

# LAWRENCE LIVERMORE NATIONAL LABORATORY

Beryllium Related Events Cause Analysis

July 1, 2008

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Independent Analysis Report


Beryllium Related Events Cause Analysis

July 1, 2008

  
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- Attachment B – List of Reviewed Documents
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## **I. Executive Summary**

Lawrence Livermore National Laboratory (LLNL) has experienced five beryllium (Be) related events over the past eighteen months. LLNL management made a presentation to the Department of Energy's Office of Health, Safety, and Security, along with the Office of Enforcement on April 18, 2008. LLNL made a commitment during that presentation to conduct an "overarching" causal analysis of the Be events. The Manager of the Hazards Control Department is the point of contact (POC) chartering an independent team to conduct a causal analysis with the following expectations:

- Review all documents related to the subject events.
- Conduct a causal analysis relationship between the events.
- Determine root and contributory cause(s)
- Provide recommendations to address stated cause(s)
- Provide a written report to the POC no later than July 1, 2008

The Beryllium Related Events Cause Analysis Team (BRECAT) met at LLNL to conduct the analysis. Documents related to each of the events were reviewed. Interviews were held with knowledgeable line and functional organization personnel. Latent organizational weaknesses were identified from the independent causal analysis conducted for the events and from the interviews. Conclusions and Recommendation for each of the weaknesses were developed and are provided in detail in the report.

The BRECATEam found many cross-cutting issues among the five events reviewed. These issues were ultimately attributed to common weaknesses in the areas of work control and communications. Key factors contributing to these two areas of weakness included:

- Lack of or inadequate R2A2s
- Reliance on less formal work control processes to augment broad scoped IWSs
- Lack of management work activity awareness/presence
- Lack of rigor in work control documents
- Non-conservative application of controls
- Poor task-level identification leading to compromised hazard analyses
- Over-reliance on informal communications, verbal and vague e-mails
- Poor hand-off of information when changing-out personnel

The key causal factors identified during the review of the Be events have the potential for impacting a wider range of activities and associated hazards that are administered by the work control and communication processes.

## **II. Introduction**

Lawrence Livermore National Laboratory (LLNL) has experienced five beryllium (Be) related events over the past eighteen months. LLNL management made a presentation to the Department of Energy's Office of Health, Safety, and Security, along with the Office of Enforcement on April 18, 2008. LLNL made a commitment during that presentation to conduct an "overarching" causal analysis of the Be events. The Manager of the Hazards Control Department (POC) chartered an independent team to conduct a causal analysis with the following expectations:

- Review all documents related to the subject events.
- Conduct a causal analysis relationship between the events.
- Determine root and contributory cause(s)
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- Provide a written report to the POC no later than July 1, 2008

The team is known as the Beryllium Related Events Causal Analysis Team (BRECAT) and a copy of the charter is contained in Attachment A. Documents related to the five events were reviewed prior to conducting the on-site portion of the analysis. Other documents were reviewed on-site as they were subsequently identified. A complete listing of all documents reviewed is contained in Attachment B. The team met at the Laboratory and conducted the on-site portion June 9, through June 13, 2008. The team conducted interviews with LLNL line and technical managers and Industrial Hygiene personnel. A listing of interviewed personnel is contained in Attachment C. These interviews were conducted to confirm and/or supplement the information contained within the written reports and documents that were reviewed during the analysis process. The interviews also provided clarification where information was missing or not completely understood.

### **III. Description of Events**

The following is a brief description of the five Be related events.

#### **A. Site 300 Contained Firing Facility Training Inconsistencies**

The LLNL ES&H Assurance Office conducted an independent assessment of implementation of the Laboratory Chronic Beryllium Disease Prevention Program. The results of the assessment identified three findings and one concern that identified significant inconsistencies among institutional training records, hazards assessment documents, and work control documents governing activities involving both beryllium and radiological materials (i.e., uranium). Specifically, the Hazard Assessment and Control Forms (HACs) did not specify the required fit testing and training courses. Records were not available to document that eight of twenty-eight workers listed in the HACs had completed required respirator fit testing and/or training courses for the types of respirators they are either required or allowed to use for work activities in a regulated beryllium area. One of the workers was found to be performing activities and using a respirator inside the Contained Firing Facility Chamber while it was a regulated beryllium area had not completed the required respirator fit testing and training courses. Two other workers performing similar work activities on the same date at that location had not completed the required "beryllium radiation" training course. Finally, only eleven of the twenty-eight workers listed in the HACs are listed in the Integration Work Sheet (IWS) covering those activities in a regulated beryllium area.

#### **B. B695 Unexpected Be Contamination**

A modification was being made to the ductwork in Building 695 Decontamination and Waste Treatment Facility. Although prior work activities in this building had generated airborne and surface levels of removable beryllium contamination, but the room had been swiped and released from beryllium work controls. The extent of the work was not communicated to the qualified health and safety staff member therefore no beryllium evaluation was conducted of the multiple pieces of duct work prior to work. A section of the duct work to be transferred was swiped for "free release" by an H&S technician, but the swipes were for radioactive contamination only. The piece showed no radiological contamination. It was assumed that because the room was cleared for beryllium there was no beryllium on or in the ducting. The piece of removed ducting was taken to the sheet metal shop where the major piece was modified and scraps were placed in a salvage bin. Approximately one week after the work was completed swipe surveys for beryllium identified contamination on multiple pieces of the same duct system in the room revealed results above the

release limit, however, the piece that was modified had swipe results below the release limit.

