04	RF SAFETY 2	
20051126 09:41:47	729	1	0	SR03S___MSTINT_BM03	FDR RF INT	
20051126 09:41:47	729	1	0	SR03S___MSTINT_BM02	FDR COOLING INT	
20051126 09:41:47	727	1	0	SR03S___MSTILK_BM15	CAV1 COOLING INT	
20051126 09:41:47	727	1	0	SR03S___MSTILK_BM14	CAV2 COOLING INT	
20051126 09:41:47	727	1	0	SR03S___MSTILK_BM13	CAV 1&2 VAC INT	
20051126 09:41:47	727	1	0	SR03S___MSTILK_BM12	PULLDOWN CABLE	
20051126 09:41:47	727	1	0	SR03S___MSTILK_BM11	PERMIT RF	
20051126 09:41:47	726	1	0	BTS____B2____BM17	PS_READY_MON	
20051126 09:41:47	726	1	0	BTS____B2____BM16	INTLKS_OK	
20051126 09:41:47	726	1	0	BTS____B2____BM12	RAD INTLK OK RF TRIP	TEST
20051126 09:37:56	727	0	1	SR03S___RFMODE_BM12	SRRF MODE RDY	
20051126 09:37:56	727	0	1	SR03S___RFCONT_BM14	SRRF RF RDY MON.	
20051126 09:37:56	727	0	1	SR03S___MSTINT_BM08	PERS SAFETY 2	
20051126 09:37:56	727	0	1	SR03S___MSTINT_BM07	BEAM PROTECT 1	
20051126 09:37:56	727	0	1	SR03S___MSTINT_BM06	BEAM PROTECT 2	
20051126 09:37:56	727	0	1	SR03S___MSTINT_BM05	RF SAFETY 1	
20051126 09:37:56	727	0	1	SR03S___MSTINT_BM04	RF SAFETY 2	
20051126 09:37:56	727	0	1	SR03S___MSTINT_BM03	FDR RF INT	
20051126 09:37:56	727	0	1	SR03S___MSTINT_BM02	FDR COOLING INT	
20051126 09:37:56	726	0	1	SR03S___MSTILK_BM15	CAV1 COOLING INT	
20051126 09:37:56	726	0	1	SR03S___MSTILK_BM14	CAV2 COOLING INT	
20051126 09:37:56	726	0	1	SR03S___MSTILK_BM13	CAV 1&2 VAC INT	

BL 7.3 ?

PERS SAFETY 2 NOT RESET AND VERIFIED PER PROCEDURE STEP 5.5 [3] [a]

BL 7.3 PSS A & B CHAIN TEST

20051126 09:37:56	726	0	1	SR03S___MSTILK_BM12	PULLDOWN CABLE	
20051126 09:37:56	726	0	1	SR03S___MSTILK_BM11	PERMIT RF	
20051126 09:36:19	855	0	1	BTS____B1____BM17	PS_READY_MON	
20051126 09:36:19	855	0	1	BTS____B1____BM16	INTLKS_OK	
20051126 09:36:19	855	0	1	BTS____B1____BM15	LEM_OT	
20051126 09:36:19	855	0	1	BTS____B1____BM12	RAD INTLK OK	
20051126 09:35:18	735	0	1	BTS____B2____BM17	PS_READY_MON	
20051126 09:35:18	735	0	1	BTS____B2____BM16	INTLKS_OK	
20051126 09:35:18	735	0	1	BTS____B2____BM12	RAD INTLK OK	
20051126 09:34:59	735	0	1	SR03S___MSTINT_BM09	PERS SAFETY 1	RF RESET?
20051126 09:30:04	845	1	0	BTS____B1____BM12	RAD INTLK OK	
20051126 09:30:04	724	1	0	SR03S___RFMODE_BM12	SRRF MODE RDY	
20051126 09:30:04	724	1	0	SR03S___RFCONT_BM14	SRRF RF RDY MON.	
20051126 09:30:04	723	1	0	SR03S___MSTINT_BM09	PERS SAFETY 1	
20051126 09:30:04	723	1	0	SR03S___MSTINT_BM08	PERS SAFETY 2	
20051126 09:30:04	723	1	0	SR03S___MSTINT_BM07	BEAM PROTECT 1	
20051126 09:30:04	723	1	0	SR03S___MSTINT_BM06	BEAM PROTECT 2	
20051126 09:30:04	723	1	0	SR03S___MSTINT_BM05	RF SAFETY 1	
20051126 09:30:04	723	1	0	SR03S___MSTINT_BM04	RF SAFETY 2	
20051126 09:30:04	723	1	0	SR03S___MSTINT_BM03	FDR RF INT	
20051126 09:30:04	723	1	0	SR03S___MSTINT_BM02	FDR COOLING INT	
20051126 09:30:04	721	1	0	SR03S___MSTILK_BM15	CAV1 COOLING INT	
20051126 09:30:04	721	1	0	SR03S___MSTILK_BM14	CAV2 COOLING INT	
20051126 09:30:04	721	1	0	SR03S___MSTILK_BM13	CAV 1&2 VAC INT	BL 7: O:: PSS1
20051126 09:30:04	721	1	0	SR03S___MSTILK_BM12	PULLDOWN CABLE	A&B CHAIN
20051126 09:30:04	721	1	0	SR03S___MSTILK_BM11	PERMIT RF	TEST
20051126 09:30:04	720	1	0	BTS____B2____BM17	PS_READY_MON	
20051126 09:30:04	720	1	0	BTS____B2____BM16	INTLKS_OK	
20051126 09:30:04	720	1	0	BTS____B2____BM12	RAD INTLK OK RF TRIP?	
20051126 09:09:13	699	1	0	SR03S___CBRINT_BM22	HVPS CROWBAR INT	
20051126 09:09:13	699	1	0	SR03S___CBRINT_BM19	HVPS KLY BEAM OC	
20051126 09:09:13	699	1	0	SR03S___CBRINT_BM18	CROWBAR DI/DT	
20051126 09:09:13	699	1	0	SR03S___CBRINT_BM17	CROWBAR EXT 1	
20051126 09:09:13	699	1	0	SR03S___CBRINT_BM16	CROWBAR EXT 2	
20051126 09:09:13	699	1	0	SR03S___CBRINT_BM15	CROWBAR HVPS O/V	
20051126 09:09:13	699	1	0	SR03S___CBRINT_BM14	KLY MOD-ANODE DK	
20051126 09:09:13	697	1	0	SR03S___CBRINT_BM20	HVPS CROWBAR RDY	
20051126 09:09:13	697	1	0	SR03S___PSINT__BM04	HVPS AC LINE U/V	
20051126 09:09:13	697	1	0	SR03S___LBLBKR_BM09	KEY INTRLK COMP	
20051126 09:09:13	697	1	0	SR03S___KLYINT_BM04	KLY HTR ENABLED	
20051126 09:09:13	697	1	0	SR03S___KLYINT_BM02	KLY HTR VOLTS OK	
20051126 09:09:13	697	1	0	SR03S___KLYINT_BM01	KLY HTR CURR OK	
20051126 09:09:13	697	1	0	SR03S___HVPS_R_BM14	SRRF HVPS RST ON	
20051126 09:09:12	698	0	1	SR03S___CBRINT_BM22	HVPS CROWBAR INT	
20051126 09:09:12	698	0	1	SR03S___CBRINT_BM19	HVPS KLY BEAM OC	
20051126 09:09:12	698	0	1	SR03S___CBRINT_BM18	CROWBAR DI/DT	
20051126 09:09:12	698	0	1	SR03S___CBRINT_BM17	CROWBAR EXT 1	
20051126 09:09:12	698	0	1	SR03S___CBRINT_BM16	CROWBAR EXT 2	
20051126 09:09:12	698	0	1	SR03S___CBRINT_BM15	CROWBAR HVPS O/V	
20051126 09:09:12	698	0	1	SR03S___CBRINT_BM14	KLY MOD-ANODE DK	
20051126 09:09:12	697	0	1	SR03S___CBRINT_BM20	HVPS CROWBAR RDY	
20051126 09:09:12	697	0	1	SR03S___PSINT__BM04	HVPS AC LINE U/V	
20051126 09:09:12	697	0	1	SR03S___LBLBKR_BM09	KEY INTRLK COMP	
20051126 09:09:12	697	0	1	SR03S___KLYINT_BM04	KLY HTR ENABLED	

