

September 22, 1999

Brigadier General Thomas F. Gioconda
Acting Assistant Secretary for Defense Programs
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0104

Dear General Gioconda:

Enclosed for your consideration and action, as appropriate, are observations developed by members of the staff of the Defense Nuclear Facilities Safety Board (Board) concerning electrical, instrumentation and control, and fire protection systems at Los Alamos National Laboratory (LANL). These observations are based on reviews of available documents and discussions with Department of Energy (DOE) staff and contractor personnel at LANL on June 15–17, 1999.

In the enclosed report, the Board's staff concludes that LANL's Work Smart Standards do not address the design of safety-class or safety-significant electrical and instrumentation and control systems. The report also identifies opportunities for improvement in a number of other areas, including design requirements for fire protection and lightning protection systems.

The Board believes the LANL Work Smart Standards need to be upgraded to include standards for safety-related systems in order to ensure compliance with established and proven industry design practices for safety systems. This upgrading is especially important given the need to design and construct new facilities, such as a replacement for the Chemistry and Metallurgy Research Building, at LANL in the near future. The Board also expects that the Work Smart Standards for safety-related systems will comply with the safety system requirements in DOE Order 420.1. In particular, if a program feature is made mandatory by an Order or requirement, it is disappointing if it only appears as guidance in Work Smart Standards.

The Board asks to be kept abreast of DOE's actions regarding the concerns discussed in the enclosed report. Please feel free to contact me if you have any questions on this matter.

Sincerely,

John T. Conway
Chairman

c: Mr. Mark B. Whitaker, Jr.
Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

August 3, 1999

MEMORANDUM FOR: G. W. Cunningham, Technical Director
J. K. Fortenberry, Deputy Technical Director

COPIES: Board Members

FROM: A. K. Gwal

SUBJECT: Review of Electrical, Instrumentation and Control, and Fire Protection Systems at Los Alamos National Laboratory

This report documents a review by members of the staff of the Defense Nuclear Facilities Safety Board (Board) A. K. Gwal, W. White, W. Shields, and A. Jordan of the electrical, instrumentation and control, and fire protection systems at Los Alamos National Laboratory (LANL). This review was conducted during June 15–17, 1999. The staff reviewed site-wide requirements for electrical, instrumentation and control, and lightning protection systems. The staff also reviewed the adequacy of site-wide requirements for fire protection and aspects of the implementation of fire protection codes and standards. In addition, the staff toured the Chemistry and Metallurgy Research (CMR) Building and Technical Area-55 (TA-55) to review the status of previously identified issues.

Site-Wide Requirements for Electrical and Instrumentation and Control Systems.

The Board's staff reviewed the adequacy of LANL's Work Smart Standards (WSS) and laboratory requirements related to electrical and instrumentation and control systems. Although the current LANL standards provide extensive direction on the design of conventional industrial electrical systems, there are no standards related to the design of safety-class or safety-significant systems. Thus, there is little contractual assurance that safety-class and safety-significant electrical systems within new or upgraded facilities will meet industry standards and Department of Energy (DOE) requirements. LANL is currently considering adding to its WSS set both Institute of Electrical and Electronics Engineers (IEEE) Class 1E standards for electrical systems and Instrument Society of America (ISA) S84.01 standard for safety-related instrumentation and control systems.

Lightning Protection System. The Board's staff evaluated operations at LANL to determine whether the lightning protection controls for certain hazardous operations were consistent with the controls being developed at the Pantex Plant. To ensure consistency with the approach taken by Pantex, LANL has used the same experts from Sandia National Laboratories who were involved in the development of controls at Pantex to evaluate lightning protection for explosive operations at LANL. In response to the recommendations of these experts, LANL is currently upgrading its existing lightning protection controls. Although the approach taken by LANL to upgrading its lightning protection requirements for certain operations appears to be on

the right track, the staff does have the following concerns:

- It will be necessary for LANL to test the insulation properties of certain components (e.g., hoist slings, vacuum lines) before these components are relied upon as nonconducting elements providing an appropriate standoff distance from electrical penetrations.
- It would be prudent for LANL to install a lightning warning and detection system to allow more reliable shutdown of vulnerable operations during lightning storms.
- Until an adequate lightning warning and detection system is operational, LANL should consider adopting compensatory measures to ensure that vulnerable operations are suspended during periods with a high probability of lightning.
- It would be prudent for LANL to update the existing authorization basis to address the recently revised requirements for mitigation of lightning hazards before conducting any operations addressed in that authorization basis.

Site-Wide Requirements for Fire Protection Systems. LANL has used the WSS process to establish requirements for fire protection. LANL's assertion about the equivalence of program requirements does not withstand careful scrutiny, however. In general, the Order 420.1 requirements appear, if at all, in the *Fire Protection Program Manual*, compliance with which is not mandatory.