#### C. B321C MTS Unprotected Be Exposure

Machine Tool Services (MTS) personnel had been tasked to remove workbenches, cabinets, and several machine tools from Room 1437 in B321C in preparation for a follow-on decontamination project to be performed by the Space Action Team (SAT). Workers were instructed via language in the Hazards Assessment and Control (HAC) document that if any dust were present, to pause the work process and contact an identified shop person. Some tasks not specifically identified in the HAC (e.g., pulling wires from under the floor in Walker ducts) were performed without being first assessed by the ES&H Team 3 Industrial Hygienist (IH). Neither the IWS nor HAC specifically identified pulling wires out of Walker ducts as part of the work scope. The HAC required respiratory protection for activities that included disconnecting or removal of system with known or anticipated internal contamination. The HAC indicated if there was no visible dust present, the use of respirators was voluntary but the presence of dust demanded the use of respiratory protection. MTS work was paused when a report of an airborne exposure of  $0.25 \mu\text{g}/\text{m}^3$  (8-hour time weighted average) to an unprotected employee was disclosed. This is above the DOE action level of  $0.20 \mu\text{g}/\text{m}^3$  but below the Permissible Exposure Limit of  $2.0 \mu\text{g}/\text{m}^3$ . The exposure was found to be a result of one or both of the following tasks:

1. Disassembly of machine tool control boxes for waste segregation purposes, and/or
2. Performing electrical disconnects of machine tools by accessing and performing work within Walker ducts.

An IH report clearly states exposed worker indicated surfaces of items and areas has a visible layer of dust. Both IH and supervisors confirmed the presence of dust on external machine surfaces. Workers indicated that dust presence was minimal.

#### D. B321C GSE Uncontrolled Be Work

An LLNL subcontractor, GSE Construction Co., began the Engineering Technology Center Upgrade (ETCU) Project to update and renovate portions of Building 321C. Building 321C has over 50 years of history with beryllium associated work and was listed a beryllium work area under the Chronic Beryllium disease Prevention Program (CBDPP). The initial hazard analysis during the ETCU work did not indicate beryllium



contamination. Subsequent to the beginning of the ETCU work, LLNL repeated the baseline beryllium survey for the entire Lab, but using wet sampling methods instead of dry. The resurvey of the 321 complex began as the ETCU project was being completed. This survey indicated the presence of beryllium surface contamination above release criteria in select areas of B321C. None of the subcontract workers were enrolled in the LLNL CBDPP, therefore none of the precautions (i.e., training, PPE, medical surveillance, etc.) were taken. The fact that LLNL did not know if these workers were exposed to beryllium contamination is a violation of the LLNL CBDPP. All employees who have been exposed to beryllium in the course of their ETCU work have been enrolled in the beryllium medical surveillance program. It is possible that unprotected workers in this building were exposed to beryllium for years.

E. BeLPT Notification Delay

LLNL implemented a program to offer current and former beryllium workers medical surveillance consistent with the provisions of 10 CFR 850. The purpose of the program is to ensure that all beryllium workers are offered beryllium examinations and that only the testing elected by each worker is performed and workers and managers are provided timely results. Employees are required to be notified of results indicating beryllium sensitivity within 10 days of receipt of such results. Health Services Department determined that the test results should be handled in a manner different than the normal test tracking protocol. The initial procedures for implementation were never committed to writing. "Normal" test results were given to a beryllium point of contact (BePOC) and communicated to the employee. "Abnormal" test results were given to the BePOC and communicated to the employee who was given options for retesting and split sample further analysis. Employees are to be notified within 10 days for abnormal test results. The responsibilities for administering and managing were transferred over time to new clinicians who passed off some responsibilities to a Medical Assistant in violation of statutory requirements. Components of the program and the respective responsibilities of the support staff were not communicated in writing. A clinician discovered Beryllium Lymphocyte Test (LPT) results for 9 separate employees whose results were past the 10 day deadline and that had not been communicated to the BePOC or the employee in a locked file cabinet. Five of these employees were sensitized.

#### **IV. Analysis Approach**

Each of the events except the B321C MTS event had a root cause analysis performed. A root cause analysis for the B321C MTS event was in process at the time of this review and analysis. The results of these causal analyses were considered in this analysis along with interviews of key personnel associated with each of the events. Additional documents associated with the 5 events were reviewed to provide the basis for the requirements and subject activities. All of the reviewed documents are listed in Attachment B. The personnel interviewed provided a perspective which may or may not have been reflected in the previous causal analyses and existing documentation that was reviewed.

This analysis considered the technical beryllium aspects associated with the 5 events including some programmatic aspects. This was not a comprehensive assessment of the beryllium program, but rather a review of the causes of the individual events to uncover common causes.

This analysis was performed to identify those "common cause" programmatic and institutional causes and/or weaknesses associated with the 5 events. Common Causes did not have to be present in all of the 5 events just a predominance across the 5 events. The approach was to tabulate the causes identified in the causal analysis for each of the events and causes identified as through a review of the additional documentation and personnel interviews. The tabulating used the DOE cause analysis tree level nodes contained in DOE G 231.1-2, *Occurrence Reporting Cause Analysis Guide*. A table of cause codes was developed and areas with common causes were analyzed by the team. Cause codes with few causes identified were not separately analyzed and included in the results.

## V. Analysis Results

### A. Beryllium Technical Analysis

The review of potential beryllium technical and programmatic issues associated with the 5 events was performed. This review was primarily performed by the beryllium subject matter expert participating on the team. The results of this review are as follows:

- A detailed assessment of the LLNL CBDPP was beyond the scope of the causal analysis
- The review that was conducted of the LLNL CBDPP revealed that all elements of 10 CFR 850 are present
- The incidents reviewed did not identify deficiencies in the CBDPP or resulted from a lack of required elements
- However, the implementation of the LLNL Beryllium Program is adversely affected by issues identified in this causal analysis

### B. Common Cause/Latent Organizational Weakness Analysis

The causal factors for the beryllium related events were taken from the completed causal analysis for four of the five events. These factors were substantiated through interviews with key facility and program personnel. Additional factors were identified during the interview process. The results of the tabulation are presented in Table 1 below (Note: codes are presented numerically and not by level of significance.)