20051126 09:09:12	697	0	1	SR03S___KLYINT_BM02	KLY HTR VOLTS OK
20051126 09:09:12	697	0	1	SR03S___KLYINT_BM01	KLY HTR CURR OK
20051126 09:09:12	697	0	1	SR03S___HVPS_R_BM14	SRRF HVPS RST ON
20051126 09:08:01	690	0	1	SR03S___PSINT__BM12	SRRF HVPSVVT RDY
20051126 09:08:01	689	1	0	SR03S___PSINT__BM12	SRRF HVPS VVT ON
20051126 09:06:47	698	0	1	SR03S___RFMODE_BM12	SRRF MODE RDY
20051126 09:06:47	698	0	1	SR03S___RFCONT_BM14	SRRF RF RDY MON.
20051126 09:06:47	697	0	1	SR03S___MSTILK_BM14	CAV2 COOLING INT
20051126 09:06:47	697	0	1	SR03S___MSTILK_BM13	CAV 1&2 VAC INT
20051126 09:06:47	697	0	1	SR03S___MSTILK_BM12	PULLDOWN CABLE
20051126 09:06:47	697	0	1	SR03S___MSTILK_BM11	PERMIT RF
20051126 09:06:45	697	0	1	SR03S___C2INT__BM05	CAV2 TUNER FLW
20051126 09:06:45	697	0	1	SR03S___C2INT__BM03	CAV2 WIN AIR FLW
20051126 09:06:45	697	0	1	SR03S___C2INT__BM00	CAV2 WTR/SYS COM
20051126 09:06:45	696	0	1	SR03S___C2INT__BM06	CAV2 WINDOW FLW
20051126 09:06:45	696	0	1	SR03S___C2INT__BM04	CAV2 TEMPERATURE
20051126 09:06:45	696	0	1	SR03S___C2INT__BM02	CAV2 WIN AIRTEMP
20051126 09:06:45	696	0	1	SR03S___C2INT__BM01	CAV2 PULLDWN CBL
20051126 09:06:43	689	0	1	SR03S___C1INT__BM06	CAV1 WINDOW FLW
20051126 09:06:43	689	0	1	SR03S___C1INT__BM05	CAV1 TUNER FLW
20051126 09:06:43	689	0	1	SR03S___C1INT__BM04	CAV1 TEMPERATURE
20051126 09:06:43	689	0	1	SR03S___C1INT__BM03	CAV1 WIN AIR FLW
20051126 09:06:43	689	0	1	SR03S___C1INT__BM02	CAV1 WIN AIRTEMP
20051126 09:06:43	689	0	1	SR03S___C1INT__BM01	CAV1 PULLDWN CBL
20051126 09:06:43	689	0	1	SR03S___C1INT__BM00	CAV1 WTR/SYS COM
20051126 09:06:43	688	0	1	SR03S___MSTILK_BM15	CAV1 COOLING INT
20051126 09:05:09	686	0	1	SR03S___C2INT__BM07	CAV2 PUMP OPER
20051126 09:05:09	686	0	1	SR03S___C2HFIN_BM13	C2 HOM H20 FLW I
20051126 09:05:46	687	0	1	SR03S___C1INT__BM07	CAV1 PUMP OPER
20051126 09:05:46	687	0	1	SR03S___C1HFIN_BM13	C1 HOM H20 FLW I
20051126 09:04:04	686	0	1	SR08U___IG1____BM03	ION GAUGE1 ON
20051126 09:03:59	683	1	0	SR08U___IG1____BM03	ION GAUGE1 ON
20051126 09:03:25	684	0	1	SR03S___C2TEMP_BM18	CAV 2 HTR ON
20051126 09:03:22	685	0	1	SR03S___C1TEMP_BM18	CAV 1 HTR ON
20051126 09:03:16	685	0	1	SR03S___C2TEMP_BM14	CAV2 HTR THERMAL
20051126 09:03:16	685	0	1	SR03S___C2TEMP_BM13	CAV2 HTR KLIXON
20051126 09:03:16	685	0	1	SR03S___C2TEMP_BM12	CAV2 HTRSCR DOOR
20051126 09:03:16	685	0	1	SR03S___C2TEMP_BM11	CAV2 TEMPERATURE
20051126 09:03:16	685	0	1	SR03S___C2TEMP_BM10	CAV2 HTR CH COMP
20051126 09:03:09	685	0	1	SR03S___C1TEMP_BM14	CAV1 HTR THERMAL
20051126 09:03:09	685	0	1	SR03S___C1TEMP_BM13	CAV1 HTR KLIXON
20051126 09:03:09	685	0	1	SR03S___C1TEMP_BM12	CAV1 HTRSCR DOOR
20051126 09:03:09	684	0	1	SR03S___C1TEMP_BM11	CAV1 TEMPERATURE
20051126 09:03:09	684	0	1	SR03S___C1TEMP_BM10	CAV1 HTR CH COMP
20051126 09:02:49	689	0	1	SR03S___C2WPMP_BM03	CAV2 PUMP OPER
20051126 09:02:49	689	0	1	SR03S___C2TEMP_BM15	CAV2 PUMP OPER
20051126 09:02:47	685	0	1	SR03S___C1WPMP_BM03	CAV1 PUMP OPER
20051126 09:02:47	685	0	1	SR03S___C1TEMP_BM15	CAV1 PUMP OPER
20051126 09:01:50	683	0	1	SR03S___C2WPMP_BM04	CAV2 TOTAL FLW
20051126 09:01:50	683	0	1	SR03S___C1WPMP_BM04	CAV1 TOTAL FLW
20051126 09:00:31	308	0	1	SR04U___IG2____BM01	ION GAUGE2 ON
20051126 09:00:23	313	1	0	SR04U___IG2____BM01	ION GAUGE2 ON
20051126 08:58:08	678	0	1	SR03S___FCLINT_BM07	CIR LOAD LCW TEM
20051126 08:58:08	678	0	1	SR03S___FCLINT_BM06	TEE LOAD LCW FLO
20051126 08:58:08	678	0	1	SR03S___FCLINT_BM05	TEE LOAD LCW TEM
20051126 08:58:08	678	0	1	SR03S___FCLINT_BM04	FDR COOL COMPLET
20051126 08:58:08	677	0	1	SR03S___MSTINT_BM02	FDR COOLING INT
20051126 08:55:56	680	0	1	SR03S___FCLINT_BM08	CIR LOAD LCW FLW
20051126 08:55:24	684	0	1	SR08U___IG1____BM03	ION GAUGE1 ON

20051126 08:55:19	683	1	0	SR08U___IG1____BM03	ION GAUGE1 ON	
20051126 08:54:49	675	1	0	SR03S___C2WPMP_BM08	CAV2 BYPASS OPEN	
20051126 08:54:48	673	0	1	SR03S___C2WPMP_BM07	CAV2 BYPASS CLSD	
20051126 08:54:48	674	1	0	SR03S___C1WPMP_BM08	CAV1 BYPASS OPEN	
20051126 08:54:48	674	0	1	SR03S___C1WPMP_BM07	CAV1 BYPASS CLSD	
20051126 08:54:15	671	0	1	SR03S___C2WPMP_BM08	CAV2 BYPASS OPEN	
20051126 08:54:15	671	1	0	SR03S___C2WPMP_BM07	CAV2 BYPASS CLSD	
20051126 08:54:15	671	0	1	SR03S___C2WPMP_BM05	CAV 2 PUMP ON	
20051126 08:54:13	673	0	1	SR03S___C1WPMP_BM05	CAV 1 PUMP ON	
20051126 08:54:12	671	0	1	SR03S___C1WPMP_BM08	CAV1 BYPASS OPEN	
20051126 08:54:12	671	1	0	SR03S___C1WPMP_BM07	CAV1 BYPASS CLSD	
20051126 08:54:11	671	1	0	SR03S___C2WPMP_BM05	CAV 2 PUMP ON	
20051126 08:54:08	671	1	0	SR03S___C1WPMP_BM05	CAV 1 PUMP ON	
20051126 08:51:56	677	1	0	SR03S___FDR__R_BC25	FEEDER INT RESET	
20051126 08:51:55	827	0	1	SR03S___FDR__R_BC23	FEEDER INT RESET	
20051126 08:51:07	826	1	0	SR03S___FCL__R_BC25	FDR COOLING RST	
20051126 08:51:07	576	0	1	SR03S___FCL__R_BC23	FDR COOLING RST	
20051126 08:50:53	668	1	0	SR03S___FDR__R_BM18	FEEDER RESET ON	
20051126 08:50:52	670	0	1	SR03S___FDR__R_BM18	FEEDER RESET ON	
20051126 08:50:34	665	0	1	SR03S___MSTINT_BM03	FDR RF INT	
20051126 08:50:33	668	0	1	SR03S___MSTINT_BM06	BEAM PROTECT 2	
20051126 08:50:33	668	0	1	SR03S___MSTINT_BM05	RF SAFETY 1	
20051126 08:50:33	668	0	1	SR03S___MSTINT_BM04	RF SAFETY 2	
20051126 08:50:25	674	0	1	SR03S___VACSUM_BM07	SEC VAC SUM CH 1	
20051126 08:50:25	674	0	1	SR03S___VACSUM_BM01	BEAM PROTECT 1	
20051126 08:50:25	674	0	1	SR03S___VACSUM_BM02	BEAM PROTECT 2	
20051126 08:50:25	673	0	1	SR03S___VACSUM_BM06	SEC VAC SUM CH 2	
20051126 08:50:25	673	0	1	SR03S___VACSUM_BM05	FAST RF TRIP 1	
20051126 08:50:25	673	0	1	SR03S___VACSUM_BM04	FAST RF TRIP 2	
20051126 08:50:25	672	0	1	SR03S___MSTINT_BM07	BEAM PROTECT 1	RF RESET?
20051126 08:50:20	669	0	1	SR03S___VACSUM_BM17	SEC 3 COMPLETE	
20051126 08:50:20	292	0	1	SR03C___RFPERM_BM15	RF_PERM_OK	
20051126 08:50:20	292	0	1	SR03S___VVR2___BM08	VVR2_OPN	
20051126 08:50:18	291	0	1	SR03S___VVR1___BM03	VVR1_OPN	
20051126 08:50:14	290	1	0	SR03S___VVR2___BM09	VVR2_CLSD	
20051126 08:50:13	115	0	1	SR03S___VVR2___BC21	VVR2_DR	
20051126 08:50:11	287	1	0	SR03S___VVR1___BM04	VVR1_CLSD	
20051126 08:50:10	365	0	1	SR03S___VVR1___BC20	VVR1_DR	
20051126 08:48:58	285	0	1	SR03S___VVR2___BM07	VVR2_UPVAC	
20051126 08:48:58	286	0	1	SR03S___VVR2___BM05	VVR2_RDY	
20051126 08:48:58	285	0	1	SR03S___VVR1___BM00	VVR1_RDY	open SR valves - S3
20051126 08:48:57	665	0	1	SR03S___RF_VAC_BM12	WIN 1 ION PUMP	
20051126 08:48:57	665	0	1	SR03S___RF_VAC_BM11	CAV 1 ION GAUGE	
20051126 08:48:57	665	0	1	SR03S___RF_VAC_BM07	PULLDOWN CBL/INT	
20051126 08:46:05	662	0	1	SR10U___IG1____BM05	ION GAUGE1 ON	
20051126 08:46:01	656	1	0	SR10U___IG1____BM03	ION GAUGE1 ON	
20051126 08:44:06	279	0	1	BR1_____KI_____BM05	THYRATHRON READY	
20051126 08:44:06	279	0	1	BR1_____KI_____BM04	CATHODE TEMP OK	
20051126 08:44:05	282	1	0	BR1_____KI_____BM05	THYRATHRON READY	
20051126 08:44:05	282	1	0	BR1_____KI_____BM04	CATHODE TEMP OK	
20051126 08:42:53	658	1	0	SR03S___CLINT__BM06	CAV1 WINDOW FLW	
20051126 08:42:11	656	0	1	SR05W___IG1____BM09	ION GAUGE1 ON	
20051126 08:42:06	656	1	0	SR05W___IG1____BM03	ION GAUGE1 ON	
20051126 08:39:18	281	0	1	BR1_____KI_____BM05	THYRATHRON READY	
20051126 08:39:17	282	1	0	BR1_____KI_____BM05	THYRATHRON READY	
20051126 08:38:56	654	0	1	SR03S___VACSUM_BM10	SEC 10 COMPLETE	