Comments on each of the three WSS documents—the Laboratory Performance Requirements (LPR), the Laboratory Implementation Requirements (LIR), and the *Fire Protection Program Manual* (Manual)—are provided in the attachment to this report. The Manual addresses some of the programmatic requirements of Order 420.1; other of those requirements can be found or inferred elsewhere in the Manual. However, there is no explicit discussion of the program features and design requirements listed in the Order. The Board's staff notes further that the Manual is guidance, not a contract requirement.

Applying the National Fire Protection Association (NFPA) Codes as requirements—as in the LPR and LIR—ensures that many aspects of fire safety at LANL will be properly addressed. However, it is clear that many specific programmatic requirements of the Order have not been adopted explicitly as contractual requirements. Even when requirements have been subsumed into guidance, different language has been used, and some requirements have been omitted. With respect to seismic criteria for safety-class sprinkler systems, it is difficult to determine the equivalence between DOE and LANL standards. The staff concludes that the WSS set does not include many of the specific program requirements in Order 420.1 and that LANL implementation guidance for fire protection does not track reliably to either the Order requirements or DOE guidance.

Previously Identified Issues. The staff reviewed the status of progress on several previously identified issues.

Maintenance at CMR Building—During a tour of the electrical distribution system in the CMR Building, the staff observed that a significant proportion of key electrical distribution equipment had expired preventive maintenance or calibration stickers. For most of this equipment, preventive maintenance or calibration was overdue by nearly 2 years. According to CMR Building engineers, the maintenance was originally postponed because the equipment was expected to be replaced shortly as part of a major upgrade to the distribution system. This upgrade was subsequently postponed, however, and may never be implemented. It would be prudent for DOE and LANL to bring this equipment into calibration as quickly as possible. Failure to maintain this equipment properly reduces its reliability significantly.

Water Supply for Fire Protection System at TA-55—Fire suppression supply lines (10-inch diameter) at TA-55 have corroded and developed leaks in various sections of the pipe. At some locations, the wall of the piping is less than 75 percent of its original thickness. The TA-55 Fire Loop Replacement Project was initiated to resolve the issue of frequent leaks in the 10-inch main-feed water pipe that supplies water to the fire suppression system at the TA-55 Plutonium Facility (PF-4). Following recent delays in replacing the TA-55 fire loop, worst-case failures were studied that would require isolating PF-4 from the main fire loop. Calculations indicate that two holes, each approximately 2.3 inches in diameter, in the 10-inch main-feed water pipe would disable the firefighting capabilities from either pump house and necessitate the isolation of PF-4 from the main loop. If the system could not be restored within 7 days, compensatory actions in place could require termination of normal operation in PF-4 and stabilization of identified material at risk within 60 days.

The Board's staff is concerned that before the fire suppression supply lines are replaced, they could degrade to the point at which they would become unreliable. Because of the combustible loading in TA-55, the staff believes a design modification that would allow the introduction of water to the sprinklers by alternate means should be considered. The Board's staff toured the PF-4 area with a senior LANL fire protection engineer and confirmed that risers could be installed easily and inexpensively outside the facility. These risers could be connected to the pumpers and provide water to the sprinklers in the event of a worst-case failure of the water supply lines that would lead to the isolation of PF-4 from the main fire loop.

Single-Failure Point in Off-site Power Supply System—The LANL electrical distribution system can receive power from two separate power-generating plants. The Board's staff previously observed that the high-voltage lines providing power to the site cross each other at one point. A failure of the transmission lines at this single point could result in loss of one or both lines and isolate the site from power for an extended period.

LANL is planning to expand the Los Alamos Electric Transmission System to upgrade and increase the reliability of the LANL and adjoining electric transmission systems and to provide

a supplemental energy supply to meet the projected growth in LANL's electric power and energy requirements. This effort will involve the construction of several new power lines. In addition to the construction of new power lines, DOE plans to uncross the Reeves and Norton Lines, the two existing 115 kV power lines coming into LANL. Uncrossing these two lines would eliminate the single point of failure discussed above and improve the reliability of the transmission system.

Attachment

ATTACHMENT

Fire Protection System at Los Alamos National Laboratory (LANL)

Los Alamos National Laboratory (LANL) has used the Work Smart Standards (WSS) process to establish fire protection program requirements. The Board's staff had requested that LANL and the DOE Los Alamos Area Office (DOE-LAAO) demonstrate the equivalence of the WSS set and implementing documentation on the one hand and DOE fire protection requirements and guidance on the other. In a series of presentations supported by detailed documentation, DOE-LAAO and LANL described the results of a such a crosswalk review.