**Table 1 – Cause Codes Tabulation**

Title	Written Cause (some are specific to the incidents, others are generic)	Cause Code
S300 Training	Short cutting work Auth LTA	A3B2C4
B321C GSE	Procedure not followed	A3B3C6
B321C MTS	HAC requirements not followed	A3B3C6
B321C GSE	Informality of communication	A4B1C1
B321C GSE	Lack of issue elevation	A4B1C1
B321C GSE	Procedure not followed	A4B1C1
B321C MTS	HAC requirements not followed	A4B1C1
B695 Duct Work	Inconsistent work control (levels applied)	A4B1C1
B695 Duct Work	Informality of communication	A4B1C1
CDBPP	Mgt. Oversight LTA	A4B1C4
B321C MTS	Supv. Oversight LTA	A4B1C4
B695 Duct Work	Mgt. Oversight LTA	A4B1C4

Be LPT Reporting	Mgt. Oversight LTA	A4B1C4
S300 Training	Mgt. Oversight LTA	A4B1C4
B321C GSE	Lack of LL follow-up	A4B1C6
B695 Duct Work	Elevated surfaces not swiped	A4B1C6
B321C GSE	Clear R2A2s LTA	A4B1C7
Be LPT Reporting	R2A2 LTA	A4B1C7
S300 Training	R2A2 LTA	A4B1C7
Be LPT Reporting	No Records Mgt. procedure	A4B2C6
Be LPT Reporting	Inadequate Reporting Procedure	A4B2C6
S300 Training	Doc Control LTA	A4B2C6
B321C GSE	Information hand off during personnel change LTA	A4B2C7
B695 Duct Work	Information hand off during personnel change LTA	A4B2C7
Be LPT Reporting	Skills, knowledge & ability	A4B2C9
B321C GSE	Hazard analysis LTA	A4B3C11
B321C GSE	Hazard Control LTA	A4B3C11
B321C GSE	Work auth docs LTA	A4B3C11
B321C MTS	Implement of work control LTA	A4B3C11
B321C MTS	Hazard not fully ID'd	A4B3C11
B695 Duct Work	Inadequate work planning (no work permit)	A4B3C11
B695 Duct Work	Review of hazards LTA	A4B3C11
S300 Training	HAC & IWS Work Control LTA	A4B3C11
S300 Training	HAC not tied to L-Train	A4B3C11
B321C MTS	IWS scope not include walker duct	A4B3C6
B321C GSE	Hazard analysis LTA	A4B3C8
B321C GSE	ID of Be worker LTA Note: As GSE decided not to perform beryllium work, there were no beryllium workers identified.	A4B3C8
B321C MTS	Hazard not fully ID'd	A4B3C8
B695 Duct Work	Review of hazards LTA	A4B3C8
B695 Duct Work	Elevated surface not swiped	A4B3C8
B321C MTS	Mgt. Oversight LTA	A4B4C4
B695 Duct Work	Supv. Oversight LTA	A4B4C4
S300 Training	Supv. Oversight LTA	A4B4C4
Be LPT reporting	Skills, knowledge & ability	A4B4C9
B321C GSE	Less conservative sampling strategy	A4B5C4
Be LPT Reporting	Staff Turnover	A4B5C4
Be LPT Reporting	Training was inadequate	A4B5C8
B695 Duct Work	Confusion on terminology (e.g. free release accessible) Note: "Free Release is not a term defined in 10 CFR 850, nor is it used	A5B1C7

	in ES&H Document 14.4.	
B321C GSE	Informality of comm.	A5B2C5
B321C MTS	Comm. of controls LTA	A5B2C5
B321C MTS	Email results sent/not understood	A5B2C5
S300 Training	HAC Policy and Procedure LTA	A5B2C5
B695 Duct Work	Maint. Manual Inadeq.	A5B2C8
B321C GSE	Written info sent/not understood	A5B3C2
B321C GSE	Timely comm. LTA	A5B3C2
B321C GSE	Comm between work groups LTA	A5B4C1
B321C MTS	Comm between work groups LTA	A5B4C1
B695 Duct Work	Comm between working groups LTA	A5B4C1
Be LPT Reporting	Training was inadequate	A6B1C2

The team took the common cause code groupings as shown above in Table 1 and analyzed the causes. Again, not all of the identified codes were subjected to analyses. The individual cause groupings are listed below for each area considered to be a latent organizational weakness. The team drew one or more conclusions for each of the groupings based on the commonalities of causal groupings and significant findings. Recommendations were then developed for addressing the conclusions following the conclusions for each group.

The use of alternate work control processes to augment the institutional IWS was identified in three of the five events reviewed. The authorized IWS in all three cases had a very broad scope encompassing numerous activities/tasks. Additional work control process (e.g., HACs and work permits) were employed to augment the IWS at the work level. Interviews clearly indicated that these processes are more heavily relied-upon to direct work activities than the IWSs. These IWS alternative processes are unfortunately not as rigorously managed as the institutional IWS process presenting inconsistencies in implementation and more limited (localized) review/concurrence.

Two of the five events demonstrated the importance of having processes in place to transfer information when replacing personnel. The movement of five or more people was involved with a heavy reliance on verbal transfer of information resulting in incomplete communications or the need to re-create missing information in both cases.

Some level of inadequate management oversight or involvement in the work activities was noted across all five events. Management was completely unaware of the issues leading up to the event in extreme cases. On-going management/maintenance of process was found lacking in other cases.

Break-downs in communication of task specific information were significant contributions in two of the five events. The lack of specific task detail prevented the thorough hazards analysis of activity hazards that would have resulted in the

implementation of more conservative controls that could have potentially prevented the events.

The R2A2s issues directly contributed to all five events. The absence of written R2A2s in one event had a direct impact to the occurrence of the event. Responsibilities became confused and incorrectly propagated after numerous personnel changes unbeknownst to all levels of management. Some aspect of R2A2s was compromised in the other events where well defined and documented R2A2s could have mitigated or eliminated the occurrence.

Detailed causal factors for latent organizational weaknesses groupings are presented by their subject area and DOE Cause Code. A causal summary matrix is provided in Attachment D.

## **B.1 WORK CONTROL - A4B3C11 (Inadequate Work Package Preparation)**

### GSE Hazards Analysis LTA

- Potential for legacy Be contamination was addressed in initial ETCU project execution plan. However, it was not addressed in the hazard analysis.