20051126 08:38:56	654	0	1	SR16S	VVR1	BM03	VVR1_OPN
20051126 08:38:56	654	0	1	SR16C	RFPERM	BM13	RF_PERM_OK
20051126 08:38:53	653	0	1	SR08S	VVR1	BM03	VVR1_OPN
20051126 08:38:53	653	0	1	SR08C	RFPERM	BM13	RF_PERM_OK
20051126 08:38:53	652	0	1	SR03S	VACSUM	BM12	SEC 8 COMPLETE
20051126 08:38:48	652	1	0	SR10S	VVR1	BM04	VVR1_CLSD
20051126 08:38:48	059	0		SR10S	VVR1	BC20	VVR1_DR
20051126 08:38:47	656	0	1	SR06S	VVR1	BM03	VVR1_OPN
20051126 08:38:47	656	0	1	SR06C	RFPERM	BM13	RF_PERM_OK
20051126 08:38:47	655	0	1	SR03S	VACSUM	BM14	SEC 6 COMPLETE
20051126 08:38:43	653	1	0	SR08S	VVR1	BM04	VVR1_CLSD
20051126 08:38:44	810	0	1	SR08S	VVR1	BC20	VVR1_DR
20051126 08:38:39	646	1	0	SR06S	VVR1	BM04	VVR1_CLSD
20051126 08:38:38	809	0	1	SR06S	VVR1	BC20	VVR1_DR
20051126 08:38:38	656	0	1	SR03S	VACSUM	BM09	SEC 1 COMPLETE
20051126 08:38:38	268	0	1	SR01C	RFPERM	BM12	RF_PERM_OK
20051126 08:38:38	267	0	1	SR01S	VVR1	BM03	VVR1_OPN
20051126 08:38:36	270	0	1	SR01S	VVR2	BM08	VVR2_OPN
20051126 08:38:28	268	1	0	SR01S	VVR2	BM09	VVR2_CLSD
20051126 08:38:27	268	1	0	SR01S	VVR1	BM04	VVR1_CLSD
20051126 08:38:27	193	0	1	SR01S	VVR2	BC21	VVR2_DR
20051126 08:38:24	443	0	1	SR01S	VVR1	BC20	VVR1_DR **open SR valves SL 6, 8, 10**

20051126 08:27:50	658	0	1	BTS	B2	BM01	REMOTE_CNTRL_ON
20051126 08:14:31	624	0	1	BTS	B2	BM17	PS_READY_MON
20051126 08:14:31	624	0	1	BTS	B2	BM16	INTLKS_OK
20051126 08:14:31	624	0	1	BTS	B2	BM15	LEM_O/T
20051126 08:13:55	629	0	1	SR03S	MSTINT	BM08	**PERS SAFETY 2**
20051126 08:13:51	630	1	0	BTS	B2	BM17	PS_READY_MON
20051126 08:13:51	630	1	0	BTS	B2	BM16	INTLKS_OK
20051126 08:13:51	630	1	0	BTS	B2	BM15	LEM_O/T
20051126 08:13:49	630	0	1	BTS	B2	BM17	PS_READY_MON
20051126 08:13:49	630	0	1	BTS	B2	BM16	INTLKS_OK
20051126 08:13:49	630	0	1	BTS	B2	BM15	LEM_O/T
20051126 08:11:02	772	0	1	BTS	B1	BM01	REMOTE_CNTRL_ON
20051126 08:10:57	759	0	1	BTS	B1	BM09	AIR_FLO
20051126 08:10:57	759	0	1	BTS	B1	BM04	SAFETY_INTLK
20051126 08:10:57	759	0	1	BTS	B1	BM03	DOOR_INTLK
20051126 08:10:57	759	0	1	BTS	B1	BM02	MAGNET_O/T
20051126 08:10:48	769	0	1	BTS	B1	BM13	AC_PHASE_LOSS
20051126 08:10:48	769	0	1	BTS	B1	BM11	LOCAL OFF
20051126 08:10:48	769	0		BTS	B1	BM14	AC_OVER_CURRENT
20051126 08:10:48	769	0	1	BTS	B1	BM12	RAD INTLK OK
20051126 08:10:48	769	0	1	BTS	B1	BM10	SCR_O/T
20051126 08:10:48	769	0	1	BTS	B1	BM08	GND_FAULT_RELAY
20051126 08:10:48	769	0	1	BTS	B1	BM07	MAGNET_WATER_FLO
20051126 08:10:48	769	0	1	BTS	B1	BM06	SMOKE_DETC_ALARM
20051126 08:10:48	769	0	1	BTS	B1	BM05	DC_OVER_CURRENT
20051126 08:10:48	769	0	1	BTS	B1	BM00	CNTRL_PWR_ON_MON
20051126 08:10:26	628	0	1	BTS	B2	BM09	AIR_FLO
20051126 08:10:26	628	0	1	BTS	B2	BM04	SAFETY_INTLKS
20051126 08:10:26	628	0	1	BTS	B2	BM03	DOOR_INTLK
20051126 08:10:26	628	0	1	BTS	B2	BM02	MAGNET_O/T
20051126 08:10:12	629	0	1	BTS	B2	BM14	AC_OVER_CURRENT
20051126 08:10:12	629	0	1	BTS	B2	BM13	AC_PHASE_LOSS
20051126 08:10:12	629	0	1	BTS	B2	BM12	RAD INTLK OK

20051126 08:10:12	629	0	1	BTS	B2	BM11	LOCAL OFF
20051126 08:10:12	629	0	1	BTS	B2	BM10	SCR_OUT
20051126 08:10:12	629	0	1	BTS	B2	BM08	GND_FAULT_RELAY
20051126 08:10:12	629	0	1	BTS	B2	BM07	MAGNET WATER FLO
20051126 08:10:12	629	0	1	BTS	B2	BM06	SMOKE_DETC_ALARM
20051126 08:10:12	629	0	1	BTS	B2	BM05	DC_OVER_CURRENT
20051126 08:10:12	629	0	1	BTS	B2	BM00	CNTRL_PWR_ON_MON
20051126 08:09:19	616	0	1	SR07U	IG1	BM03	ION GAUGE1 ON
20051126 08:09:14	608	1	0	SR07U	IG1	BM03	ION GAUGE1 ON
20051126 08:04:53	668	0	1	SR03S	MSTINT	BM09	PERS SAFETY 1
20051126 08:05:21	601	1	0	SR03S	LBL3KR	BM09	KEY INTRLK COMP

START TESTING
(SETUP)

0800 → 1642

ALS Shielding Incidents Descriptions and Immediate Actions

Radiation Hutch Installation – September, 2005

On September 19, installation of the beamline 12.3.2 radiation hutch was scheduled to begin. An ALS work permit was posted at the job site. One item called out in the permit was the requirement for a Shielding Change Form to be filled out when the adjacent hutch shielding was to be modified.

