

John T. Conway, Chairman  
A.J. Eggenberger, Vice Chairman  
John W. Crawford, Jr.  
Joseph J. DiNunno  
Herbert John Cecil Kouts

## DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004  
(202) 208-6400



December 21, 1994

The Honorable Victor H. Reis  
Assistant Secretary  
for Defense Programs  
Washington, D.C. 20585

Dear Dr. Reis:

The Defense Nuclear Facilities Safety Board (Board) submitted Recommendation 94-4, *Deficiencies in Criticality Safety at Oak Ridge Y-12 Plant*, to you on September 27, 1994. In preparing the Recommendation, the Board had the benefit of a report prepared by its staff. The enclosed report may be of use to you and your associates in preparing an implementation plan.

The Board has designated Mr. James McConnell of our technical staff to be available to provide any additional information DOE personnel may require. He can be reached at (202) 208-6479.

Sincerely,

John T. Conway  
Chairman

c: The Honorable Charles B. Curtis, Under Secretary  
Mr. Mark Whitaker, EH-6

Enclosure

**ADHERENCE TO SAFETY REQUIREMENTS AND  
CONDUCT OF OPERATIONS**

**AT**

**THE OAK RIDGE Y-12 PLANT**

This issue paper was prepared for the Defense Nuclear Facilities Safety Board by the following staff members:

Wayne Andrews  
Steve Krahn  
James J. McConnell

September 27, 1994

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1. **Overview:** Proper conduct of operations is a key aspect of any integrated, systems engineering-based health and safety management strategy. The Defense Nuclear Facilities Safety Board (DNFSB) places a high level of attention on evaluating this functional area at the Department of Energy's (DOE's) defense nuclear facilities. This report describes the conduct of operations at the Y-12 Plant at Oak Ridge, Tennessee.

Formal conduct of operations is a fundamental cultural approach in the nuclear industry that significantly lessens the likelihood of an inadvertent criticality excursion. Although Y-12 has made some improvements over the past two years, activities at the plant still do not comply with DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*. The DNFSB staff has identified many conduct of operations deficiencies during reviews at Y-12. The DNFSB has pointed out this fact to both DOE Oak Ridge and Martin Marietta Energy Systems (MMES) senior management.<sup>1,2,3</sup> Although the Y-12 management appears willing to change the existing operational culture, they clearly have not implemented the changes effectively.

From June to September 1994, several violations of Operational Safety Requirements (OSRs) and other safety limits occurred at the Y-12 Plant. On September 22, 1994, the DNFSB staff identified several violations of nuclear criticality safety limits for special nuclear material storage vaults at Y-12. Because of these findings, MMES management made a decision to curtail Y-12 activities performed under Criticality Safety Approvals (CSAs). MMES also began a comprehensive site-wide review of compliance with all CSAs. In the first few days of this review, several hundred CSA noncompliances have been identified. The DNFSB staff believes this is a clear indication of an institutional culture that lacks the appropriate level of rigor and formality associated with conduct of operations.

This report is based on the DNFSB's visits to Y-12, including visits by DNFSB staff and outside experts. It addresses conduct of operations and other closely related topics including safety requirements, training and qualification of personnel, and operational readiness reviews. The report identifies the various Orders, standards, and guidelines that are pertinent to these functions at Y-12. In addition, it summarizes the various DNFSB correspondence on these issues related to the Y-12 Plant.

2. **Discussion:** This section identifies the standards and requirements related to conduct of operations and criticality safety, describes the operations at the Y-12 Plant, and identifies the issues and DNFSB actions in these areas.
  - a. **Assessment of Y-12 Operations Against Applicable DOE Orders, Guidelines, and Standards:** The Y-12 Plant processes and stores more highly enriched uranium (HEU) than any other site in the United States. Therefore, it is essential that Y-12 properly execute the conduct of operations and nuclear criticality safety functions. DOE Orders 5480.19, *Conduct of Operations Requirements for DOE Facilities* and 5480.24, *Nuclear Criticality Safety* are among the most important DOE standards describing necessary attributes of programs in these two functional areas.

The DNFSB stated in its 1994 Annual Report to Congress that it has ". . . observed only limited progress toward implementation of [DOE Orders and other guidance documents related to conduct of operations] at many facilities and has noted a general lack of understanding and commitment to the concepts set forth in DOE Order 5480.19 by DOE's managers and contractors."<sup>4</sup> This statement was made regarding all DOE defense nuclear facilities, but could have been made more strongly if the DNFSB were describing the Y-12 Plant specifically. The following paragraphs will review DOE Orders 5480.19 and 5480.24 and cite only a sampling of examples where noncompliances have been observed by the DNFSB staff. The examples cited should not be considered all inclusive, but rather as representative of the DNFSB's observations at Y-12 over the last two years.

1. DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*

Chapter I: Operations Organization and Administration

States in part, "Investigations, audits, reviews, and self-assessments are a part of the checks and balances needed in an operating program." *These inspections were not being done, at least not effectively. If they were, many hundreds of CSA noncompliances would have been identified previously and could have been corrected.*

Chapter II: Shift Routines and Operating Practices

States in part, "Round inspection sheets should be developed and approved by the operations supervisor. . . . Safety limits derived from Technical Specifications or Operational Safety Requirements should be highlighted." *Recently, a DNFSB staff member observed a shift changeover in Building 9212. Neither the off-going operators nor the oncoming ones used a written checklist or procedure. This appeared to be the standard operating procedure for shift changeover. The shift changeover process did not include comprehensive safety limits in the form of references to CSAs, OSRs and/or Limiting Conditions of Operation.*

Chapter XII: Operations Turnover

States in part, "Shift turnovers should be guided by a checklist . . . and should include an inspection of appropriate facility instrumentation." *During a DNFSB staff-observed changeover, a staff member asked an oncoming supervisor what an illuminated "high temp" light meant. He stated, "I don't really know but since it's already been on for over a week, it probably doesn't matter."*

2. DOE Order 5480.24, Nuclear Criticality Safety:

Paragraph 7a.(2)(b) states that programs for nuclear criticality safety shall satisfy the requirements of the following American National Standards Institute/American Nuclear Society ANSI/ANS nuclear criticality safety standards:

*ANS-8.1, Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, except paragraphs 4.2.2 and 4.2.3.*

"4.1.4 Materials Control. Appropriate materials labeling and area posting shall be maintained specifying material identification and all limits on parameters that are subjected to procedural control." *Many CSA noncompliances were a result of inappropriate or nonexistent labels and/or postings concerning fissionable material being stored.*

"4.1.5 Operational Control. Deviations from procedures and unforeseen alterations in process conditions that effect nuclear criticality safety shall be reported to management and shall be investigated promptly." *This was not accomplished during the original event -- it took almost an hour for proper actions to be taken.*

*ANS-8.7, Guide for Nuclear Criticality Safety in the Storage of Fissile Materials.*

"4.1.2 Methods of storage control and operational practices approved by management shall be described in written procedures. Persons participating in the transfer and storage of material shall be familiar with these procedures. Limits for storage shall be posted." *During a tour of Building 9212, the staff noted that limits were not posted on a storage array. In addition, operating personnel proved their lack of familiarity by being unable to find the CSA applicable to a particular HEU storage array.*

*ANS-8.19, Administrative Practices for Nuclear Criticality Safety.*

"9.5 Control of spacing, mass, density, and geometry of fissile material shall be maintained to assure subcriticality under all normal and credible abnormal conditions." *Although the intent of the MMES CSA process was, in part, to ensure the provisions of this paragraph were implemented, a fundamental unfamiliarity with the CSAs and poor conduct of operations allowed noncompliant events to take place.*

**b. Description of Y-12 Operations, Particularly Highly Enriched Uranium Processing:**

The Y-12 Plant has been the primary DOE site for the chemical and metallurgical processing of HEU since the beginning of the Manhattan Project. The following operations are conducted at Y-12.

1. Receipt and Preparation of Materials: Building 9212 can receive HEU in virtually any form possible including metal, alloys, oxides, fluorides, chlorides, sulfides, phosphates,

and organics. The "head-end" chemical processes in Building 9212 separate the HEU streams from some impurities. The output is an impure uranium-bearing nitric acid solution - uranyl nitrate hexahydrate  $[\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}]$  suitable for purification in the extraction process.