### GSE Hazard Controls LTA

- GSE personnel working in upper strata environments of B321C were not identified as Be workers and so were not included in the LLNL CBDPP and subject to the appropriate Be work controls. Note 1: Renovation of contaminated facilities is not an authorized activity under the CBDPP. Note 2: As GSE declared that they did not perform beryllium work, identification was a moot point.

### GSE Work Authorization Documents LTA

- IWS scope did not address potential Be hazards in non-work process areas. The hazards analysis/IWS was not updated to incorporate the upper strata Be contamination lessons learned from the North Las Vegas Be investigation.

### MTS Implementation of Work Controls LTA

- Work was not stopped nor the IH consulted when visible dust was observed, as required by the HAC (It should be noted that there was subsequent confusion on the amount of dust present.)
- HAC-required controls (mandatory and voluntary use of respirators) were not properly implemented.
- Inconsistent conservative application of controls between SAT (conservative application of respiratory controls) and MTS personnel (less conservative) working in same work areas.
  - o ES&H IH graded input to MTS management not conservative enough to adequately control hazards.

- MTS decision to implement conservative respiratory protection requirements was not applied in a timely enough manner to adequately control hazards.

#### MTS Hazards not fully identified

- All aspects (task break-out) of the work activity were not adequately identified and subject to the hazards analysis process (i.e., Wire pulling from the Walker Duct.)

#### B695 Work Planning LTA

- No work permit was generated to address the removal of the duct.
- Scope of the established RHWM work permitting process only applied to work performed by non-RHWM personnel. This resulted in the duct removal work being reliant on a broad-scoped IWS as the work activity work control document.
- Scheduled work planning walk-down of the duct removal was not performed.

#### B695 Review of Hazards LTA

- IWS did not address working with Be contamination on elevated surfaces. The hazards analysis/IWS did not reflect the upper strata Be contamination lessons learned from the North Las Vegas Be investigation, or from LLNL experience in B231 and B 321C.
- The ES&H Team was not notified of the duct removal activity. This resulted in the lack of a real-time hazards analysis of the duct removal activity.

#### S300 Training Inconsistencies

##### Work Control (HAC & IWS) LTA

- HACs are not subject to the same level of review as an IWS. HAC generally only document review by an IH or IS.
- HAC and IWS controls were not always consistently identified. Errors were noted in HACs where IWS-prescribed training requirements were inaccurately listed in the HACs.

##### HAC not tied to L-TRAIN

- HAC-specific controls were not captured in the IWS and links to institutional tracking tools (e.g., L-TRAIN).
- HAC-required training tracked using two separate training tracking tools (i.e., L-TRAIN).

#### CONCLUSIONS

- Various methods of work controls (i.e., HACs, Work Permits, IWSs) not consistently applied/implemented across the institution.

- Compliance with established work control processes is not being consistently met.
- HAC is improperly used as an institutional work control tool. In other words, HACs are referenced in the ES&H Manual but not specifically addressed as a formal institutional work control document.
- Reliance on overly-broad IWS scope descriptions has resulted in inadequate work planning (e.g., hazards identification) and review (e.g., hazards analysis.)

## RECOMMENDATIONS

- Evaluate the use of HACs as a valid institutional work control tool for identifying multiple hazards and controls.
- Clarify the proper use of IWSs as a work control tool and promulgate clear instructions for its applications.
- Establish an institutional policy that line management will ensure that institutional work control process is followed.
- LLNL Senior Management to provide guidance on work groups to review their IWSs for examples of overly broad scopes and to revise them with enough detail to allow for the assignment of sufficient controls.

### **B. 2. HAZARDS ANALYSIS PROCESS - A4B3C8 (Frequent job or task shuffling)**

#### GSE Hazards Analysis LTA

- Potential for legacy Be contamination was addressed in initial ETCU project execution plan. However, it was not addressed in the hazard analysis.

#### GSE identification of Be Worker LTA

- GSE personnel working in upper strata environments of B321C were not identified as Be workers and so not included in the LLNL CBDPP. Note: As GSE declared that they did not perform beryllium work, identification was a moot point.

#### MTS hazards not fully identified

- The hazards analysis process was compromised by not providing the IH with the needed task-level detail to properly identify all hazards and controls.

#### B695 review of hazards LTA

- Project planning did not include ES&H Team review for hazards identification
- Project planning did not include potential for Be contamination at elevated surfaces.

## CONCLUSIONS



- Hazards identification process is not fully effective in identifying hazards prior to work being performed.
- Lessons Learned are not being incorporated into hazards analysis process.
- The use of broad work scopes in work control documents do not allow for a full identification of analysis of the hazards.

#### RECOMMENDATIONS

- Revise hazards analysis process to require:
  - o identification and evaluation of hazards down to the task level and
  - o incorporation of relevant lessons learned into hazards identification
- Ensure that work control/work planning processes include a review by qualified personnel, specifically members from HCD.

#### **B. 3. Management & Supervisory Oversight - A4B1C4 (Management follow-up or monitoring of activities did not identify problems) & A4B4C4 (Direct supervisory involvement in task interfered with overview role.**

##### CBDPP Management Oversight LTA

- CBDPP management did not elevate program implementation issues to senior management for their attention.

##### MTS Management oversight LTA

- Work controls employed by MTS Project management and ES&H Team disciplines were not conservative enough to adequately control the Be hazards associated with the MTS activities.
  - o MTS application of HAC-required controls were not adequate to control the Be hazards.
  - o MTS decision to implement conservative respiratory protection requirements was not applied in a timely enough manner to adequately control hazards.

##### B695 Duct Work Management oversight LTA

- B695 management improperly utilized a work control process which failed to ensure that ES&H Team discipline review of the duct removal work was evaluated prior to work being performed.

##### Site 300 Training Management oversight LTA

- Line management did not ensure that HAC-identified training was being captured in the institutional database (i.e., LTRAIN).
- Line management did not ensure that HAC content (which was more detailed than the IWS) was included in the approved work authorization document.