On September 20, the contractor requested entry into the adjacent hutch (which was allowed since the hutch was accessible at the time). The contractor then began removing shielding, which was not allowed since the Shielding Change Form had not been completed, and the entire beamline had not been taken offline, as called for in the Shielding Control Procedure. As soon as the beamline scientist realized the shielding had been removed, he arranged for the beamline to be taken offline, and the appropriate procedures, including verification of the shielding before bringing the beamline online, to be followed. The Personnel Safety Shutter for the beamline was closed at all times when the shielding was removed, precluding any radiation from being introduced in the beamline.

The root cause was identified as poor control of outside contractor activities.

Immediate actions taken included:

1. Drafted and field-tested an additional work permit page specifically for outside contractors, with stop points, safety requirements and restrictions, and "read and understood" signatures.
2. Installation of the next hutch required continuous presence of knowledgeable ALS personnel as a field test.

Monochromator Enclosure – October, 2005

On October 15, a momentary power interruption caused problems for the monochromator on beamline 4.2.2, which required opening the shielding surrounding the monochromator for repair.

On October 16, the PI requested the Tamper Proof Screw Removal (TPSR) tool from the Control room to remove the shielding to perform the repairs. The Shielding Control Form was not

completed, and the beamline had not been taken offline, as called for in the Shielding Control Procedure. On October 17, the PI once again requested the TPSR tool, to replace the shielding.

On October 18, the PI requested that an ALS Beamline Coordinator key the beamline online. The Beamline Coordinator realized that the beamline had never been taken offline, and immediately verified that the monochromator shielding was in place, and completed the Key-Enable and Shielding Control Procedures. The Personnel Safety Shutter for the beamline was closed at all times when the shielding was removed, precluding any radiation from being introduced in the beamline until after the independent verification of the shielding.

Immediate actions taken included:

1. All Operators were reminded to verify that the beamline is taken offline and the Shielding Control Form is filled out before releasing the TPSR tool. This was reinforced by providing a separate logbook for the TPSR tool, with checkboxes indicating the above verification.
2. An ALS All-Hands meeting (and two makeup meetings for those who could not attend) was held to go over the shielding incidents, emphasize the critical nature of shielding changes, and solicit suggestions for improvements.
3. Following the All-Hands meeting, ALS management decided to further restrict the use of the TPSR tool, so that designated ALS staff members would control the actual use of the tool.
4. The Laboratory Director met with the ALS Acting Director and Deputy Director to discuss the incidents.
5. The Laboratory Radiation Safety Committee agreed to establish a subcommittee to review and investigate the recent shielding control incidents at the Advanced Light Source (ALS). The charge includes, "... assess the effectiveness of current shielding control procedures, engineering controls, training, EH&S staff support and management oversight as needed to develop proposed corrective actions to prevent the likelihood of recurrence." The subcommittee held its first meeting on December 2, 2005.
6. A further ALS All-Hands meeting was held the Laboratory Director, to reinforce the critical importance of safety at the ALS.

7. The ALS Acting Director asked the Laboratory Director to convene an external review committee (with experts from other DOE synchrotrons) to,
   - Review RSC internal incident report and corrective actions.
   - Review the radiation protection program at the ALS, with particular attention to the shielding control policies, procedures, and practices.
   - Examine the shielding control violations over the last several months and recommend changes to the program to minimize the likelihood of similar incidents in the future.
   - In particular, review the practices at the hard x-ray beamlines for protection from radiation, and, if needed, recommend changes to provide a higher level of protection.

Interlock Test – November, 2005

On November 23, an ALS Beamline Coordinator correctly took beamline 7.3.1 offline for shielding removal, following all appropriate procedures. During a routine interlock test on November 26, the RF (Radio Frequency system) interlock apparently tripped on this beamline's Radiation Safety System chassis. This trip was not anticipated by our procedures, and therefore the procedure did not address how to clear the trip. The beamline was brought online to clear this trip, and allow the test to continue. During this interlock test the ALS was shut down for the Thanksgiving holiday. On Monday, November 28, the ALS began a two-day maintenance period, with beam not scheduled for user operations until Tuesday night at midnight.

On Tuesday, November 29, about 10:00 am, an ALS Beamline Coordinator was checking over the beamlines which would need to be brought back online for user operations. The coordinator noticed that the beamline had not been taken offline. He immediately took the beamline offline (which then requires verification of the shielding before bringing the beamline online) and notified ALS management. The Personnel Safety Shutter for the beamline was closed at all times when the shielding was removed, preventing any radiation from being present in the beamline.

Immediate actions taken included:

1. The ALS Deputy Director notified the ALS Control Room that no beam was to be allowed into the storage ring until explicitly authorized by the Deputy Director. Conditions to allow beam included:

- Audit all open shielding control forms to ensure the beamlines are accually offline.
- Independent verification of shielding replacement for any open shielding control forms.

The ALS Deputy Director authorized the introduction of beam into the storage ring, and the beamlines were enabled following verification of the above conditions.

2. Further shielding changes were suspended until shielding control procedures were modified, and reviewed and approved by the Laboratory Radiation Safety Committee.
3. The Laboratory Director met with the ALS Deputy Director, Associate Beamline Scientist, and Beamline Coordinator to discuss this incident.
4. The interlock procedure is not to be used until further review and approval.

LAWRENCE BERKELEY LABORATORY
ADVANCED LIGHT SOURCE • ESG
Bldg. 2 Room 2-431 Extension 7730

Mar

MEMORANDUM

To: Ben Feinberg

From: Process Improvement Team

Re: **Beamline Review Process**

Introduction

The Process Improvement Team (PIT) has solicited recommendations from a broad spectrum of the ALS staff on how to improve the beamline review process. This request was enthusiastically met with an impressive list of well-thought-out suggestions. In general, three necessary improvements to the beamline review process became immediately obvious. First, a greater seriousness in reviewing beamlines is needed by all those involved; a laissez-faire attitude seems to have become prevalent, with ALS guidelines not being followed. Second, education of ALS personnel in radiation hazards particular to synchrotrons is necessary for all those building and working at the beamlines. Third, a one-time introduction to the entire beamline review process for ALS beamline designers/builders is necessary. A great deal of confusion about the stages and purposes of the review process exists. More specific proposals that need to be adopted are enumerated below.

General Improvements

1. The committee discovered a number of critical topics that were treated at an almost folklore level. Neither engineering notes nor guidelines exist on multiple critical items discussed during the review process. Design criteria/guidelines, similar to what has been done for gas bremsstrahlung shielding, need to be incorporated into the ALS Beamline Design Requirements guide (PUB-3114), along with the criteria for a drawing/description that can be used for verification and the required signoff procedure. The guidelines need to include:

a. hutch construction, including consideration of focused beams.
b. direct synchrotron hazards and shielding requirements.
c. scattered synchrotron hazards and shielding requirements.
d. ultra violet light hazards and shielding requirements.
e. beamline viewport hazards and design requirements.
f. criteria for bellows in areas with radiation levels requiring shielding.
g. design criteria for O rings in high radiation areas.
h. prevention of beamline disassembly, especially in high radiation areas.
i. hazards and safety guidelines for sections of beamlines before the first optic.
j. hazards and safety guidelines for sections of beamlines with high power.

2. An external review of the beamline review process by personnel from other light sources would be advisable. This would allow us to learn from their experience and help us develop a process consistent with those of other facilities.

3. Endstations and ancilliary equipment are not currently part of the review process, but it is clear to the committee that with the growing complexity of endstations, some review process is necessary. Similarly, experimental equipment (e.g. x ray generators) intended for future use on a beamline, can be brought into the ALS and operated prior to any kind of review or approval. The Beamline Review Committee should have jurisdiction in reviewing this equipment. Special guidelines as to when and how endstations and ancilliary equipment need to be reviewed are necessary.

4. Guidelines on how beamline changes are to be handled need to be created, especially from the time of the beamline Conceptual Design Review to the Beamline Design Review to the Beamline Readiness Review. Changes need to have a paper trail so that the Beamline Review Committee can track them as committee membership changes.

Improvements Specific to the Beamline Review Process.