2. Uranium Extraction: After any required pre-treatment in the head-end processes, the HEU product stream goes through a fairly standard chemical processing system.<sup>5</sup> The extraction portion of the uranium processing system removes impurities from the HEU product stream. The input to this section is unpurified  $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  and the output is highly purified  $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ .
  3. Reduction and Conversion: This final phase of chemical processing in Building 9212 involves reducing the uranyl nitrate to an oxide and, if required, to a fluoride and then metal. The input to this phase is purified  $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  and the output is either  $\text{UO}_3$ ,  $\text{U}_3\text{O}_8$ , or uranium metal.
  4. Parts Manufacturing Process: Enriched uranium feedstock is prepared in Building 9212 and cast into either part shapes or billets. Part shapes and billets are then transferred to Building 9215 for additional processing or final machining.
  5. Assembly and Disassembly: Enriched uranium assembly and disassembly operations are concentrated in Buildings 9204-2 and 9204-2E. Components, including enriched uranium parts, are fabricated and/or procured and subsequently installed in capsule or canned subassemblies. Disassembly operations are divided into two groups, Quality Evaluation and Reclamation. Quality Evaluation involves the disassembly of weapons returned from the field and subassemblies selected from current production programs, both for evaluation purposes. Reclamation involves the disassembly of obsolete subassemblies to reclaim salvageable materials.
  6. Interim Storage: Most of the U.S. supply of HEU in interim storage is at Oak Ridge. This material is stored primarily as metal but some is also stored as an oxide (predominantly  $\text{U}_3\text{O}_8$ ). This material is stored in Building 9720-5 and in vaults and vault-type cages in other facilities at Y-12.
- c. **Chronological Summary of Recent DNFSB Reviews and Correspondence on Safety Issues at Y-12**: The DNFSB's recent concerns at the Y-12 Plant focus on four major areas: 1) compliance with safety requirements, 2) conduct of operations, 3) training and qualification, and, 4) operational readiness reviews. The following is a discussion of the facts and bases for these concerns at the Y-12 Plant.
1. Compliance with Safety Requirements: The DNFSB first raised the issue of safety requirements with DOE in Recommendation 90-2, *Design, Construction, Operation, and Decommissioning Standards at Certain Priority DOE Facilities* on March 8, 1990. In

Recommendation 90-2, the DNFSB recommended that DOE identify the safety standards used to control defense nuclear activities, assess their adequacy, and determine the extent of their implementation. The DNFSB followed up Recommendation 90-2 with Recommendation 91-1, *Safety Standards* on March 8, 1991, which asked DOE to strengthen its ability to implement a standards-based safety culture.

The staff conducted a review to assess the implementation of Recommendations 90-2 and 91-1 at the Y-12 Plant in June 1992. That review identified several deficiencies in the implementation of the DOE standards program at Y-12 including failure to implement and assess compliance with DOE Orders such as 5480.21, *Unreviewed Safety Questions*, 5480.22, *Technical Safety Requirements*, and 5480.23, *Nuclear Safety Analysis Reports*, in a timely fashion. The review also noted concerns about the then draft DOE Order 5480.CRIT on criticality safety. On July 7, 1992, the DNFSB issued a letter to the Secretary of Energy forwarding the staff's trip report for DOE action.<sup>6</sup>

On January 21, 1993, the DNFSB issued Recommendation 93-1 which included a sub-recommendation that DOE give priority to completing site-wide Order compliance self assessment (OCSA) reviews at facilities that assemble, disassemble, and test nuclear weapons, including the Y-12 Plant. In May 1993, the staff visited Y-12 to assess the OCSA program. The staff found that little had been done to address the issues raised in the DNFSB's 1992 letter and that most of the technical deficiencies persisted. As a result, the DNFSB issued a reporting requirement on June 8, 1993, requiring DOE to analyze both the 1992 trip report and the 1993 trip report (provided with the letter) and describe the corrective actions planned.<sup>7</sup> On August 31, 1993, DOE submitted a plan to improve the OCSA program at Y-12.<sup>8</sup> This plan also became the Oak Ridge specific portion of the DOE Implementation Plan for sub-recommendation four of DNFSB Recommendation 93-1.

The DOE's schedule for improving its OCSA program at the Y-12 Plant extended over many months. In December 1993, the DNFSB staff visited Oak Ridge to assess progress on the schedule. Subsequently, the DNFSB issued a letter to the Secretary of Energy on December 27, 1993, complimenting the DOE on its efforts up to that point, but also suggested that more remained to be done.<sup>9</sup>

In April 1994, the DNFSB staff conducted another review to assess the OCSA program at Y-12. The staff found that, while most of the commitments from the DOE Implementation Plan for Recommendation 93-1 had been satisfied, the program still required significant upgrades. The staff noted that improvements were specifically required in the program to assess adherence to DOE safety Order requirements.

On August 23, 1994, the DNFSB forwarded six trip reports to DOE concerning staff reviews at Y-12 conducted since April 1993. One of those reports discussed a DNFSB staff review conducted at Y-12 on November 3-5, 1993.<sup>10</sup> That report identified a



concern with the definition of the authorization bases for facilities at Y-12 and suggested that Y-12 management review their criticality safety analyses.

