January 7, 2003

EA-02-117
EA-02-257

Mr. Lew W. Myers
Chief Operating Officer
FirstEnergy Nuclear Operating Company
Davis-Besse Nuclear Power Station
5501 North State Route 2
Oak Harbor, OH 43449-9760

SUBJECT: DAVIS-BESSE NUCLEAR POWER STATION
NRC SPECIAL INSPECTIONS - SUBSTANTIAL POTENTIAL FOR AN OVEREXPOSURE OF OCCUPATIONAL WORKERS (REPORT NO. 50-346/02-16(DRS)) AND UNCONTROLLED RELEASE OF RADIOACTIVE MATERIAL TO THE ENVIRONMENT (REPORT NO. 50-346/02-06(DRS)) TWO PRELIMINARY WHITE FINDINGS

Dear Mr. Myers:

On February 20, 2002, several contract workers were both internally and externally contaminated with radioactive material while installing steam generator nozzle dams at the Davis-Besse plant. In April 2002, the NRC staff became aware that four of these individuals were determined to be contaminated with low levels of radioactive material upon their arrival at other nuclear power plants and that the source of the contamination was potentially from their work at Davis-Besse. On April 17, the NRC dispatched a Special Inspection Team (SIT) to the Davis-Besse site and surrounding areas in accordance with NRC Management Directive 8.3, "NRC Incident Investigation Program." The SIT was chartered to review the circumstances surrounding the release of low levels of radioactive material from the Davis-Besse facility, to evaluate the public dose consequences associated with the event, and to assess your review and response to the event.

In August 2002, the NRC staff became aware that contamination surveys and air samples collected from various areas of the plant during the February 2002 steam generator work exhibited trace amounts of transuranic (TRU) isotopes. The NRC staff initiated discussions with your staff regarding the potential internal dose consequences resulting from the ingestion and/or inhalation of TRUs, and your staff then collected fecal and urine samples from one of the contaminated individuals. The sample analysis results that were disclosed to the NRC on September 25th and 26th indicated that the individual may have received a radiation dose in excess of NRC limits from the internal contamination received during the steam generator work in February. On September 30, the NRC dispatched another SIT to the Davis-Besse site in accordance with NRC Management Directive 8.3. This team was chartered to develop a time line and set of facts surrounding the planning for and conduct of the steam generator nozzle dam installations, to evaluate the scope and thoroughness of your dose assessments for the exposed individuals, and to perform independent dose estimates.

On December 13, 2002, the NRC completed these special inspections. The enclosed reports document the findings from both special inspections, which were discussed with you and other members of your staff during a preliminary public exit meeting on October 16, 2002, and during a final exit meeting conducted during a telephone discussion on December 13, 2002.

Report No. 50-346/02-16(DRS) discusses two findings that appear to have low to moderate safety significance. As described in sub-sections b1 and b2 of this report, your staff failed to: (1) conduct adequate evaluations to characterize the radiological work conditions; and (2) take timely and suitable measurements of radioactive material in air in work areas and adequately monitor the occupational intake of these materials by workers. These findings were assessed using the occupational radiation safety significance determination process (SDP) as potentially safety significant findings that were preliminarily determined to be White, (i.e., findings with some increased importance to safety) which may require additional NRC inspection. The findings each have low to moderate safety significance because the failure to perform adequate radiological evaluations resulted in a substantial potential for an exposure to workers in excess of regulatory limits, and the failure to adequately measure the concentrations of radioactive material in the air and monitor the occupational intake of radioactive material by workers resulted in a compromised ability to assess dose.

The findings also appear to be apparent violations of NRC requirements and are being considered for escalated enforcement action in accordance with the “General Statement of Policy and Procedure for NRC Enforcement Actions” (Enforcement Policy), NUREG-1600. The current Enforcement Policy is included on the NRC’s website at www.nrc.gov/OE .

We believe that sufficient information was considered by the NRC staff to make a preliminary significance determination. However, before we make a final decision on this matter, we are providing you an opportunity to present to the NRC your perspective on the facts and assumptions used by the NRC to arrive at the findings and their significance at a Regulatory Conference, or through a written submittal to the NRC that provides your position on the findings. If you choose to request a Regulatory Conference, it should be held within 30 days of the receipt of this letter. We encourage you to submit supporting documentation at least one week prior to the conference in an effort to make the conference more efficient and effective. If a Regulatory Conference is held, it will be open for public observation. If you decide to submit only a written response, such submittal should be sent to the NRC within 30 days of the receipt of this letter.

Please contact Tom Kozak at (630) 829-9866 within 10 business days of the date of this letter to notify the NRC of your intentions. If we have not heard from you within 10 days, we will continue with our significance determination and enforcement decision and you will be advised by separate correspondence of the results of our deliberations on this matter.