The functioning of the committee should be improved, with attendance required (or an alternate present), detailed minutes kept, material given to reviewers well in advance of meetings, material from past meetings available to committee members before a meeting, specific areas of expertise delineated, etc. Specific recommendations to improve the process are:

a. The Beamline Readiness Review should be made into an ALS procedure with an accompanying checklist. A checklist of required documentation for the review process should be established.

b. Having a beamline fully designed before it is reviewed is unrealistic. Some agreement between the Beamline Review Committee chairman and the project leader as to when a beamline design review should take place is necessary. Modifications after the Beamline Design Review should be explicitly reviewed during the Beamline Readiness Review. If the modifications are significant enough, an additional Beamline Review may be necessary. What constitutes a modification that needs reviewing is a complicated issue needing special attention.

c. A Beamline Readiness Review timetable should be officially established to prevent rushed, last-minute reviews of beamlines.

d. The Beamline Readiness Review should not be done until the beamline is fully complete as defined by the Beamline Readiness Review Document, i.e. exclusion zones are in place, the vacuum is at the required level, etc.

e. A detailed checklist for the radiation checkout during beamline commissioning needs to be made by the radiation technician who will perform the checkout, the beamline engineer, the project scientist, and the EH&S radiation safety officer.

f. Clarification between the Beamline Readiness Review and the Beamline Readiness Walkthrough is necessary. Both functions appear to be so intimately connected that the functions should be performed by the same

group of people. The Beamline Readiness Review Walkthrough should be done by the Beamline Readiness Review Committee as a group at the beamline to insure that what is "on the floor" is what was reviewed at the Beamline Design Review and the Beamline Readiness Review.

g. Rules defining the Beamline Review Committee operation should be created, for consistency between changes in committee membership. An attendance list for the beamline review process of the critical people involved in building the beamline is needed.

h. Clear written definition of the entire Beamline Design Review/Readiness Review/Walkthrough decision-making process is necessary. In particular, what is to be done in the case of a member's dissension from the majority? Does a member with a particular expertise have a veto over others who do not have expertise in that area? How are appeals to a decision to be made? What is the process to be followed if a decision is to be overruled by someone higher in the chain of command?

i. The PIT also recommends a once-a-year recommissioning inspection and full radiation resurvey of the beamline to check against hazards and undocumented changes. Comparison with the original radiation survey measurements should be made before recertification is done. Mechanical and electrical safety inspections should also be included.

j. Only one beamline should be reviewed at a time by the committee.

ALS Safety Officer

The ALS safety officer should be involved in the beamline review process: the Beamline Design Review and Beamline Readiness Review and Beamline Commissioning. This individual should serve as a one-stop safety person, as is found at the NSLS, with improved emphasis on radiation safety. In addition this individual needs to have complete safety responsibility and oversight of the beamlines.

ALS User Interface

The PIT recommends an improvement in the interface to the beamline users and builders. A single resource person who has an experimental background and who is familiar with ALS personnel is needed to help builders/users meet the ALS requirements and guidelines. This person should be the Beamline Review Committee chairperson or an assistant to the chairperson and assist during the review of a beamline. Such an individual would provide continuity during changes in committee membership.

Operational Issues

The PIT was made aware of several operational issues that are not directly safety related, but significantly affect the operation of the facility and, indirectly, its safety.

The PIT recommends:

a. A floor layout with location of fiducials on major beamline components be provided before a beamline is approved for running. (A complete CAD drawing would be preferred, but it is unrealistic to require that.)

b. A schematic seismic diagram be created for each significant part of a beamline.

c. The following items needs to be located together at each beamline in a standard format and a standard location with key selected items (1, 2, 6, 8, 11) displayed prominently:

1. Egress routes
2. Responsible persons and their phone numbers
3. Radiation shielding diagrams and pictures
4. Seismic information
5. Vacuum procedures
6. Safety checklist
7. Radiation survey information (worst/best case)
8. Up-to-date beamline drawing
9. Key-enable procedure.
10. AHDs
11. Experimental Summary Sheet
12. Room for pertinent beamline information.

d. Portable radiation survey monitors should be accessible to all for their convenience at any time at central locations (such as near fire extinguishers), as is now done at many facilities. The ALS should be responsible for the calibration and maintenance of the monitors. These monitors would be comparable to voltmeters now used by users.

Appendix T: 1999 PIT report

Draft memo
rev 11/30/99

To: Jim K
From : Construction Procedures PIT
A. Catalano
D. Colomb
R. Duarte
J. Gregor
J. Harkins
D. Hamamotot
R. Miller
K. Woolfe

On June 28, 1999 you requested that Joe Harkins organize a group to discuss how to improve our procedures related to managing the details of shutdown activities. The Construction Procedures Process Improvement Team was formed and met 5 times from July 14 through October 4. We understood the driving force behind your request was the problems with failure to properly reconnect water to the sector 4 center bend magnet and the 5.0 Photon Stop during the June 1999 Shutdown. We also, however, looked at other problems that we have encountered during construction activities.

Causes

We first developed a list of root causes as follows:

1) Not clear who is in charge. Sometimes there isn't a Project Manager assigned (i.e. the 5.0 Photon Stop).
2) Task Managers (Project Managers) don't have a complete understanding of the installation details or time to check.
3) No procedural requirement for a final check before start up when it is new construction that does not include a bypass/interlock, does not result in a completed beamline (BRR walk through) or does not modify shielding (i.e. the 7.3 photon stop replacement).
4) Interlocks may not be effective (i.e. girder water interlock not sensitive enough).
5) Incomplete documentation for equipment safety issues.
6) Electrical modifications not scheduled or reviewed (i.e. not brought to maintenance meeting).
7) When water lines are jumpered, so that the flow switches continue to make up, the possibility of an accident is increased since removal of this jumper may be missed when the system is restored. (According to Catalano this practice is no longer used.)

Solutions

We then developed a list of possible solutions as follows:

1) Identify who is in charge and their duties. Should include management of schedule and installation.
2) Develop a work order checklist procedure (or incorporate checklist into existing by pass/interlock procedure). Checklist should be posted at the work site and should be signed when completed and signed when verified complete.
3) Work Permit System.
4) Appoint an Accelerator Coordinator that is responsible for reviewing, inspecting and approving all modifications. This person could also determine the level of reviewing and checking that is appropriate for the work proposed.

Recommendations

After review of each of the possible solutions we developed a list of recommendations as follows:

1) The Bypass procedure was modified during this PIT but we feel that these modifications are important enough that a training session on this procedure should be held with all pertinent personnel.
2) An "implementation" of the project management system should be conducted including training and there should be confirmation from ALS management that "this is the way we are going to do business". Roles and terms (like "task manager") should be defined. Follow up should be done to determine that the system is being followed.
3) The possibility of a dedicated person to be responsible for all modifications to the accelerator is appealing to the PIT (an Accelerator Coordinator). This person would not be subject to conflicting changes in priorities by the engineering or scientific staff. This person would also become very familiar with the accelerator and could provide some preservation of knowledge as personnel involved in the accelerator construction are retiring. A job description is attached.
4) Use of a Work Permit system is appealing to the PIT for several reasons. Preventitive maintenance will become increasingly necessary as the ALS equipment becomes older and as more and more Users depend on reliable operations. Work Permits would provide the systematic review by one person (or a responsible designee) of all modifications to the accelerator and beamlines. Work Permits would provide the tracking necessary for a successful proactive maintenance program.

ALS Safety Process Improvement Team: Findings, Comments, Recommendations, February 1, 2004 Final Report

A Process Improvement Team (PIT) was appointed by Ben Feinberg on Oct. 7, 2003 to resolve concerns and make recommendations about the process of building and maintaining equipment at the ALS.

PIT Members: B. Bailey, D. Colomb, N. Kelez, G. Perdue, S. Rossi, R. Schlueter (chair), T. Warwick,

Twofold Motivation behind request:
(1) recent increase in the frequency of minor safety incidents and
(2) incident with a contractor inappropriately removing shielding (contractor was trained and badged, yet was unaware of the safety hazard created by drilling out a tamper-proof screw)

Charge:
(1) Recommend clear roles and responsibilities as a beamline undergoes construction, commissioning, and becomes operational.
(2) Recommend methods to accommodate unforeseeable time delays that may occur during construction. Provide a mechanism to rebaseline project schedules to provide adequate time for safe completion of each project.
(3) Recommend where and what level of oversight would be beneficial.
(4) Recommend whether some version of a work permit should be established for all maintenance activities, and, if so, what level of rigor should be required.

General Findings and Comments:
The ALS is a maturing facility with increasingly complex user needs and associated safety requirements. It is prudent to periodically reassess the way the ALS is run as an operating facility and make adjustments as appropriate. Reassessment along several fronts is presently already underway, e.g. via

- developing roles for a maintenance supervisor, and perhaps a facility coordinator (Feinberg),
- development of a template beamline readiness checklist (Wolfe) ,
- development of Project Management, CAD, and general documentation standards and protocols for beamline projects (Duarte), and
- making a spare parts inventory assessment and developing a preventive maintenance plan (Thur).

It is incumbent upon us collectively to develop procedures and protocols and encourage practices that efficiently serve the needs of the scientific users and, while not being unnecessarily burdensome or bureaucratic, also give preeminence to insuring the safety of personnel and equipment. The effectiveness of and accountability in adherence to developed procedures and protocols should be periodically assessed.

(1) Roles & responsibilities as a beamline undergoes construction, commissioning, and becomes operational:

Findings:

- In 1999 a PIT was formed with the intent of improving procedures related to managing machine shutdown activities. The 1999 PIT made recommendations regarding training on procedures, implementation of a project management system, creation of an Accelerator Coordinator position, and implementation of a work permit system. Specific to shutdowns, duties of a shutdown manager, task managers, and craft/shop supervisors were delineated. These recommendations were largely implemented (e.g. designating task managers for long shutdown-related tasks (Harkins), and development of the ALS Project Management System/Manual (Krupnick, Harkins), which addressed cost estimates, changes and control thereof, project management, and project roles and responsibilities. Implementation of others was deferred (e.g. institution of a formal work permit system) or handled in a modified form or on a reduced scale (e.g. development of an accelerator coordinator position/role). On some beamline projects, schedules and personnel needs have not been reviewed with regularity, as intended in the developed plan.
- Concerns regarding implementation of specified safety features (e.g. in hutches) has been voiced by several engineers.
- Concerns regarding safety protocols and procedures have been voiced by several engineers (e.g. apparent openings in enclosures, torn safety labels).