#### CONCLUSIONS

- Management risk decisions are not conservative enough to adequately address consequences of hazards present (i.e., did not employ a questioning attitude or consider worst case scenarios).
- Management does not have the adequate presence in the field/facilities to ensure work activities are meeting their expectations.

#### RECOMMENDATIONS

- Senior management needs to establish clear expectations and guidelines for making appropriate risk decisions to control hazards.
- Line management needs to increase their presence and oversight of work activities.

#### **B.4 R2A2s Implementation LTA - A4B1C7 (Responsibility of personnel not well-defined or personnel not held accountable)**

##### GSE Implementation of R2A2s LTA

- Ineffective implementation of the CBDPP roles and responsibilities.
- CBDPP Manager has an "Unofficial" status.

##### BeLPT Implementation of R2A2 LTA

- R2A2s for the BePOC were not documented or clearly defined.
- Health Services Department personnel drawing blood and handling testing results were not provided with written R2A2s.
- R2A2s for the Medical Assistants were not appropriate (too much responsibility and authority assigned)

##### S300 Training Implementation of R2A2s LTA

- Responsibility for implementation of PIM 93 is not clear.
- Responsibility for review and concurrence with HACs is not clear.
- Responsibility for ensuring that subcontractor personnel are trained, qualified on beryllium and are in an approved monitoring program is not assigned.

#### CONCLUSIONS

- Inconsistent use of documented job/function responsibilities (varies among directorates)
- Some jobs/functions are lacking documented R2A2s
- Existing documented R2A2s are not task specific
- Lack of institutional process for establishing qualifications for some job positions/functions
- Division of responsibilities (DOR) between Beryllium program direction and ES&H Team disciplines implementation needs clarification and strengthening

## RECOMMENDATIONS

- Perform an Extent of Condition Review across the Institution to identify situations where positions or titles have been assigned for which R2A2s or position descriptions are not clearly defined
- For common job functions that exist at the directorate level, ensure that, where applicable, the same R2A2s are used to ensure consistent expectations.
- For existing R2A2s, ensure that the necessary level of specificity exists to clearly identify task-specific elements, rather than just generically describe a job description. This may entail delineating R2A2s at the individual level, rather than merely for a role.

### **B. 5 Communications LTA - A5B2C5 (Ambiguous instructions/requirements) & A5B4C1 (Communications between work groups less than adequate)**

- Excessive use of informal communications (i.e., use of e-mails where formal memos are needed)
- Inadequate of communication between work groups
  - o Timely communication of significant issues
- Need for clear and concise guidance with documentation (i.e., memos to programs, etc.) Significant issues or guidance should be clearly stated early in the memo and not buried behind data.
- Turnover of staff resulting in handoff of information problems

## CONCLUSIONS

- Formality of communications was found not consistent with the level of follow-up expectations.
  - o Significance information was commonly provided through informal e-mails without indication of significance or expectation for follow-up which resulted in missing or lack-luster follow-up responses.
- Information is not consistently being communicated in a clear objective manner between activity management and support groups (e.g., ES&H Teams).
  - o Significant information was provided through the use of formal reports but the significance was compromised through the use of "down-played" content ultimately resulting in a lack of robust follow-up response.
  - o Work scopes are not being communicated between work groups with adequate task-level detail to ensure adequate understanding and analysis.
- Significant issues are not being communicated to line/facility management in a timely enough manner to ensure prompt action.
  - o Management needs to be apprised of significant issues real-time
- Frequent change-out of personnel have resulted in poor hand off of key knowledge (i.e., information and responsibilities)

- Current hand-off processes are informal, inconsistent and at times non-existent
- Recent workforce restructuring efforts have the potential for magnifying this issue

## RECOMMENDATIONS

- Establish new or refine existing organizational policy/protocol to:
  - Clearly define expectations for grading level of formality to reflect level of significance of communications
  - Perform proper level of review prior to issuance to ensure consistency and clear communication of significance
  - Set expectation for timely communication of significant issues to affected management
- Establish institutional expectation for “day-of” worker discussions addressing specific task-level break-outs and associated hazards/control discussions
  - For start of new activities, ensure appropriate support oversight personnel are involved
- To address the broad scoped IWS issue, consider extending the newly revised IWS process task-break-out element to all IWS (not just support activities)
- Establish an institutional expectation for transfer of key information/records/R2A2s when personnel transfer out of positions

### **B. 6. Procedures and Records LTA - A4B2C6 (Means not provided to assure procedures/documents/records were of adequate quality and up-to-date)**

#### BeLPT Records Management Inadequate

- Records management and procedures are inadequate to provide quality and process control

#### B695 Records Management Inadequate

- Records management and procedures are inadequate to provide quality and process control

#### Overall HAC Revision Control

- Procedures controlling HAC revisions are inadequate to provide quality and process control

## CONCLUSIONS

- Lack of an established information transfer process has resulted in the reliance on ad-hoc, inconsistent management of important information and records
  - Management of important records has been left up to individuals resulting in loss of or incomplete transfer of “corporate” knowledge

- Procedures used to direct activities were ineffective
  - o Quality of procedures were inadequate in their content
    - Ambiguous content (e.g., unclear mixture of requirements and guidance – HAC Policy Implementation Manual)
    - Incomplete content - not all relevant activities included (e.g., RHWM Maintenance Manual and HSD BeLTP procedure)

#### RECOMMENDATIONS

- Establish institutional information/record management direction addressing personnel transfer/succession
- Require management assessment of activity procedures to ensure their completeness and effectiveness

#### VI. SUMMARY

The conclusions and recommendations contained in this report were based on the causes of a series of beryllium events. These causes when analyzed collectively have led to a number of latent organizational weaknesses. The same weakness could be identified by analyzing radiation protection or lead incidents or any other hazardous process. Most of the weaknesses identified are not new to LLNL. Majority of these deficiencies had been identified in previous independent assessment and corrective action plans. It is suggested that the recommendations contained in this report can be incorporated into current upgrades and improvement initiatives currently underway with the transition activities.