Since the NRC has not made a final determination in this matter, no Notice of Violation is being issued for these inspection findings at this time. In addition, please be advised that the number and characterization of apparent violations described in Report No. 50-346/02-16(DRS) may change as a result of further NRC review.

Report No. 50-346/02-06(DRS) documents one finding of very low safety significance (Green) which was determined to involve a violation of NRC requirements. However, because of the very low safety significance and because it is entered into your corrective action program, the NRC is treating this finding as a Non-Cited Violation consistent with Section VI.A of the NRC Enforcement Policy. This finding involved the uncontrolled release of low levels of radioactive material into the public domain. The level of radioactive material involved with this release presented little potential for adverse health effects or consequences to the general public. Adequate corrective actions have been developed which, if properly implemented, should preclude an uncontrolled release such as this from recurring. If you deny this Non-Cited Violation, you should provide a response with the basis for your denial, within 30 days of the date of this inspection report, to the Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, D. C. 20551-0001; with copies to the Regional Administrator, Region III; the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, D. C. 20555-0001; and the NRC Resident Inspector at the Davis-Besse Nuclear Power Station.

While these findings do not appear to represent a current safety issue based on the corrective actions initiated by your staff, on October 30, 2002, the NRC's Davis-Besse Oversight Panel Restart Checklist was revised to include an assessment of the Davis-Besse radiation protection program. Prior to restart of the plant, NRC inspection will be conducted to assure that these aspects of the radiation protection program are functioning adequately.

In accordance with 10 CFR Part 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC website at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

John A. Grobe, Chairman
Davis-Besse Oversight Panel

Docket No. 50-346
License No. NPF-3

Enclosures: 1. NRC Inspection Report No. 50-346/02-16(DRS)
2. NRC Inspection Report No. 50-346/02-06(DRS)

See Attached Distribution

cc w/encls: B. Saunders, President - FENOC
R. Fast, Plant Manager
Manager - Regulatory Affairs
M. O'Reilly, FirstEnergy
Ohio State Liaison Officer
R. Owen, Ohio Department of Health
Public Utilities Commission of Ohio
President, Board of County Commissioners
Of Lucas County
President, Ottawa County Board of Commissioners
D. Lochbaum, Union of Concerned Scientists

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/RA/
John A. Grobe, Chairman
Davis-Besse Oversight Panel

Docket No. 50-346
License No. NPF-3

Enclosures: 1. NRC Inspection Report No. 50-346/02-16(DRS)
2. NRC Inspection Report No. 50-346/02-06(DRS)

See Attached Distribution

DOCUMENT NAME: G:DRS\ML030070606.wpd

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U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket No:	50-346
License No:	NPF-3
Report No:	50-346/02-16(DRS)
Licensee:	FirstEnergy Nuclear Operating Company
Facility:	Davis-Besse Nuclear Power Station
Location:	5501 North State Route 2 Oak Harbor, OH 43449-9760
Dates:	September 30 through December 13, 2002
Inspectors:	T. Kozak, Team Leader W. Slawinski, Senior Radiation Specialist P. Lee, Radiation Specialist C. Martin, Radiation Specialist M. Mitchell, Radiation Specialist
Approved by:	John A. Grobe, Chairman Davis-Besse Oversight Panel

SUMMARY OF FINDINGS

IR 05000346-02-16(DRS), FirstEnergy Nuclear Operating Company; on 09/30-12/13/2002; Davis-Besse Nuclear Power Station. Special Inspection.

This report covers a two-week onsite special inspection by four regional inspectors and a team leader that focused on compliance with NRC rules and regulations as they relate to the facts and circumstances associated with the planning for and conduct of steam generator nozzle dam installation, and the assessment of worker dose resulting from intakes of radioactive material. Two findings each preliminarily characterized as White were identified. The significance of most inspection findings is indicated by their color (Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process" (SDP). Findings for which the SDP does not apply may be "Green" or be assigned a severity level after NRC management review. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

A. Inspector Identified Findings

Cornerstone: Occupational Radiation Safety

(TBD) The licensee failed to conduct an adequate evaluation (survey) of the radiological hazards that led to inadequate job controls for steam generator nozzle dam installation. The failure to adequately evaluate the potential radiological hazards associated with nozzle dam installations is an apparent violation of 10 CFR 20.1501, which requires licensees to conduct adequate evaluations to ensure compliance with the occupational exposure limits of 10 CFR 20.1201.