Over the last few months there have been several occurrences at the Y-12 Plant that suggest a continued failure to comply with CSA/OSR requirements and other safety requirements. On June 28, 1994, the Y-12 Plant had an occurrence involving an overpressurization of the deuterium plant in Building 9805-1 caused by an explosive mixture of oxygen and hydrogen in four cells.<sup>11</sup> The MMES investigation of that occurrence identified two instances when different people noted indications requiring the plant to be immediately shut down and the building to be evacuated. Neither operator took the proper actions.

In an occurrence on July 13, 1994, a safety system in Building 9212 actuated when carry-over from an evaporator containing uranium solids activated a gamma detector.<sup>12</sup> Three occurrences involving OSR violations followed this incident.<sup>13,14,15</sup>

On September 22, 1994, four members of the DNFSB staff (S. Krahn, J. McConnell, W. Andrews and T. Dwyer) identified an array of storage containers for nuclear device components in Building 9204-2E that violated the CSA for the vault-like cage in which they were stored.<sup>16</sup> The staff then evaluated the other vault-like cage in the same immediate area and identified that dissimilar containers were mixed on the same pallet and arranged in various arrays. These arrays also violated the CSA (the same CSA applied to both vault-like cages).<sup>17</sup>

After the DNFSB staff notified DOE management of the event, DOE and MMES began a comprehensive review of all CSAs at Y-12 and other sites operated by MMES under DOE Oak Ridge Operations Office purview. By Monday, September 26, 1994, DOE and MMES had identified 238 violations of CSAs, although none were more serious than a Level IV Criticality Safety Infraction. A Level IV Criticality Safety Infraction is a MMES classification of a discrepancy that does not result in less than two contingencies remaining in place to prevent an actual criticality event. Maintaining double contingency (as defined in ANSI/ANS-8.1-1983, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*) is a requirement of DOE Order 5480.24, *Nuclear Criticality Safety*.

2. Conduct of Operations: Formal DNFSB and Department of Energy interaction on the subject of conduct of operations (ConOps) dates from the DNFSB's first full-year annual report in 1991.<sup>18</sup> That annual report described the DNFSB's view of disciplined operations, including the tie to safety analyses and requirements and the tie to personnel training and qualification.

On August 18, 1992, the DNFSB issued Recommendation 92-5, *Discipline of Operations*, which recommended that, for nuclear facilities scheduled for long-term

continued programmatic defense operations (such as Y-12), DOE should institute a style and level of conduct of operations at least comparable to that required for commercial nuclear facilities.

In a March 25, 1994 letter to DOE, the DNFSB noted that they had observed slow implementation of the DOE Orders pertaining to training and ConOps at Y-12. The report enclosed with the letter identified numerous problems such as inadequate procedures, lack of action to correct procedural violations, failure to follow safety-significant requirements of procedures, and lack of approved procedures for some operations. The letter went on to state:

"The Board is forwarding the enclosed report to you for use by the Oak Ridge Operations Office during their review of MMES's revised [ConOps and training] implementation plans. *The Board expects you and your staff to consider the systemic problems that are evident from the attached report during your assessment of the larger process of achieving compliance with all DOE safety Orders at the Oak Ridge Y-12 Plant*" (emphasis added).

The various occurrence reports noted previously also highlight inadequate ConOps. For example, the MMES report for the deuterium plant incident identified such problems as failure to follow the Class 1 procedure (i.e., a safety-significant procedure requiring verbatim compliance), failure to follow safety-related requirements, and failure to take logs or record required data.

In the September 1994 CSA violation incident, the DNFSB staff identified the violation to the supervisor of the material handlers responsible for stacking the containers, a senior MMES manager and his deputy responsible for the facility in which the containers were stored, a criticality safety engineer, and the DOE Facility Representative. None of the supervisors or managers present took the proper actions required by the MMES procedure Y70-150, *Nuclear Criticality Safety*. Those requirements are: back away at least 15 feet, control the area (to prevent any physical changes), and notify Criticality Safety or the Plant Shift Superintendent. Only the Facility Representative even acknowledged that the conditions were a potential criticality safety violation (but he did not take the appropriate immediate action). DOE and MMES took the proper actions only after members of the DNFSB staff notified the DOE Site Office Manager.