**Attachment A - Beryllium Related Events Causal Analysis Team Charter  
Letter**

Interdepartmental letterhead

Mail Station L- 382

Ext. 3-7640

June 2, 2008

**To:** Distribution  
**From:** Richard C. Nugent  
**Subject:** Beryllium Related Events Causal Analysis Team (BRECAT)

---

**Beryllium Related Events Causal Analysis Team**

**Lead:** Al Wagner, BIA  
Burney Hook, SRS  
Jim Merrigan  
Warren Rued  
Tim Smith

The LLNS POC for this effort is Dick Nugent.

Over the past eighteen months, Lawrence Livermore National Laboratory (LLNL) has incurred five beryllium (Be) related events. These events are:

1. Uncontrolled Be work performed in B 321C.
2. Unexpected Be contamination found.
3. Notification of Be sensitized individuals not made in a timely manner.
4. Chronic Beryllium Disease Prevention Program training record inconsistencies found.
5. Unprotected exposure above the administrative level but, below the permissible exposure level during work in B 321.

LLNL management made a presentation to the Department of Energy's Office of Health, Safety, and Security, along with the Office of Enforcement on April 18, 2008. During that presentation, LLNL made a commitment to conduct an "overarching" causal analysis of events 1-4, above. As event #5 occurred after that commitment was made, we are including it, as well.



The BRERAT is expected to execute the following:

- Review all documents related to the subject events.
- Conduct a causal analysis relationship between the events.
- Determine root cause and related contributory cause(s).
- Provide recommendations to address stated cause(s).
- Provide written report to the POC no later than July 1, 2008.

The BRERAT will begin their review on June 9, 2008, with a draft report provided for factual accuracy on June 23, 2008.

LLNL will provide all supporting documents to team members. A full list of personnel for interview consideration is also being provided. Office and meeting space will be provided.

Deliverables:

1. Draft report submitted for factual accuracy - June 23, 2008
2. Close out meeting with selected attendees - June 20, 2008
3. Final report July 1, 2008

  
Richard C. Nugent, Manager  
Hazards Control Department

Distribution:

Fulton, George	L-379
Glauser, Hank	L-051
Houghton, Susan	L-003
Klineberg, Ed	L-379
Lane, Monya	L-123
Liedle, Steve	L-001
Macenski, Allen	L-510
McConnell, Steve	L-382
Merrigan, Jim	L-510
Nakahara, Dan	L-293
Perkins, Brian	L-546
Peterson, Barbara	L-001
Rauhat, Kathryn	L-701
Rued, Warren	L-051
Seward, Jim	L-723
Smith, Tim	L-384
Souza, Lori	L-090
Wagner, Alan	L-390



## **Attachment B – List of Reviewed Documents**

Certain of the documents listed were also reviewed as part of the beryllium technical and program review.

### Site 300 Training Incident

Contractor Assurance Office Lessons Learned, "Reanalyze Hazards in Your Work When New Information is Received", LL-2008-LLNL-03, UCRL-AR-403010, April 17, 2008

Memo to BRECAT from Richard C. Nugent, "Beryllium Events Causal Analysis Team (BRECAT)", June 2, 2008 – BRECAT Charter

LLNL Chronic Beryllium Disease Prevention Program (CBDPP) Implementation of 10 CFR 850, Revision 5.1, UCRL-AR-144636-Rev-5.1, September 24, 2007

HCD Analytical Laboratory Industrial Hygiene results report, STAR Batch: 20106342

### Site 300 Training Incident

"LLNL Training Record Inconsistencies Identified by Internal Assessment", Noncompliance Tracking System Report, NTS-LSO-LLNL-LLNL-2006-0026

"Extent of Condition and Causal Analysis Review of the HAC and IWS Interface", SEP-07-003, James Merrigan, June 1, 2007

"Activity-level Work Control", Decision Memorandum, CCB-DM-002, Rex Beach, September 19, 2007

"Corrective Action Plan (CAP) for the Chronic Beryllium Disease Prevention Program (CBDPP) Implementation Assessment – part 2 – (Be Program Pts)", LLNL ES&H Assurance Office (EAO), April 18, 2006

Hazard Assessment and Control Form, HAC-801-CFF-Be7U26.doc, David Zalk, Steve Keller, Preparation date August 22, 2005

### B695 Unexpected Contamination

"Unexpected Beryllium Contamination and Associated Ducting, Building 695", Noncompliance Tracking System Report, NTS-LSO-LLNL-LLNL-2008-0002

"Beryllium Contamination and Release of Beryllium Contamination Material Critique Report", 695-07-0001, rev. 4, Leah Pahler, December 10, 2007

"Beryllium contamination and release of beryllium Contamination material"  
presentation critique summary slides

"Radioactive and Hazardous Waste Management Division Building 695 Segment  
of the Decontamination and Waste Treatment Facility Causal Analysis and  
Extent of Condition Evaluation of the Beryllium", LLNL-AR-403561, Art O'Grady,  
April 11, 2008

Integration Work Sheet 10331.09, "Maintenance and repair of RHWM facilities  
and equipment"

#### BeLPT Notification Delay

"Medical Surveillance and Removal of the Chronic Beryllium Disease Prevention  
Program is LTA", Noncompliance Tracking System Report, NTS-LSO-LLNL-  
LLNL-2007-0022

"Analysis Report: BeLPT Notification Delay, Rev. 1", LLNL-AR-402850, Jan Tulk,  
et al, Revised April 24, 2008

"Health Services Department, LLNL/HSD Beryllium Medical Surveillance  
Program", James Seward, May 19, 2005

"Beryllium Medical Test/Exam Processing Procedure", CP-MS-BE-03, James  
Seward, January 31, 2008

#### B321C MTS

"Critique Review of the Unprotected Be Exposure of an Engineering Machine  
Tool Services Employee in B321C", ESH&Q-2008-059, James Merrigan, May 05,  
2008

Memo to Paul Dean from Ryan Kamerzell, "B321C/SMFF Baseline Beryllium  
Inventory Sampling Results", HCD-TD-T3-08-004, March 10, 2008