The LANL contractual requirements set includes the National Fire Protection Association (NFPA) Codes, the Uniform Building Code (UBC), and Occupational Safety and Health Administration (OSHA) fire protection requirements contained in 29 Code of Federal Regulations (CFR) 1910. The next level of mandatory standards is Laboratory Implementation Requirements (LIR) 402-910-01-2, entitled *LANL Fire Protection Program*. Program implementation is guided by the *LANL Fire Protection Program Manual* and other manuals and procedures covering specific topics. Parallel DOE fire protection requirements are Order 420.1, *Facility Safety*; the *Fire Protection Implementation Guide* for this Order; DOE-STD 1066-97, *Fire Protection Design Criteria*; the *DOE Fire Protection Handbook*; and a variety of other DOE issuances.

The crosswalk performed by LANL indicated, in the laboratory's view, that "LANL documents establish general compliance with DOE Order and Guide requirements." LANL and LAAO believe the crosswalk results demonstrate that the overall scope of the LANL program documentation and DOE requirements and standards are similar from the point of view of safety.

LANL's assertion about the equivalence of program requirements does not withstand careful scrutiny, however. In general, the Order 420.1 requirements appear, if at all, in the *Fire Protection Program Manual* (Manual), compliance with which is not mandatory. Comments follow on each of the three WSS documents—the Laboratory Performance Requirements (LPR), the LIR, and the Manual.

Laboratory Performance Requirements

The LPR contains two operative sections: "Performance Criteria" and "Contractual Work Smart Standards." The four performance criteria listed can be summarized as follows:

- A fire protection program with certain features must "exist."
- Fire protection issues at all facility phases "shall be addressed."

- A fire department must “exist.”
- The Laboratory Director must appoint a Fire Marshal who will serve as the "Authority Having Jurisdiction" (AHJ) for NFPA Code purposes.

These standards are so general and vaguely worded that not much can be drawn from them.

More important is the next section of the LPR, the Contractual Work Smart Standards. This set includes the following:¹

- 29 CFR 1910, Occupational Safety and Health Standards,² as applicable and appropriate
- NFPA [sic],³ as applicable and appropriate
- UBC, as applicable and appropriate

The second of these, the NFPA Codes, results in some consistency with Order 420.1, which also mandates compliance with NFPA Codes. The use of the qualifiers "as applicable and appropriate" for each group of requirements is problematic. All consensus codes are used only "as applicable," and a consensus code generally states its applicability at the outset. The term "as appropriate" is undefined; the LPR does not specify who determines "appropriateness" or in accordance with what standard.

Laboratory Implementation Requirements

Section 6.0 of the LIR, "Implementing Requirements," would be expected to contain a full set of fire protection program requirements equivalent to those in Order 420.1 if LANL's assertion of equivalence were to be supportable. This, however, is not the case.

This section starts off well by reaffirming the commitment to the NFPA Codes and to meeting a "Highly Protected Risk" standard of protection. Section 6.1, "General Requirements," however, falls far short of the 11 programmatic requirements and 10 design requirements contained in Sections 4.2.1 and 4.2.2, respectively, of Order 420.1. Sections 6.2, 6.3, 6.4, and 6.5 of the LIR are assignments of functions and responsibilities

¹ Only the major standards are covered here; a few others are very limited in scope and do not bear significantly on the fire safety program.

² Subpart L of 19 CFR 1910 covers fire protection.

³ The word "Codes" is missing in the original LPR.

within LANL, not substantive requirements. Hence, the LIR also fails to incorporate any significant portion of Order 420.1 requirements.

Fire Protection Program Manual

The *Fire Protection Program Manual* addresses some of the programmatic requirements of Order 420.1. For example, Section 4.2 states: "A FHA [Fire Hazards Analysis] is required for each new Laboratory facility and for each facility requiring a SAR [Safety Analysis Report]." The parallel provision from the Order, Section 4.2.1, states that an FHA is required "for all nuclear facilities, significant new facilities, and facilities that represent unique or significant fire safety risks." Other Order requirements can be found or inferred elsewhere in the Manual. But nowhere is there to be found an explicit restatement of the program features and design requirements listed in the Order. In addition, the LANL crosswalk does not cover requirements applicable to the fire department because the fire department is under contract to DOE, not LANL. This legal distinction, however, does not excuse the lack of program requirements for the fire department, or eliminate the need for prefire plans or a baseline needs assessment for gauging the adequacy of firefighting forces.

In other cases, the differences between the wording of the Order and that of the Manual are so significant that the sense of the Order requirement is lost. An example is the provisions for "written fire safety procedures" in the Order:

[The fire protection program must have] written fire safety procedures governing the use and storage of combustible, flammable, radioactive and hazardous materials so as to minimize the risk from fire. Such procedures shall also exist for fire protection system impairments and for activities such as smoking, hot work, safe operation of process equipment, and other fire prevention measures which contribute to the decrease in fire risk.

