



Department of Energy
Under Secretary for Nuclear Security
Administrator, National Nuclear Security Administration
Washington, DC 20585



September 25, 2014

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Dr. William H. Goldstein
Laboratory Director
Lawrence Livermore National Security, LLC
Lawrence Livermore National Laboratory
7000 East Avenue
Livermore, California 94550

WEA-2014-03

Dear Dr. Goldstein:

This letter refers to the Department of Energy's (DOE) investigation into the facts and circumstances related to the sulfuric acid burn event at Lawrence Livermore National Laboratory, Site 300, building 827D. The event occurred on February 12, 2013, during the chemical synthesis of a high explosive. The results of the investigation were provided to Lawrence Livermore National Security, LLC (LLNS) in an investigation report dated November 20, 2013. An enforcement conference was held on February 11, 2014, with LLNS representatives to discuss the report's findings and LLNS's response. A summary of the conference and list of attendees is enclosed.

The National Nuclear Security Administration (NNSA) considers the sulfuric acid burn event to be of high safety significance. During the event, three workers in the vicinity of the high explosive synthesis operation experienced inhalation and dermal exposures when the contents of a 100-liter reaction vessel sprayed into the work area. The two employees who were closest to the reaction vessel addition port experienced first- and second-degree burns on areas of the face, extremities, and torso from a direct acid splash. The third employee was exposed to sulfuric acid mist but suffered no visible injuries. The event revealed deficiencies in work planning and control processes, emergency response, industrial hygiene, management responsibilities, and pressure safety.

Based on an evaluation of the evidence in this matter, NNSA has concluded that violations of 10 C.F.R. Part 851 (Part 851), *Worker Safety and Health Program*, by LLNS have occurred. Accordingly, NNSA is issuing the enclosed Preliminary Notice of Violation (PNOV), which cites four Severity Level I violations and two Severity Level II violations. In recognition of the \$365,000 contract fee reduction levied on LLNS by the Livermore Field Office for the worker safety and health



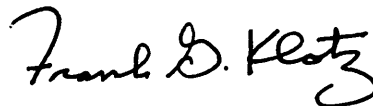
program deficiencies associated with the event and in accordance with 10 C.F.R. § 851.5 *Enforcement*, paragraph (c), no civil penalty will be issued for the violations of Part 851 cited in this PNOV.

Pursuant to 10 C.F.R. § 851.42, *Preliminary Notice of Violation*, you are obligated to submit a written reply within 30 calendar days of receipt of the enclosed PNOV and to follow the instructions specified in the PNOV when preparing your response. If no reply is submitted within 30 calendar days, in accordance with 10 C.F.R. § 851.42(d), you relinquish any right to appeal any matter in the PNOV, and the PNOV will constitute a final order.

Our NNSA Livermore Field Office has been monitoring LLNS corrective actions including the Laboratory's Work Planning and Control Project Plan improvement initiatives. I encourage direct and continuing LLNS senior management leadership and support on these critical initiatives as the safety of all workers is paramount to our NNSA Enterprise mission.

After reviewing your response to the PNOV, including any proposed additional corrective actions entered into DOE's Noncompliance Tracking System, NNSA will determine whether further action is necessary to ensure compliance with worker safety and health requirements. NNSA will continue to monitor the completion of corrective actions until these matters are fully resolved.

Sincerely,



Frank G. Klotz

Enclosures: Preliminary Notice of Violation (WEA-2014-03)
Enforcement Conference Summary and List of Attendees

cc: Nicole Nelson-Jean, NA-LL
Connie DeGrange, LLNS
Richard Reback, DNFSB

Preliminary Notice of Violation

Lawrence Livermore National Security, LLC
Lawrence Livermore National Laboratory

WEA-2014-03

A U.S. Department of Energy (DOE) investigation into the facts and circumstances associated with the sulfuric acid burn event that occurred on February 12, 2013, at Lawrence Livermore National Laboratory (LLNL), Site 300, building 827D, identified multiple violations of DOE worker safety and health requirements by Lawrence Livermore National Security, LLC (LLNS). The violations involved deficiencies in (1) hazard identification, assessment, prevention, and abatement; (2) safety and health standards; (3) emergency response; (4) industrial hygiene; (5) management responsibilities; (6) and pressure safety.