Letter to Camille Yuan-Soo Hoo from Steve Liedle, "Recent Beryllium Personal  
Air Sample Results for Machine Tool Services Work in B321C, Room 1437A,  
HCD-DO-08-073:RCN/ln, April 28, 2008

Hazard Assessment and Control Form, HAC-B321C Beryllium Decontamination  
and Consolidation, Ryan Kamerzell, March 31, 2008

Memo to John DeJonge, Pete Schoenberger and Dave Prokosch from Ryan  
Kamerzell, "Building 321C Beryllium Decontamination Project Air Sample Results  
from Machine Tool Services MTS), Special Materials Manufacturing Facility

(SMMF), and Hazards Control Department (HCD) Personnel from October 2007 to April 2008 (IWS 11434 and 14244)", HCD-T3-08-012, April 24, 2008

April 14, 2008 e-mail notification to exposed worker from ES&H Team IH documenting the exposure results and their previous discussions on potential exposure causes.

April 14, 2008 e-mail notification to HCD and IH Section management of B321C exposed MTS worker from ES&H Team 3 Deputy Team Lead.

Memo to Ms. Camille Yuan-Soo Hoo, NNSA LSO from Steven D. Liedle, LLNL Deputy Director "Recent Beryllium Personal Air Sample Results for Machine Tools Services work in B321C, Room 437A".

March 6, 2008 e-mail notification to facility owners (PADs, programs leads) and facility managers from Hazards Control Department Head providing direction on how to deliberately proceed in lieu of recent Beryllium contamination events.

"321C (Decontamination Period): Beryllium Personal Sample Results – September 2007 – April 2008" air monitoring sampling results plot.

Integration Work Sheet 11434.01, revision 49, "Machine Tool Services – installation, modification and service" and IWS change audit log

Integration Work Sheet 14244.01, revision 15, "Access to Special Materials Machining Facility and IWS change audit log

Note: IWS 14244.01 DOCUMENTS THAT MTS/TRED INITIATED MORE CONSERVATIVE WORK CONTROLS (100% RESPIRATOR PROTECTION)  
From change audit log:

This statement was added to the the scope of work:	Schoenenberger , P.	04/09/2008 11:41
Despite considerable air sampling data suggesting there is no reparable risk for general housekeeping work, workers are required to take the conservative approach with regards to PPE while moving, dismantling or disturbing equipment and or cabinets within Rm 1437. All TRED personnel that will be moving, dismantling or disturbing equipment within Rm 1437 shall wear respirators while performing this work. Donning and doffing the respirators should be done in the same area as other PPE is donned and doffed. If any worker is conducting work requiring a respirator, then anyone in the same room is also required to wear a respirator.		

B321C GSE

"The Implementation of the CBDPP is Inadequate – Uncontrolled Be Work Performed", Noncompliance Tracking System Report, NTS-LSO-LLNL-LLNL-2008-0005

"Independent Analysis Report: Uncontrolled Beryllium Work in B321C – 2007", ESH&Q 2008-0039, LLNL-AR-402614, Alfred Ogurek, et al, March 7, 2008

"Beryllium/B321C Independent Analysis Team Final Results – February 29, 2008" presentation slides, presented to LLNL Director and Deputy Director

"Beryllium/B321C Independent Analysis Team Final Results – April 7, 2008" presentation slides, presented to the NNSA Laboratory Site Office, ESH&Q-2008-047

"Beryllium/B321C Independent Analysis Team Final Results – April 24, 2008" presentation slides, presented to Facility Management All-Hands, ESH&Q-2008-053

ES&H Manual, Document 14.4, "Working Safely with Beryllium", June 21, 2007

Hazards Control Department Occupational Health & Safety Section "Summary Findings of the Building 321 Verification Survey" report dated July 12, 2007. Report addressed from George Fulton, CIH, Beryllium Program Manager to Paul Dean, Building 321 Manager

Engineering 320 Block Facility Safety Plan Appendix A: Building Diagrams – Figure 4, Building 321C – First Floor

#### Other Documents

LLNL PIM 91: IH Surface Contamination Sampling ("Swipe Sampling") for Beryllium

Total Beryllium by ICP-AES with Microwave Digestion

Elements by ICP-AES Using Microwave Digestion

**Attachment C – Personnel Interviewed**

Ed Klinenberg, IH Section Leader

Gordon Krauter, 300 Area Facility Manager

Paul Dean, Building 321 Facility Manager

Ryan Kamerzell, ES&H Team 3 Industrial Hygienist

John DeJonge, MTS Supervisor

Donna Mailhot, 695 RHWM

John Bowers, Group Leader RHWM

Ed Baylosis, ES&H Team 1 Industrial Hygienist

Kathleen Noonan, Operations Division Leader (Deputy Department Head at time of event)

Jeff Freeman, IA Member

George Fulton, Industrial Hygiene Subject Matter Expert, Beryllium

# Attachment D – BRECAT Causal Summary Matrix

	<b>GSE Event B321C</b>	<b>MTS Event B321C</b>	<b>BeLPT Event HSD</b>	<b>Duct Event B695</b>	<b>CFF Training Event S300</b>
<b>A. Work Control</b>	<p>- ETCU Project Management – Legacy Be contamination was not addressed as in hazard analysis.</p> <p>- Engineering Directorate – Governing IWS did not address Be contamination at upper strata as a potential hazard.</p> <p>- ES&amp;H Team – Discipline review of IWS did not identify Be contamination at upper strata as a potential hazard.</p> <p>- Institutional – GSE workers working in the upper strata of</p>	<p>- MTS Management / ES&amp;H Team - Established work controls (HAC controls) were not implemented in a conservative manner to adequately control the Be hazards associated with the MTS activities.</p> <p>- MTS – Incomplete task identification compromised the ability to perform adequate hazards analysis resulting in inadequate work controls.</p> <p>- MTS – Use of overly-broad IWS resulted in</p>	<p>- HSD - Relied upon work controls (procedures) did not provide adequate level of direction to ensure proper task execution.</p>	<p>- RHWM – Use of broad-scope IWS resulted in reliance of work permit as workplace work control document. Work permit not consistently applied to all work activities (performed by RHWM versus non-RHWM personnel).</p> <p>- RHWM – Authorized IWS did not address Be contamination at upper strata as a potential hazard.</p> <p>- ES&amp;H Team – Discipline review of IWS did not identify Be contamination at upper strata as a potential hazard.</p> <p>A.D.4 - RHWM – Failed to employ</p>	<p>- CFF – Use of broad-scope IWS resulted in reliance of HAC as workplace work control document. HAC not subject to same level of review/concurrence as IWS.</p> <p>- Institutional – HAC and IWS are institutional work control documents commonly used, but their levels of review/concurrence are inconsistent.</p>