3. Training and Qualification: The DNFSB has consistently identified the lack of sufficient numbers of adequately trained personnel as one of the most significant safety-related problems at DOE's defense nuclear facilities.

On May 28, 1992, the DNFSB issued Recommendation 92-2, *DOE Facility Representative Program*, which recommended improvements in the training and qualification program for DOE Facility Representatives. On September 27, 1992, the

DNFSB issued Recommendation 92-7, *Training and Qualification*, which addressed the need for DOE to increase senior management involvement in training issues. The Recommendation also stressed the need to accelerate plans at DOE nuclear facilities to implement the DOE Order on training and qualifying nuclear material handlers, supervisors, and support personnel. Recommendation 92-7 explicitly identified reviews at the Oak Ridge Y-12 Plant as providing part of the basis for the Recommendation.

On June 1, 1993, the DNFSB issued Recommendation 93-3, *Technical Capability in the Defense Nuclear Facilities Programs*, which identified the need for improved selection and training of federal employees involved in defense nuclear facility safety activities. This Recommendation became the blanket under which DOE planned to implement both Recommendation 93-3 and Recommendation 92-7.

The DNFSB sent a letter to the Secretary of Energy on September 24, 1993, forwarding three trip reports on training and qualification.<sup>19</sup> One of those trip reports concerned the Y-12 Plant. In the cover letter, the DNFSB stated that "Observations from these visits have led the Board to focus considerable attention on DOE's need to improve the selection, training, and qualification of personnel associated with the defense nuclear facilities, especially the weapons complex, on the premise that properly trained and qualified personnel are essential for the protection of public health and safety." The Y-12 Plant trip report enclosed with that letter identified numerous deficiencies with both the DOE Oak Ridge and MMES training and qualification programs.

On March 25, 1994, the DNFSB issued the results of a six-month study of training, qualification, and conduct of operations at Y-12 (see also section 2 above).<sup>3</sup> The report identified that the training and qualification program at the Y-12 Plant had retrogressed considerably over the span of the six-month study. The report stated that the MMES training and qualification program was informal and did not ensure that only appropriately trained and qualified operators were assigned to fissionable material handler duties. In response to the DNFSB staff's findings, DOE and MMES proposed a corrective action plan to address the DNFSB's concerns. That program is being implemented but the schedule has been slipping.

During the occurrence of September 22, 1994, the DNFSB staff questioned the DOE and MMES escorts about the required actions for a suspected criticality safety infraction. The personnel all responded with technically satisfactory answers. However, they were unable to discuss the applicable CSA although it had been updated only 13 days before the incident. Additionally, the first criticality safety engineer who arrived at the scene was apparently unable to interpret the CSA.

4. Operational Readiness Reviews: The DNFSB has issued six Recommendations on Operational Readiness Reviews (ORRs) including: 90-4, 91-3, 91-4, 92-1, 92-3, and 92-6. As a specific deliverable of Recommendation 92-6, DOE developed an Order, 5480.31, *Startup and Restart of DOE Nuclear Facilities* and an associated standard to

cover ORRs and Readiness Assessments (RAs). In addition, the DNFSB has discussed ORRs in each of its last four annual reports. The DNFSB continues to provide clarification to DOE concerning the pivotal role the DNFSB believes ORRs play in verifying that nuclear activities are safe to start or restart.

On March 24-25, 1993, the DNFSB staff conducted a review of the MMES ORR conducted to support the startup of disassembly operations conducted in Building 9204-2E. The staff found numerous deficiencies with the MMES process. Subsequently, the DNFSB issued a reporting requirement<sup>20</sup> requiring DOE to assess the MMES ORR process and to identify any required improvements. The DOE response dated June 10, 1993, identified many weaknesses with the MMES ORR process. The DOE committed that all future Y-12 Plant nuclear activity ORRs and RAs would be conducted according to DOE Order 5480.31 and the tenets of DNFSB Recommendation 92-6. MMES has not conducted any nuclear facility/activity ORRs or RAs since the DOE issued their June 10, 1993, response, although they have conducted non-nuclear startups (see below).

On December 17, 1993, approximately 1900 gallons of dilute sodium hypochlorite solution (NaOCl) leaked into a storm drain from a dike in Building 9204-2. One finding of the subsequent Type B Investigation was that MMES incorrectly concluded that an ORR was not required before restarting the process that resulted in the release.