The National Nuclear Security Administration (NNSA) has grouped and categorized the violations as four Severity Level I violations and two Severity Level II violations. As explained in 10 C.F.R. Part 851, Appendix B, *General Statement of Enforcement Policy*, § VI(b)(1), “[a] Severity Level I violation is a serious violation. A serious violation shall be deemed to exist in a place of employment if there is a potential that death or serious physical harm could result from a condition which exists, or from one or more practices, means, methods, operations, or processes which have been adopted or are in use, in such place of employment.” Section VI (b)(2) states, “[a] Severity Level II violation is an other-than-serious violation. An other-than-serious violation occurs where the most serious injury or illness that would potentially result from a hazardous condition cannot reasonably be predicted to cause death or serious physical harm to employees but does have a direct relationship to their safety and health.”

Pursuant to 10 C.F.R. § 851.5(b) and Department of Energy Acquisition Regulation 48 C.F.R. § 970.5215-3 *Conditional Payment of Fee* (clause I-087) under contract number DE-AC52-07NA27344 between NNSA and LLNS, the Livermore Field Office administered a contract fee reduction in the amount of \$365,000 for the violations associated with this event. As a result, and in accordance with 10 C.F.R. § 851.5(c), DOE proposes no civil penalty for the violations cited in this Preliminary Notice of Violation (PNOV).

As required by 10 C.F.R. § 851.42(b) and consistent with Part 851, Appendix B, the violations are listed below. If this PNOV becomes a final order, LLNS may be required to post a copy of this PNOV in accordance with 10 C.F.R. § 851.42(e).

I. VIOLATIONS

A. Hazard Identification, Assessment, Prevention, and Abatement

Title 10 C.F.R. § 851.10, *General requirements*, subsection (a), states that “[w]ith respect to a covered workplace for which a contractor is responsible, the contractor must: . . . (2) [e]nsure that work is performed in accordance with: (i) [a]ll applicable requirements of [10 C.F.R. Part 851]; and (ii) [w]ith the worker safety and health program for that workplace.”

Title 10 C.F.R. § 851.21, *Hazard identification and assessment*, subsection (a), states that “[c]ontractors must establish procedures to identify existing and potential workplace hazards and assess the risk of associated workers injury and illness. Procedures must include methods to: (1) [a]ssess worker exposure to chemical, physical, biological, or safety workplace hazards through appropriate workplace monitoring;. . . (4) [a]nalyze designs of new facilities and modifications to existing facilities and equipment for potential workplace hazards; (5) [e]valuate operations, procedures, and facilities to identify workplace hazards; (6) [p]erform routine job activity-level hazard analyses;. . . [and] (8) [c]onsider interaction between workplace hazards and other hazards . . .” In accordance with subsection (c), “[c]ontractors must perform the activities identified paragraph (a) of this section, initially to obtain baseline information and as often thereafter as necessary to ensure compliance with the requirements of [10 C.F.R. Part 851, Subpart C].”

Title 10 C.F.R. § 851.22, *Hazard prevention and abatement*, subsection (a), states that “[c]ontractors must establish and implement a hazard prevention and abatement process to ensure that all identified and potential hazards are prevented or abated in a timely manner.” This paragraph also requires that “(1) [f]or hazards identified either in the facility design or during the development of procedures, controls must be incorporated in the appropriate facility design or procedure” and “(2) [f]or existing hazards identified in the workplace, contractors must: . . . (iii) [p]rotect workers from dangerous safety and health conditions.”

Subsection (b) of 10 C.F.R. § 851.22 states that “[c]ontractors must select hazard controls based on the following hierarchy: (1) [e]limination or substitution of the hazards where feasible and appropriate; (2) [e]ngineering controls where feasible and appropriate; (3) [w]ork practices and administrative controls that limit worker exposures; and (4) Personal protective equipment.”

Title 10 C.F.R. Part 851, Appendix A, section 3, *Explosives Safety*, at subsection (b), states that “[c]ontractors must comply with the policy and requirements specified in the DOE Manual 440.1-1A, DOE Explosives Safety Manual, Contractor Requirements Document (Attachment 2), January 9, 2006 (incorporated by reference, see [10 C.F.R.] § 851.27).” DOE Manual 440.1-1A, requires a formally documented process hazard analysis (PrHA) before beginning any explosives synthesis. The PrHA must be updated and revalidated at least every five years.