# Attachment D – BRECAT Causal Summary Matrix

	<p>B321C were not identified as Be workers within the CBDPP and were not subject to appropriate Be work controls.          Note: GSE made a determination that they would not perform beryllium related work.</p>	<p>reliance of HAC as workplace work control document. HAC not subject to same level of review/concurrence as IWS.          - Institutional – HAC and IWS are institutional work control documents commonly used, but their levels of review/concurrence are inconsistent.</p>		<p>ES&amp;H Team task/work place review of activity prior to performing task</p>	
<p><b>B. R2A2s</b></p>	<p>- HCD – Ineffective implementation of CBDPP and ES&amp;H Team (IH) roles and responsibilities relative to communication, elevation, and response to elevated</p>	<p>- MTS/ ES&amp;H Team – Ineffective implementation of MTS management and ES&amp;H Team (IH) roles and responsibilities to ensure adequate level of controls are applied at the</p>	<p>- HSD – R2A2s are not adequately defined, written, or communicated for the BePOC and Medical Assistants.          - HSD – Ineffective implementation of HSD management oversight roles and responsibilities for</p>	<p>- RHWM – Ineffective implementation of management oversight roles and responsibilities to ensure proper ES&amp;H work place review prior to commencing work.</p>	<p>- CFF – Responsibility for ensuring subcontractor training current LTA          - HCD - PIM 93 implementation responsibility not clear          - HCD - HAC</p>

# Attachment D – BRECAT Causal Summary Matrix

	monitoring data.	work place to effectively control Be hazards.	ensuring proper implementation of the BeLPT reporting process.		review/concurrent responsibility not clear
<b>C. Hazards Analysis</b>	<p>- ETCU Project Management – Legacy Be contamination was not addressed in hazard analysis.</p> <p>- Institutional – GSE workers working in the upper strata of B321C were not identified as Be workers within the CBDPP and were not subject to appropriate Be work controls.</p> <p>Note: GSE made a determination that they would not perform beryllium related work.</p>	<p>- MTS – Incomplete task identification compromised the ability to perform adequate hazards analysis resulting in inadequate work controls.</p>	No issue identified	<p>- RHWM– Authorized IWS did not address Be contamination at upper strata as a potential hazard.</p> <p>- ES&amp;H Team – Discipline review of IWS did not identify Be contamination at upper strata as a potential hazard.</p> <p>- RHWM – Failed to ensure ES&amp;H Team discipline review of the task/work place was conducted prior to performing task.</p>	No issue identified



## Attachment D – BRECAT Causal Summary Matrix

<p><b>D. Management Oversight</b></p>	<p>- CBDPP management - Failed to elevate implementation issues to upper management for their attention</p>	<p>- MTS Management/ ES&amp;H Team - Established work controls (HAC controls) were not implemented in a conservative manner to adequately control the Be hazards associated with the MTS activities.</p>	<p>No issue identified</p>	<p>- RHWM – Failed to ensure ES&amp;H Team discipline review of the task/work place was conducted prior to performing task.  - RHWM – Failed to ensure scheduled walk-down of the task/work place was conducted prior to performing task.</p>	<p>- CFF – Failed to ensure HAC-identified training requirements were being captured in the institutional training database (LTRAIN)  - CFF – Failed to ensure HAC content was properly captured in the work authorization document (IWS).  - HCD – HAC use not integrated into institutional IWS/LTRAIN process</p>
<p><b>E. Communications</b></p>	<p>- HCD – Informality of communications (vague e-mails) was not appropriate for the significance of the information being</p>	<p>- MTS - Work scopes were not communicated between work groups (MTS and ES&amp;H Team) with appropriate task-level detail to ensure adequate</p>	<p>- HSD – BelPT results were not communicated to affected workers in a timely manner.</p>	<p>- RHWM - Work scopes were not communicated between work groups (RHWM and ES&amp;H Team) with appropriate task-level detail to ensure adequate</p>	<p>No issue identified</p>

# Attachment D – BRECAT Causal Summary Matrix

<p>communicated.</p> <ul style="list-style-type: none"> <li>- HCD – Significant information was not communicated to affected management in a timely manner.</li> <li>- HCD – Monitoring reports communicated results in a conflicted and mis-leading manner.</li> <li>- HCD – Communication and information transfer between personnel moving between assignments was informal and at times non-existent.</li> </ul>	<p>understanding and follow-up analysis.</p>	<p>understanding and follow-up analysis.</p>	<p>understanding and follow-up analysis.</p>
<p><b>F. Procedures &amp; records</b></p>	<p>- HCD – Multiple change-out of IHs/ Team Leads</p>	<p>- HSD - Relied upon procedures did not provide</p>	<p>- RHW – Procedure (Maintenance 93) was written in</p>

# Attachment D – BRECAT Causal Summary Matrix

	<p>resulted in loss of transfer of information, including records.</p>		<p>adequate level of direction to ensure proper task execution.                      - HSD – Multiple change-out of Drs/ Med Assts resulted in loss of transfer of information, including records.</p>	<p>Manual) was incomplete in applying its work permitting process to work solely performed by non-RHWM personnel.</p>	<p>a manner the provided vague, ambiguous, and unclear direction.</p>
--	------------------------------------------------------------------------	--	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------