The June 28, 1994, deuterium plant incident (discussed earlier) also involved an inadequate contractor RA for a non-nuclear start-up. The investigation report identified that the RA did not evaluate several core requirements of DOE Order 5480.31. These included a failure to check for adequate procedures and safety limits, a failure to ensure safety-related management responsibilities were well understood, a failure to adequately assess the level of conduct of operations, and a lack of a startup test plan. The deficiencies of the contractor's RA became obvious when the incident occurred *just 25 hours* after resuming operations.

- 3. Summary and Conclusions:** Despite the DNFSB Recommendations, site specific reporting requirements, publicly-issued trip reports, and numerous staff reviews described above, recent events indicate that the personnel at the Oak Ridge Y-12 Plant still have not integrated several fundamental concepts supporting safe operations into their daily routines. These fundamental concepts include providing adequate procedures (based on safety analyses), ensuring the work force is properly trained, expecting compliance with requirements, and conducting nuclear facility operations formally. All these concepts are necessary in an integrated, systems engineering-based health and safety management strategy required for a modern DOE defense nuclear facility.

## END NOTES

1. August 31, 1993 letter from the Honorable Hazel R. O'Leary, Secretary of Energy, to the Honorable John T. Conway, Chairman, DNFSB, *Response to the June 8, 1993 Letter and Trip Report Regarding the Review of Implementation of DNFSB Recommendations 90-2 and 91-1*.
2. February 28, 1994 letter from the Honorable John T. Conway, Chairman, DNFSB, to the Honorable Victor H. Reis, Assistant Secretary for Defense Programs, *Report on Liquid and Gaseous Effluent at the Y-12 Plant, December 1-3, 1993*.
3. March 25, 1994 letter from the Honorable John T. Conway, Chairman, DNFSB, to the Honorable Victor H. Reis, Assistant Secretary for Defense Programs, *Staff Review of Training, Qualification, and Conduct of Operations Conducted at the Oak Ridge Y-12 Plant*.
4. Defense Nuclear Facilities Safety Board, *Annual Report to Congress*, February, 1994.
5. Benedict, Pigford, and Levi, *Nuclear Chemical Engineering*, McGraw-Hill, Inc. New York, 1981.
6. July 7, 1992 letter from the Honorable John T. Conway, Chairman, DNFSB, to the Honorable James D. Watkins, Secretary of Energy, *Review of Implementation of DNFSB Recommendations 90-2 and 91-1*.
7. June 8, 1993 letter from the Honorable John T. Conway, Chairman, DNFSB, to the Honorable Hazel R. O'Leary, Secretary of Energy, *Review of Implementation of DNFSB Recommendations 90-2 and 91-1 and Radiological Controls at the Y-12 Plant*.
8. August 31, 1993 letter from the Honorable Hazel R. O'Leary, Secretary of Energy, to the Honorable John T. Conway, Chairman, DNFSB *Response to the June 8, 1993 Letter and Trip Report Regarding the Review of Implementation of DNFSB Recommendations 90-2 and 91-1*.
9. December 27, 1993 letter from the Honorable John T. Conway, Chairman, DNFSB to the Honorable Hazel R. O'Leary, Secretary of Energy, *Improvements in Compliance with DOE Orders at the Y-12 Plant*.
10. Memorandum C.H. Keilers to G.W. Cunningham, *Y-12 - Safety Analyses/ Criticality/ Chemical Safety Review (November 3-5, 1993)*.
11. Occurrence Report ORO--MMES-Y12DEFPGM-1994-0013.
12. Occurrence Report ORO--MMES-Y12DEFPGM-1994-0015.

13. Occurrence Report ORO--MMES-Y12DEFPGM-1994-0017.
14. Occurrence Report ORO--MMES-Y12DEFPGM-1994-0019.
15. Occurrence Report ORO--MMES-Y12DEFPGM-1994-0021.
16. Criticality Safety Approval FM-B2E-106, *Stacked Fissile Container Storage* (U) - CSA is CONFIDENTIAL.
17. Occurrence Report ORO--MMES-Y12DEFPGM-1994-0022.
18. Defense Nuclear Facilities Safety Board, *Annual Report to Congress*, February 1991.
19. September 24, 1993 letter from the Honorable John T. Conway, Chairman, DNFSB, to the Honorable Hazel R. O'Leary, Secretary of Energy, *Selection, Training, and Qualification of Personnel in the Defense Nuclear Complex*.
20. April 21, 1993 letter from the Honorable John T. Conway, Chairman, DNFSB, to Dr. Everet H. Beckner, Acting Assistant Secretary for Defense Programs, *Operational Readiness Review Process at the Y-12 Plant Building 9204-2E*.