Comments:

- There is a need for training of ALS personnel by LBNL and ALS safety professionals to communicate a shared safety philosophy, protocols, and procedures implemented at the ALS. Additionally, there is a need for a continual dialogue between LBNL and ALS safety professionals and ALS personnel, so as to maintain the safest possible environment and the confidence therein amongst ALS personnel.
- Voiced radiation safety concerns at superbend beamlines point to the need to clearly communicate what safety protocols have been implemented.
- With regard to radiation safety: RSS procedures are sound, as are the Bremsstrahlung shielding procedures. Hard x-ray safety, e.g. with the new superbend beamlines, is given very critical attention. Specific attention, at the Beamline Design stage, during the BeamLine Readiness Review, and thereafter is given to (along with other safety concerns):
    - hutch design (e.g. wall thickness, features overlap)
    - safety of the white-beam part of the beamline
    - potential leaks of scattered x-rays
    - mechanical integrity of shielding components

  This requires that both the radiation shielding professionals and Eng. staff work together to insure that (a) ALS hutches are leak-free, built to specification, with secure components upon key-enable, to be followed by (b) radiation survey as an independent verification as to the radiation safety of the environment. This

important belt-and-suspenders approach was identified as being crucial to maintain the confidence of the Engineering personnel in the soundness of the ALS safety philosophy, protocols, and procedures.

- With the full data from the BDR, the hutch implementation can be checked at the BRRW. So, for example, ALS policy regarding tamper proof screws, labeling thereof, can be enforced at the BDR, then verified at the BRRW.
- The ALS implements various levels of protection against inadvertent removal of shielding (e.g. by contractors), including
  - Labeling
  - Visual inspection at key enable (OK for Bremmstrahlung, Pb, and radiation stickers, but impossible for wall integrity of a hutch, so this must be done at time of construction)
  - Radiation survey at first key enable (for hard x-ray lines) and at other appropriate times as planned
  - Vigilance on the part of many individuals looking for:
    - Work on a beamline while still enabled
    - Work on shielding without a permit
    - Work by persons unknown
- The Beamline Review Committee Chair presently serves to coordinate floor space requests and resolve conflicting needs. In-house ALS beamline projects are required to pass the BRC CDR, in addition to having a cost estimate, schedule, and staffing plan. Engineering should be directly involved early in cost estimating, scheduling, and development of the staffing plan. At an early stage in a design, the beamline design team should consider the space restrictions outlined in the beamline's CDR so that inconsistencies with operational needs of neighboring beamline users can be discerned early and major redesign/rework can be avoided.
- One possibility for improving the level of planning and floor space allocation and continuity would be to form a small Planning Committee, with both engineering and scientific representation, under the direction of the Division Deputy for Planning. Committee appointment could be relatively long term in order achieve the continuity not currently found in the BRC. Whatever the implementation, the key point is that engineers feel that development of a cohesive and viable plan truly needs engineering input and understanding.

Recommendations:

- A clear designation of who is in charge of the beamline at any given time is desirable:
  - Prior to first key enable, the **beamline design team, including project leader, project manager, and project engineers(s),** is collectively responsible for the beamline. Specific roles and responsibilities among these team members are as delineated in the ALS Project Management Manual, and are summarized below. It should be noted that project engineers should also be included in the early project planning and organizing so that they can be reasonably expected to take ownership of a project's technical integrity, schedule, and cost downstream.

- The beamline project leader and designee(s) defend the beamline at the reviews and answers questions from the inspection team, etc.
- Until the beamline becomes operational, safety issues should be handled by means appropriate for a beamline under construction, e.g. vacuum procedures, Pb handling procedures, crane operation rules, etc.
- When beamline is enabled, the new situation calls for a having single individual, the **beamline scientist**, in charge of both beamline operational and safety issues.
- An up-to-date log should be maintained, listing who is the single individual responsible for safety at each beamline.
- A formal handoff between the engineering **beamline design team** and the **beamline scientist** is appropriate at end of readiness walkthrough, upon BRRW checklist completion. This is addressed in K. Wolfe's revised Readiness Review Walkthrough Information Sheet.

- Recommended roles and responsibilities as a beamline undergoes construction, commissioning, and becomes operational:
  - Beamline project leader –
    - has ultimate responsibility for achievement of project objectives, including technical, cost, and schedule
    - represents project in interactions with ALS management
    - provides overall scientific vision and technical goals
    - approves the project plan
  - Beamline project manager –
    - has primary responsibility for planning, organizing, and controlling the project
    - prepares the project plan (scope, WBS, schedule, change controls, status updates)
  - Beamline project engineers –
    - are responsible for the technical integrity of project deliverables
    - responsible for meeting cost and schedule objectives
    - responsible for managing the engineering effort, including design supervision, and engineering staffing
  - Beamline Review Committee Chair –
    - responsible for impartial review and monitoring of new BL design and commissioning
  - Beamline scientists –
    - responsible for all operational issues after first key-enable
    - responsible for all safety issues and BL/ES modifications after key-enable
    - appraise maintenance coordinator of modifications, repairs, and maintenance needs
  - Beamline coordinators – assume their beamline responsibilities after first key-enable
    - a radiation survey at every key-enable on x-ray beamlines is not necessary, but a visual inspection of shielding and stickers on hard x-ray lines is warranted

- appraise maintenance coordinator of modifications, repairs, and maintenance needs

- Maintenance coordinator – under the direction of a facility coordinator,
  - determines maintenance needs and schedule
  - is to be appraised of all modifications, repairs, and maintenance needs
  - oversee vendors that do work on any of the following: accelerator, beamlines, endstations, or building
  - responsible for inspection and sign off after contractor work is finished
- Facility overseer, see (3) below
  - responsible for continuous monitoring of all beamline, experimental floor, and accelerator activities, including safety issues associated with proposed beamline modifications
  - coordinates the activities of the Maintenance Coordinator, Accelerator Engineer, Building Manager, etc. regarding facility activities, including beamline construction or modifications.
- Radiation Safety Professional –
  - responsible for monitoring safety aspects of BL design and incorporation of safety features
  - responsible for radiation safety inspection at BRRW
  - responsible for periodic monitoring of operational beamlines
  - responsible for radiation safety enforcement and compliance
  - responsible for training ALS personnel and communicating a shared safety philosophy, protocols, and procedures for the ALS
- All –
  - responsible for bringing any perceived radiation safety issue to the attention of LBNL and ALS safety personnel, and if not satisfactorily resolved, to the attention of ALS management.

(2) Methods to accommodate unforeseeable time delays during construction; mechanism to rebaseline project schedules

Findings:

- There is always a push to bring on beamlines as soon as possible; the Beamlines Review Committee, to some extent, acts to control this process so as to avoid compromising safety under pressure from users or beamline scientists.
- ALS management, via continual involvement in safety issues, sets the example in acknowledging that safety is indeed the top priority.

Comments:

- The impact of a serious accident in both individual and institutional terms is tremendous (even more so than winning a Nobel).

Recommendations:

- Establish early and maintain regularly communication links between mechanical, electrical, and controls Engineering groups to coordinate, monitor, and schedule system interface activities.

- Establish a standard of engineering and project management documentation.
- Retain contingency time in projects. At the outset of projects define a level contingency commensurate with the unknowns of the project. Continue to reflect this same percentage contingency on work remaining as the project proceeds. This allows for a continual buffer. On projects with clear deadlines, work to establish realistic schedules early and assign reasonable contingency estimates to the project. Aggressively manage schedule contingency. The R&D nature of many of our projects makes it difficult since many project changes occur along the way. If a change to the project is requested/proposed, then a clear estimate of the schedule impact needs to be presented and a decision must then be made whether we can proceed with the scope change.
- Refer to the tech schedule of major projects; keep the schedules up to date with realistic deadlines and milestones. Keep the (future) beamline scientist, coordinator, and users appraised of changes and delays.
- Expanding on the comments regarding a Planning Committee from section (1) - Representative(s) from Engineering working with ALS Planning (Krupnick/Rossi) and ESG/SSG could develop a viable initial layout and plan that could then be more accurately estimated and scheduled. Engineers feel that delays and cost/schedules changes can the result from initial incomplete assessment, understanding, and definition of the project. Early collaborative effort described here could provide the mechanism to help mitigate initial underestimates and overly optimistic scheduling/costing.

(3) What level of oversight would be beneficial?

Findings:

- The ALS has recently split the maintenance coordinator and building manager roles.