The LANL crosswalk first notes that the LPR/LIR commitment to the NFPA Codes can be credited toward the above requirement, a reasonable point, but not a complete response. The NFPA Codes provide substantive guidance that can be used to write fire safety procedures, but the Codes do not impose writing of a complete set of fire safety procedures as a program requirement in itself. The only section of the Manual with any relevance to this requirement is Section 4.3., "Facility Operating Procedures," which states in part:

Facility operating procedures and/or technical specifications shall address the fire protection features of the facility that are required for safe operation and mitigating potential fire hazards and damage. When a facility's fire protection systems are out of service or

damaged, compensatory measures shall be implemented until the systems or equipment are restored to full service. The operating procedures shall specifically define the compensatory measures to be implemented consistent with the significance of the impairment.

While the second and third sentences of this statement reasonably capture the Order requirement on impairment procedures and compensatory measures, there is no comparability between "written fire safety procedures governing..." and "facility operating procedures and/or technical specifications...." The two passages are addressing entirely different types of procedures.

Finally, it must be observed that the Manual is guidance, not a contractual requirement. Thus there is no parallel between incorporating the Order as a contractual requirement and using the Manual as program guidance.

It is fair to say that applying the NFPA Codes as requirements—as is done by the LPR and LIR—ensures that many aspects of fire safety at LANL will be properly addressed. However, it is also clear that many specific programmatic requirements of the Order have not been explicitly adopted as contractual requirements; even when those requirements have been subsumed into guidance, different language has been used, and certain requirements have been omitted.

Comparisons with Other Guidance

During the review, LANL provided three other crosswalks. The most important of these compares LANL program requirements and guidance against DOE-STD 1066-97, *Fire Protection Design Criteria*. This crosswalk demonstrates that some key safety provisions of the design guide (which was derived in part from DOE Order 6430.1A) have not been incorporated into LANL's internal guidance; in other cases, not enough information is provided to gauge equivalence.

Two examples will suffice. Section 5.3.1 of DOE-STD 1066-97 states:

All facilities of significance, including facilities where a fire could cause unacceptable off-site consequences to health and safety, should be protected by an automatic fire suppression system [usually a wet pipe sprinkler system]. A decision to install another type of fire suppression system should be based on engineering analysis performed by a fire protection engineer.

The LANL-supplied crosswalk, reference 6, cites these two provisions from the LIR as parallels:

Complete automatic suppression systems shall be installed per NFPA

codes and standards where the MFL [maximum fire loss] exceeds \$1 million, or where a fire will result in the loss of a Laboratory 'mission critical' program. (Section 6.1.2)

Because of the high risk and/or high profile operations at some LANL sites, additional fire detection and/or suppression systems may be necessary. Where the above conditions are identified...they shall be mitigated through new design or retrofit. For extremely valuable pieces of equipment...the cognizant DOE fire protection authority, the qualified LANL fire protection engineer, the facility manager or program office, and the Fire Marshall shall establish fire protection requirements on a case by case basis. (Section 6.1.3)

These two provisions do not mention public health and safety as a basis for installing an automatic fire suppression system, but rather focus on property protection and mission interruption. This is a significant difference.

With respect to seismic criteria for safety-class sprinkler systems, it is difficult to determine the equivalence between the DOE and LANL standards. Section 7.3 of DOE-STD 1066-97 provides detailed seismic enhancements (over and above NFPA-13) for such systems to provide additional assurance that they will perform safety-class functions as needed, or will not interfere with safety-class systems through spurious activation or failure. The LANL crosswalk (p. 16) cites no specific parallel standards in the LPR, LIR, or Manual. It does make reference to LANL Construction Specifications and the use of Performance Categories in design. Nowhere does it appear that the specific guidance in the DOE standard has been adopted.

Prefire Plans and Baseline Needs Assessment

Finally, during the review on site, neither the LANL Emergency Management organization nor the fire department (under contract to DOE-LAAO) presented crosswalk data addressing important program features such as prefire plans; fire department staffing, training, and equipment; and the use of a baseline needs assessment. Order 420.1 requires these program features. The staff is concerned that program features required by Order do not appear explicitly and exactly in the crosswalk data. During discussions, it was stated that prefire plans are in use; it was stated further that a baseline needs assessment has been conducted, and fire department staffing levels are consistent with that assessment. Without knowledge of the specific standards being applied in this area, however, the staff cannot determine whether the DOE criteria are being met.

Conclusions

The staff concludes that the WSS requirements set does not include many of the specific program requirements in Order 420.1. The staff concludes further that LANL's

implementation guidance for fire protection does not track reliably to either the Order requirements or DOE guidance.