Contrary to these requirements, LLNS failed to establish and implement a work planning and control process that identified, assessed, and abated workplace hazards consistent with the applicable requirements and procedures invoked by the approved LLNS 10 C.F.R. Part 851 worker safety and health program described in *the LLNL Worker Safety and Health Program*, LLNL-AR-499076 (dated September 2012) and *LLNL Environment, Safety and Health Manual* (ES&H Manual), UCRL-AM-133867 (dated May 17, 2012). Specific examples include the following:

1. The LLNS PrHA did not fully address the hazards associated with equipment design and configuration, such as those created by the stacking arrangement of the glass reaction and addition vessels, and the methods of chemical addition. The addition of fuming sulfuric acid was not adequately assessed to evaluate the rate of addition relative to change in enthalpy, pressure relief capability, and vessel configuration. The PrHA did not address the consequences of failure of engineering and administrative controls, and seismic safety issues were not addressed in the design and configuration of the equipment.
2. LLNS did not effectively use the hierarchy of controls required by 10 C.F.R. § 851.22, in that LLNS relied on personal protective equipment (PPE) rather than other preferable control measures for the addition process. Equipment design limitations directly contributed to the event. The reaction vessel utilized to synthesize LLM-105 lacked an adequate number of ports and proper chemical dispensing equipment to safely add fuming sulfuric acid, requiring personnel to manually pour approximately two liters of fuming sulfuric acid into the reaction vessel. Ports were not adequately sealed or oriented to safely direct chemicals if expelled from the vessel during the reaction, as actually occurred.
3. LLNL did not clearly communicate expectations for work control, in that conflicting requirements for preparing work control documentation led to confusion over the purpose and expectations for adherence to the work procedures. Facility Safety Plan S-300.8 requires work instructions for the peer review to be written clearly and in sufficient detail to permit workers to use them as a step-by-step procedure. However, ES&H Manual Document 17.1, *Explosives* (revision 10, implementation date December 16, 2011), states that the peer review may contain guidelines (similar to procedural steps) for the purpose of describing the scope of work, but that it is not a formal work procedure. In addition, workers were allowed to use skill of the craft to perform synthesis activities, e.g., adding fuming sulfuric acid through unconventional means, thus introducing new hazards. This deviation from the work control documentation resulted in employee exposures that had not been adequately analyzed or mitigated.
4. LLNS failed to follow peer review procedures intended to ensure the objectivity of the process for identifying and controlling hazards. ES&H Manual Document 17.1 prohibits individuals who are directly involved in the subject work from participating as peer reviewers. However, the lead chemist conducting the work activity also served as a member of the Peer Review Committee that approved the work.

Collectively, these noncompliances constitute a Severity Level I violation.

B. Safety and Health Standards

Title 10 C.F.R. § 851.23, *Safety and health standards*, subsection (a), states that “[c]ontractors must comply with the following safety and health standards that are applicable to the hazards at their covered workplace: . . . (3) Title 29 C.F.R. Part 1910, ‘Occupational Safety and Health Standards,’ excluding 29 C.F.R. 1910.1096, ‘Ionizing Radiation’ . . . (9) American Conference of Governmental Industrial Hygienists (ACGIH) ‘Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices’ (2005) (incorporated by reference; see [10 C.F.R.] § 851.27) when the ACGIH Threshold Limit Values (TLVs) are lower (more protective) than the permissible exposure limits in 29 C.F.R. Part 1910.”

Title 29 C.F.R. § 1910.132, *General requirements*, subsection (a), *Application*, states that “[p]rotective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact.”

Paragraph (d)(1) of 29 C.F.R. § 1910.132 states that “[t]he employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). If such hazards are present, or likely to be present, the employer shall: (i) [s]elect, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment; (ii) [c]ommunicate selection decisions to each affected employee; and (iii) [s]elect PPE that properly fits each affected employee.”

Title 29 C.F.R. § 1910.133, *Eye and face protection*, subsection (a), *General requirements*, paragraph (1), states that “[t]he employer shall ensure that each affected employee uses appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation.”

Title 29 C.F.R. § 1910.134, *Respiratory protection*, subsection (a) *Permissible practice*, paragraph (2), states that “[a] respirator shall be provided to each employee when such equipment is necessary to protect the health of such employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protection program, which shall include the requirements outlined [in 29 C.F.R. 1910.134 (c)]. The program shall cover each employee required [by 29 C.F.R. §1910.134] to use a respirator.”

Title 29 C.F.R. § 1910.134, subsection (d), *Selection of respirators*, “[r]equires the employer to evaluate respiratory hazard(s) in the workplace, identify relevant workplace and user

factors, and base respirator selection on these factors. The paragraph also specifies appropriately protective respirators for use in [atmospheres immediately dangerous to life or health], and limits the selection and use of air-purifying respirators.”