Comments:

- The ALS could explore whether utilizing a facility coordinator (FC) in addition to the newly defined maintenance position could result in a smoother, safer, more efficient operation. The facility coordinator ideally would have a full understanding of the facility and its systems.
- A facility coordinator would be responsible for
  - The entire facility, including the building, the experimental floor, and inside the shield walls
  - planning and execution of daily activities associated with basic operation of the facility
    - Work order/job order implementation, activities, and archiving, as outlined below
    - Facility and machine maintenance and construction
    - Safe and consistent operation of experimental floor and BL/ES
  - coordinating the activities of the Maintenance Coordinator, Accelerator Engineer, Building Manager, etc. regarding facility activities, including beamline construction or modifications.

Recommendations:

- Appoint a maintenance coordinator, with responsibilities as outlined above. (Completed - Oct. '03)
- Separate maintenance and operations heads. (completed)
- Consider establishing a facility coordinator position in addition to the newly defined maintenance position. The facility coordinator ideally would have a full understanding of the facility and it's systems, and would implement the work permit system, below, oversee the building, the experimental floor, and inside the shield walls, and supervise the maintenance coordinator, building manager, accelerator engineer, etc.

(4) establishment of a work permit for maintenance activities; what level of rigor?

Findings:

- The EE side of the house uses a job order system. It is not really a work permit as outlined below, but is a way used to verify all tasks are completed. It has worked for the EE's for many years in multiple jobs. It still requires the personal touch to insure smooth completion of tasks.
- Regarding Logbooks – there are procedures in place. 'Key' gets entered in the logbook.

Comments:

- Setting boundaries as to what is subject to the work permit process is necessary, as BL scientists are constantly tweaking their beamlines. The general rule is that anything remotely impacting safety should be routed through the permit process. Any doubt as to whether a proposed 'tweak' qualifies should be referred to the Facility coordinator. Response should be rapid, so as not to be cumbersome. Erring on the side of not asking is a serious disregard for safety protocol.
- There is a consensus among technicians and engineers that establishment of a job order system would facilitate keeping track of the status of jobs and enhance safety.
- A WO system can be based on the current Web Job Order System already implemented by the ME Dept. The data base and web interface already exist and are maintained by CIS. It can be accessed by any computer and any user. Only minimal additions are necessary to satisfy functional requirements. A framework for approval, distribution, documentation, attachment, and close-out already exist. We could base ours on Daresbury's PTW system, using an existing File Maker Pro template. Server/primary access point is in the control room.

Recommendations:

- Implement a job order or job tag system, as outlined below. This process for job document recording and tracking would be conducive to a safe, orderly process of securing the accelerator after a maintenance day shutdown and will enable us to better manage all aspect of maintenance. Although the system is fairly

structured, it would better guarantee personnel safety and consistent operation desired by all. The aim is to:

- create a database that would issue a job tag or order on the spot;
- ensure that all the proper tasks are listed on the job tags;
- ensure tasks are properly reviewed and qualified people assigned to task determination, implementation and oversight
- generate an electronic copy and a paper copy that would be issued to the person in charge of that particular task;
- monitor a job during its duration;
- ensure that the craftsperson's assigned to the job date and sign off on the paper copy that is posted near the job;
- at job's conclusion close out the tag in the database and retain paper copy in a binder available to the operations group

- The maintenance coordinator should determine the specifics of any formal contractor protocol. Together the contractor and maintenance coordinator can make up a list of job tasks, which are posted during the job, and subsequently checked off.
- Special attention should be given to any changes in shielding. The existing shielding change form and protocol should be modified to be consistent with the proposed job order/work order plan.
- A Strawman job order/work order implementation plan is outlined below:
  - For tasks inside the shield wall:
    - WO is submitted to the FC prior to shutdown planing meeting
      - work request is discussed with relevant experts and is approved/disapproved
      - time, resources, procedures, and inspection checklist are compiled and documented on the WO
      - task is added to shutdown list and WO is distributed to resources and responsible oversight with documentation
      - task is completed and WO closed, with appropriate inspection and sign off
    - WO is submitted to the FC after shutdown planning meeting
      - FC contacts and reviews work request with relevant experts and approves/disapproves or postpones until next shutdown planning meeting
      - time, resources, procedures, and inspection checklist are compiled and documented on the WO
      - task is added to shutdown list and WO is distributed to resources and responsible oversight with documentation
      - task is completed and WO closed, with appropriate inspection and sign off
    - All WO's are closed-out by the end of shutdown
      - All inspections and reviews are completed and signed off
      - Incomplete tasks are reviewed and assessed by responsible individual(s) and partially closed-out
  - For building/facilities related tasks (procedure is similar to that above):

- WO is submitted to the FC
    - FC contacts and reviews work request with relevant experts and approves/disapproves
    - time, resources, procedures, and inspection checklist are compiled and documented on the WO
    - task is added to shutdown list and WO is distributed to resources and responsible oversight with documentation
    - task is completed and WO closed, with appropriate inspection and sign off

- for tasks on the beamlines/end station:
    - BL/ES construction
        - JO is submitted to the ALS Tech/Survey with appropriate documentation (assembly drawing, installation/ fiducialization drawing, etc.) and scheduled at Tuesday planning meeting
        - task is completed
        - BL engineer is responsible for inspecting and closing out the JO
        - All construction JO's are closed out prior to BRRW
    - BL/ES modification
        - BL key-off initiates notification of BL scientist, BL coordinator, and FC.
        - All work is documented in BL logbook and tasks outside the purview of the beamline coordinator require beamline scientist and FC approval.
        - BL scientists are responsible for compliance with ALS procedures and final inspection.
    - Facility/infrastructure work
        - Any work affecting a BL, including water interlock testing, electrical modifications, etc. require notification of the affected BL scientist

PROCEDURE	Page 1 of 7
Number: DRAFT DRAFT DRAFT	
Revision: Rev. 0	
Issue Date: December, 2005	
Review Period: 3 years	
Supercedes Issues:	

Title:

Maintenance and Installation Work at the Advanced Light Source
- Use of the ALS Work List and the ALS Work Permit

Section where used:

ALS Operations, Engineering, Mechanical Technicians (MT), Electronics Installation (EI), Electronics Maintenance (EM), and Electricians Sections

Prepared by	Date	Reviewed by	Date	Approved by	Date
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Revision Log:

Rev. No.	Effective Date	Pgs. Affected	Brief Description of Revision

1.0 PURPOSE

To describe the use of the Advanced Light Source (ALS) Work List and the ALS Work Permit as tools for the organization, communication, control, and documentation of maintenance and installation work at the ALS facility.

2.0 SCOPE

LBNL's ALS synchrotron facility is an intensively used, complex particle accelerator with very high demands for reliability and minimization of downtime. Maintenance and installation work must be well planned and coordinated among the technical staff so that it can be successfully completed within the periodically scheduled shutdown shifts (approximately 24 hours per month). Some maintenance and installation projects are especially complex and may have potential personnel safety or

machine protection consequences. This procedure describes the use of the ALS Work List and the ALS Work Permit as flexible and effective tools for the organiza-

2.0 SCOPE, Cont.

tion, communication, control, and documentation of maintenance and installation work at the ALS facility.

3.0 REFERENCES

DOE Order 420.2B, Safety of Accelerator Facilities, Implementation Guide, Chapter II.B.1.h.

4.0 REQUIRED MATERIALS, EQUIPMENT, SUPPLIES, TOOLS, AND MANPOWER

ALS Work List Form (an MS Word table)
ALS Work Permit Form (an MS Word table)
ALS Facility Coordinator
Person In Charge of Work (for Work Permit)
ALS Specialists, if needed
Mechanical/Electrical Engineers involved
ALS Technicians and Supervisors

5.0 PROCEDURE

5.1 Use of the ALS Work List

[1] The ALS Work List (example attached in Appendix I) is a continuously evolving MS Word table which lists all projects, large and small, intended to be done on the next scheduled maintenance one or two day shutdown shift(s). It is maintained by the ALS Facility Coordinator and it serves several puposes:

[a] A vehicle for planning and discussion of work and interfaces among the technician supervisors and Operations personnel. This takes place at a standing meeting in conference room 6-1105 at 8:15 on Thursdays.

[b] A notification to the wider ALS staff of work that will be done at the next shutdown. This happens via e-mail distribution of the final Work List following [a].

[c] A verification that the accelerator and its critical systems have been restored to operational condition for start-up. At the end

of the shutdown work shift, critical line items on the master copy of the Work List in the control room are signed off as complete, incomplete, or deferred by the individual work item leaders.

[d] A documented record of work items done at the ALS. Past Work Lists serve as a record of what was done and when.

[2] The ALS facility Coordinator is responsible for conducting the continuous Work List cycle. A narrative of this process is as follows:

Following the completion of a one or two day shutdown (typically on a Monday or Tuesday), the master Work List is collected from the control room to be used as a basis for a draft Work List for the next shutdown, typically two weeks later. (A reference copy of the master list is left in the control room as a reference.) The MS Word file for the previous list is edited and saved as a new draft document for the coming shutdown. Completed items are deleted; incomplete and deferred items are retained for discussion. The form is edited to place the carry-over items at the top of each subsection, with blank lines available for write-in items at the discussion session. Subsection headings which have proved to be useful for organizing the work are: LINAC/LTB/BTF/BOOSTER/ BTS, STORAGE RING- Hi Priority, Other SR Work, RF SYSTEMS, BEAMLINES, CRANE / HOIST WORK, CONTROL SYSTEM/CR, ALS SAFETY ITEMS, and FUTURE SCHEDULING. With careful editing and use of abbreviations, it is almost always possible to keep the list to two pages in length. (See attached example form.)