Contrary to these requirements, LLNS failed to establish and document appropriate PPE and implement other measures to protect workers from potential hazards associated with the synthesis operation. LLNS did not ensure that the researcher donned PPE suitable for the potential hazards; the PPE used during addition of the fuming sulfuric acid provided inadequate protection. Research personnel directly involved with addition of the acid wore safety glasses and butyl gloves at the time of the incident and lacked proper face, head, body, and respiratory protection. The procedure employed (i.e., manual addition of a substantial volume of a highly corrosive chemical) necessitated increased personal protective measures, in the absence of effective engineering controls. The deficiency resulted, in part, because of confusion over LLNS policy, a lack of appreciation of the exposure hazard, and an incomplete understanding of vessel conditions, such as the aqueous content and pressure relief capability.

This noncompliance constitutes a Severity Level I violation.

C. Emergency Response

Title 29 C.F.R. § 1910.120, *Hazardous waste operations and emergency response*, subsection (q), *Emergency response program to hazardous substance releases*, identifies requirements for emergency response to hazardous substance releases. The requirements of subsection (q) that are applicable to this investigation are specified below.

Title 29 C.F.R. § 1910.120(q)(3) subparagraph (iii) states that “[b]ased on the hazardous substances and/or conditions present, the individual in charge of the ICS [Incident Command System] shall implement appropriate emergency operations, and assure that the personal protective equipment worn is appropriate for the hazards to be encountered.”

Title 29 C.F.R. § 1910.120(q)(3) subparagraph (iv) states that “[e]mployees engaged in emergency response and exposed to hazardous substances presenting an inhalation hazard or potential inhalation hazard shall wear positive pressure self-contained breathing apparatus while engaged in emergency response, until such time that the individual in charge of the ICS determines through the use of air monitoring that a decreased level of respiratory protection will not result in hazardous exposures to employees.”

Contrary to these requirements, LLNS failed to take adequate precautions during response activities following the incident to protect employees from the hazards. The incident resulted in the emission of substantial quantities of sulfuric acid liquid and mist into room 105. Affected employees evacuated room 105 due to sulfuric acid mist and concern about continued exposure. The overpressurization and chemical release from the vessel were unexpected, creating an unknown condition for which LLNS research and response personnel had no definitive explanation at the time of the event. Material contamination, mislabeling, or human error may have created a continuing unsafe condition, e.g., further chemical/energy

release from the reaction vessel. Despite these conditions, an LLNS first responder entered the room immediately after the incident, without PPE.

This noncompliance constitutes a Severity Level I violation.

D. Industrial Hygiene

Title 10 C.F.R. Part 851, Appendix A, section 6, *Industrial Hygiene*, states that: “[c]ontractors must implement a comprehensive industrial hygiene program that includes at least the following elements: (a) [i]nitial or baseline surveys and periodic resurveys and/or exposure monitoring as appropriate for all work areas or operations to identify and evaluate potential health risks; (b) [c]oordination with planning and design personnel to anticipate and control health hazards that proposed facilities and operations would introduce; . . . [and] (d) [p]olicies and procedures to mitigate the risk from identified and potential occupational carcinogens.” The requirements under section 6 are implemented, in part, by ES&H Manual, Volume 2, Part 14, *Chemical*.

Title 10 C.F.R. § 851.23 requires contractors to comply with 29 C.F.R. § 1910.1000, *Air contaminants*, and the ACGIH “Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices” (2005) when the ACGIH TLVs are lower (more protective) than the Occupational Safety and Health Administration (OSHA) permissible exposure limits required by 29 C.F.R. Part 1910. The ACGIH TLV for sulfuric acid is 0.2 mg/m³ as an 8-hour time weighted average (TWA), thoracic fraction. OSHA’s permissible exposure limit for sulfuric acid is 1 mg/m³ as an 8-hour TWA.

Specific examples of LLNS’s failure to comply with these requirements include the following:

1. LLNS did not assess the potential for worker exposure to sulfuric acid during manual addition of fuming sulfuric acid. The methods of manual chemical addition were inconsistent with the anticipated exposure profile, negating the existing exposure assessment.
2. LLNS did not identify the concern regarding exposure to a carcinogen. ES&H Manual Document 14.12, *Safe Handling of Carcinogenic Materials* (revision 6, approved November 21, 2012), requires the responsible individual to contact Health Services if a worker is exposed to or there is a mishap that involves a carcinogen. Employees involved in the incident were exposed to sulfuric acid mist, which the International Agency for Research on Cancer identifies as a Group 1 carcinogen.

Collectively, these noncompliances constitute a Severity Level II violation.

E. Management Responsibilities

Title 10 C.F.R. § 851.20, *Management responsibilities and worker rights and responsibilities*, subsection (a), states that “[c]ontractors are responsible for the safety and

health of their workforce and must ensure that contractor management at a covered workplace: ... (3) [a]ssign worker safety and health program responsibilities, evaluate personnel performance, and hold personnel accountable for worker safety and health performance.”

Contrary to this requirement, LLNS failed provide an adequate system to ensure that the chemical synthesis work could be conducted safely. The LLNL management process for reviewing and approving scale-up experimental work relied heavily on research staff to identify and control hazards, recognize the limitation of work scope associated with research activities, and involve management and ES&H subject matter experts when new hazards were introduced. Equipment limitations and process hazards necessitated a more thorough analysis of work planning and control documentation.

This noncompliance constitutes a Severity Level II violation.

F. Pressure Safety

Title 10 C.F.R. Part 851, Appendix A, section 4, *Pressure Safety*, paragraph (a) states that “[c]ontractors must establish safety policies and procedures to ensure that pressure systems are designed, fabricated, tested, inspected, maintained, repaired, and operated by trained and qualified personnel in accordance with applicable and sound engineering principles.”

Paragraph (b) of Appendix A, section 4, states that “[c]ontractors must ensure that all pressure vessels, boilers, air receivers, and supporting piping systems conform to: (1) [t]he applicable American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (2004), sections I through section XII including applicable Code Cases (incorporated by reference; see § 851.27)[,] (2) [t]he applicable ASME B31 (Code for Pressure Piping) standards as [listed in paragraphs (b)(2)(i) through (x) of Appendix A, section 4]; [and] (3) [t]he strictest applicable state and local codes.”

Subsection (c) of Appendix A, section 4, states that “[w]hen national consensus codes are not applicable (because of pressure range, vessel geometry, use of special materials, etc.), contractors must implement measures to provide equivalent protection and ensure a level of safety greater than or equal to the level of protection afforded by the ASME or applicable state or local code.”

Contrary to these requirements, the reaction vessel did not include a pressure relief device or adequately designed pressure relief system to safely address potential elevated pressure during the synthesis process, such as that created by the rapid addition of fuming sulfuric acid. The ASME Boiler and Pressure Vessel Code, 2004, section VIII, Rules for Construction of Pressure Vessels, requires all pressure vessels within the scope of the Division to have overpressure protection. LLNS did not ensure that the vessel met ASME requirements or provide equivalent protection, consistent with 10 C.F.R. Part 851, Appendix A, section 4, *Pressure Safety*, paragraph (c). Further, LLNS did not conduct or document analyses to evaluate the integrity of the reaction vessel and ancillary equipment that may be

affected by repeated use, cycling, overpressurization, vibration, corrosion, or other factors, in accordance with sound engineering principles.

This noncompliance constitutes a Severity Level I violation.

II. REPLY

Pursuant to 10 C.F.R. § 851.42(b)(4), LLNS is hereby obligated to submit a written reply within 30 calendar days of receipt of this PNOV. The reply should be clearly marked as a “Reply to the Preliminary Notice of Violation.”

If LLNS chooses not to contest the violations set forth in this PNOV, the reply should clearly state that LLNS waives the right to contest any aspect of this PNOV. In such case, this PNOV will constitute a final order upon the filing of the reply.

If LLNS disagrees with any aspect of this PNOV, then as applicable and in accordance with 10 C.F.R. § 851.42(c)(1), the reply must: (1) state any facts, explanations, and arguments that support a denial of an alleged violation; and (2) discuss the relevant authorities that support the position asserted, including rulings, regulations, interpretations, and previous decisions issued by DOE. In addition, 10 C.F.R. § 851.42(c)(2) requires that the reply include copies of all relevant documents.

Please send the appropriate reply by overnight carrier to the following address:

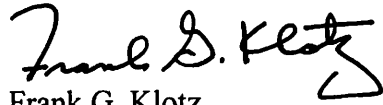
Director, Office of Enforcement
Attention: Office of the Docketing Clerk
U.S. Department of Energy
19901 Germantown Road
Germantown, MD 20874-1290

A copy of the reply should also be sent to the Manager of the Livermore Field Office.

Pursuant to 10 C.F.R. § 851.42(d), if LLNS does not submit a written reply within 30 calendar days of receipt of this PNOV, LLNS relinquishes any right to appeal any matter in this PNOV, and this PNOV will constitute a final order.

III. CORRECTIVE ACTIONS

Corrective actions that have been or will be taken to avoid further violations should be delineated, with target and completion dates, in DOE's Noncompliance Tracking System.



Frank G. Klotz
Under Secretary for Nuclear Security
Administrator, NNSA

Washington, DC

This 25th day of Sep 2014