The draft Work List for the coming shutdown is distributed to the work leaders, operations, and project personnel at the 8:15 Thursday meeting. (Typically 10 to 15 people) The Facility Coordinator leads a free-ranging discussion of the work items, covering concerns, preparation, and coordination issues. Anyone at the meeting can propose a new work item. These face to face discussions are a critical part of infrastructure communications at the ALS. Each person who regularly attends these meetings leaves with a broad knowledge of what is going on at the facility and how his own work fits into the bigger picture.

Using notes from the 8:15 discussion, the Facility Coordinator prepares a revised Work List for the coming shutdown. Depending on the ALS calendar, there may or may not be an additional Thursday 8:15 meeting to further discuss and refine the list before the shutdown. Although it is not always possible, the second discussion session is well worthwhile, since significant new work and changes in

previously planned work often materialize in the intervening week. Each of these meetings is only as long as it needs to be, usually less than 45 minutes.

Following the last discussion, the Facility Coordinator produces a final Work List for the coming shutdown. Items that are critical for machine start-up are noted, and the responsible leaders are highlighted in bold type. This listed is distributed as an e-mail attachment to meeting attendees and to a much longer list of ALS staff, for information purposes. The e-mail message may call attention to items that were added since the last discussion, and reminds the leaders of critical projects (by name) of their control room sign-off responsibilities. The final list is typically sent out on the Friday preceding a Monday shutdown.

On the morning of the shutdown day, the Facility Coordinator posts the master copy of the Work List in the ALS control room for information to the operators, and for completion sign-offs by the project leaders. The master copy is identified by a red heading which typically reads: Master Copy – for Sign-Offs. This red heading separates the master copy from any photocopies that may be made, and allows us to keep track of original sign-off signatures.

At the end of the shutdown day(s), the master copy Work List in the control room is consulted by the accelerator operators to determine whether work items which may have an effect on machine start-up or safety have been completed. If there are questions on the status of specific projects, the Work List serves as a guide to whom should be called. The original copy of the master Work List remains in the control room until the next day, when it is collected by the Facility Coordinator and replaced with a photocopy. The master copies are maintained in a chronological file.

And then the cycle repeats for the next one or two day shutdown ...

5.2 Use of the ALS Work Permit

[1] Background: The position of ALS Facility Coordinator was created in 2004 in response to concerns over inadequate coordination and communication of work being done at the ALS. The ALS is a complex facility, and some projects were beginning to have unanticipated effects on other systems, or missed safety concerns. Better anticipation, control, communication, and documentation of work to be done was needed, and the creation of a suitable Work Permit system was part of the brief for the new Facility Coordinator (Will Thur). The use

of Work Permit-like systems at other accelerator facilities was researched and reported on at a series of ALS staff meetings. Will proposed and developed a Work Permit for the ALS which was intended to address our deficiencies effectively, without adding a burdensome bureaucracy.

[2] An example ALS Work Permit is attached as Appendix II. The key principals of the Work Permit are:

[a] Use : As noted in the heading, a Work Permit is required for "accelerator maintenance and installation work which may have personnel safety or machine protection consequences".

[b] Every project covered by a Work Permit has a designated "Person In Charge". Personal responsibility is a key principle of the Work Permit system.

[c] The written Work Permit is created by the Facility Coordinator, the Person In Charge, and other involved staff in a discussion session where the the proposed work is explained and broken into subtasks. Time is taken to anticipate the consequences of the work on other ALS systems and functional groups. Possible complications, risks, and safety reminders are noted. Relevent ALS Procedures and references are attached. This discussion is intended to take place in advance of the day the work is to be done, to avoid time pressures and allow for considered thought on the project.

[d] On the work day, the completed yellow Work Permit and attachments are posted at the work site as an immediate reference for anyone working on the job. (A copy is also filed in an ALS Control Room binder.) Sub-tasks are signed off by the Person In Charge as the work is completed. Unanticipated complications, concerns, or deviations from the plan are noted by hand on the Work Permit as the work progresses.

[e] When the work is complete, the form is closed out by a signature from the Person In Charge, with the statement "This work has been completed with due regard for all concerns noted above". The Control Room copy is also updated.

[f] The file of completed Work Permits serves as a documented record of critical work done at the ALS and of any remaining concerns which may affect future operations.

[3] Development of the Work Permit: This form evolved in several iterations during its first six months of use, but now seems to be serving its purpose well. It is an MS Word tabular document, and the size of its fields can be varied to suit a given situation. The most critial information is listed on the cover page where it is most likely to be seen. Previous attempts and experiences at other facilities often turned out to be too prescriptive; - accelerator facility work is far too varied and complex to allow lists of check boxes, for example. The ALS Work Permit is intended to be a flexible medium for planning and controlling a wide variety of maintenance and installation activities with an equally wide variety of concerns and consequences.

[4] In addition to the Work Permit form, several evolving checklists and sets of notes are used by the Facility Coordinator as discussion aids in anticipating potential problems for the wide variety of work that may be covered by an ALS Work Permit. Current examples are given in Appendix III. These lists are important because experience at other accelerator facilities has shown that it is a mistake to try to incorporate comprehensive reminders in the Work Permit form itself. Such forms become long, routine, and mostly irrelevent to a given application. The ALS Work Permit is meant to be a flexible document that can be used in a wide variety of situations, with inputs from a wide variety of ALS staff.

[5] Specific instructions for filling in the Work Permit information fields :

[a] Cover Page

Work Description: A one or two line title easily understood by ALS staff

Permit #: A sequential filing number

Status: Draft, Active, Closed Out, or possibly Deferred or Cancelled

By: Person preparing the Work Permit, usually the ALS Facility Coordinator (with signature)

Date: Date of preparation

PROCEDURE	Page 7 of 7
Number: DRAFT DRAFT DRAFT	
Revision:	

Person in Charge: An ALS staff member who is personally responsible for the overall coordination and outcome of the project (with signature)

Planned Work Dates: As planned, but subject to change

Sub-Task Checklist and Notes: This field is intended to be tailored to the specific project. It will generally start with some introductory explanation of the work, and include identifiable sub-tasks to be signed off as the work progresses. Safety reminders and cautions can be prominently displayed in this main field.

Affected Systems: From checklists, discussion, and listed to stimulate thinking about unanticipated consequences.

Tech. Groups Involved: Also intended to help in anticipating interactions and ommissions in planning

Discussed with: A record of who was involved in the planning and thought process recorded in the work permit

Complications, Risks, and Safety Reminders: A specific field for concerns to be kept in mind during the work process

[b] Second Page

References (J.O.s, Procedures, Dwgs, etc.): A reminder of reference materials that may be useful during the course of the work. Many of these will be physically attached to the posted Work Permit at the work site.

Comments from Work Site - Complications, Concerns, Deviations from Plan, Advice for Next Time: This is intended to be a free-form field for hand-written notes by the personnel doing the work. – A chance to record lesson learned in the work experience for later reference.

Close-Out by Person in Charge: As noted, the signature in this box means that "This work has been completed with due regard for all concerns noted above." This signature emphasizes the personal responsibility of the Person In

Charge, and tells the ALS Control Room that the work has been fully completed (or not, as noted).

Follow-Up Task : A place to note related tasks that will follow the completion of the main project covered by the Work Permit

6.0 APPENDICES

Appendix I An example ALS Work List

Appendix II An example ALS Work Permit

Appendix III ALS Work Permit preparation checklists and notes

Ernest Orlando Lawrence
Berkeley National Laboratory

ADVANCED LIGHT SOURCE
Bldg. 80 • Room 230 • Ext. 6692

December 19, 2005

Memorandum

To: SMT, Staff Safety Committee Members

From: Janos Kirz

Subj: ALS Staff Safety Committee

In the interest of more complete ALS staff involvement and communication, I am establishing a multidisciplinary safety committee to review any significant safety and health concerns at the ALS, recommend corrective actions, and monitor follow-up.

The charter of the committee is to:

Perform a comprehensive review of ALS ESH policies and procedures as concerns and incidents warrant, recruiting ALS and LBNL ESH and/or technical experts as required.

Oversee investigations of all ALS incidents, examining causes, and possible solutions.

Recommend corrective actions to me, as well as reporting on the progress of their completion.

Provide updates to other interested ALS staff.

The first task will be to recommend implementation plans for the corrective actions on ALS radiation protection policies and practices put forward by the Radiation Safety Committee subcommittee. Also, recommend additional corrective actions and implementation plans, as warranted.

Membership of the committee is listed below. The ALS Deputy Division Director is an ex-officio member of the committee, and the ALS ESH Program Manager is available to assist the committee in current LBNL and ALS ESH policy, as well as investigation and causal analysis. At the organizational meeting the committee should choose the chair.

Thank you very much for your willingness to serve on this critical committee.

Dist: SMT
Committee Members:
D. Colomb
S. Jacobson
N. Kelez
M. Martin
H. Padmore
C. Ralston
A. Robinson
C. Steier
K. Woolfe