This issue has been preliminarily determined to have low to moderate safety significance (White). This issue represented a performance deficiency because the licensee had several indicators of potentially degraded radiological conditions and had opportunities to identify and evaluate the radiological hazards present in the steam generator environment but failed to adequately do so prior to worker entries. The failure to conduct an adequate evaluation resulted in a substantial potential for an overexposure. The substantial potential for an overexposure is based on the fact that the concentrations of transuranic isotopes could have been greater, which would have resulted in increased worker dose from the intakes. Due to the licensee's failure to conduct representative surveys, they were unaware of the concentration of transuranic isotopes. Also, since the intakes resulted primarily from the resuspension of contaminants, it would only have taken a minor alteration in the physical activity performed by the workers while in the steam generator bowls to have increased the airborne radiological hazards to levels that could have caused internal exposures in excess of regulatory limits. These factors collectively or individually created a radiological environment that could have resulted in an overexposure to the workers.

(TBD) The licensee failed to take timely and suitable measurements of radioactive material in the air, in workers' bodies, or excreted from the workers during and following the nozzle dam installations. The failure of the licensee to obtain and properly analyze

representative air samples during the work activity and/or adequately conduct bioassay measurements so as to characterize the radiological intake is an apparent violation of 10 CFR 20.1204.

This issue has been preliminarily determined to have low to moderate safety significance (White). This issue represented a performance deficiency because the failure to obtain suitable or timely measurements resulted in a compromised ability to assess dose. The licensee's failure to determine the transuranic isotopes present in the steam generator prior to the job, to adequately determine the quantity of radionuclides in the workers' bodies until over 200 days after the event, and the failure to obtain representative air samples in the workers' breathing zones all contributed to the compromised ability to assess dose. The licensee's final dose of record was based on dose estimates derived from steam generator area contamination surveys coupled with in-vivo bioassay information.

REPORT DETAILS

Summary of Plant Status: The plant was shut down for a refueling outage throughout the inspection period.

4. OTHER ACTIVITIES (OA)

4OA3 Event Follow-Up (93812)

Background and Event Overview

On February 20, 2002, several contract workers were both internally and externally radioactively contaminated while installing steam generator nozzle dams at the Davis-Besse plant. In April 2002, the NRC staff became aware that four of these individuals were determined to be radioactively contaminated upon their arrival at other nuclear power plants and that the source of the contamination was potentially from their work at Davis-Besse. On April 17, the NRC dispatched a Special Inspection Team (SIT) to the Davis-Besse site and surrounding areas in accordance with NRC Management Directive 8.3, "NRC Incident Investigation Program." The SIT was chartered to review the circumstances surrounding the release of radioactive material from the Davis-Besse facility, to assess the public dose consequences associated with the event, and to evaluate the licensee's review and response to the event. The results of that inspection are documented in NRC Inspection Report No. 50-346/02-06(DRS).

In August 2002, the NRC staff became aware that removable contamination surveys (smears) and air samples collected from various areas of the plant, including an air sample taken inside one of the steam generators, exhibited trace amounts of transuranic (TRU) isotopes. The NRC staff initiated discussions with your staff regarding the potential internal dose consequences of the ingestion and/or inhalation of TRUs. Following those discussions, your staff then collected fecal and urine samples from one of the contaminated individuals. The sample analysis results that were disclosed to the NRC on September 25th and 26th indicated that the individual may have received a radiation dose in excess of NRC limits from the internal contamination received during the steam generator work in February. On September 30, the NRC dispatched another SIT to the Davis-Besse site in accordance with NRC Management Directive 8.3. The results of that inspection are documented in this report.

a. Inspection Scope

The purpose of this special inspection was to develop a time line and set of facts surrounding the planning for and conduct of the steam generator nozzle dam installations, to evaluate the scope and thoroughness of the licensee's dose assessments for the exposed individuals, to perform independent dose estimates, and to identify any regulatory issues associated with this event.

Time Line For Planning and Conducting Steam Generator Nozzle Dam Installations

On March 16-19, 2001, the licensee conducted a bench marking trip to another nuclear facility to learn about alternate shutdown chemistry practices.

On August 27, 2001, based on information gained during the bench marking trip, the licensee considered a change to its shutdown chemistry controls which would reduce the time necessary for primary system cleanup after the induced CRUD burst.

In November 2001, the licensee decided to add hydrogen peroxide after primary system drain down (@ 26 inches) and after nozzle dam installation, instead of injecting the chemical before complete drain-down with the primary system filled to the level of the reactor vessel flange (@ 80 inches).

On January 22, 2002, the licensee completed the preparation of Radiation Work Permit (RWP) 2002-5303, "Install and remove nozzle dams and nozzle dam FME covers and equipment setup."

On January 23, 2002, the ALARA review was completed for RWP 2002-5303.

On February 18, 2002, the ALARA briefing was completed for RWP 2002-5303.

On February 19, 2002 (at 0201 hours), with the primary system water level about 25 feet above the reactor vessel flange (steam generators half filled), both steam generators and the pressurizer were vented to the atmosphere. The upper steam generator manways were then removed.

On February 20, 2002 (at 0314 hours), with the primary system water level at 80 inches, the reactor head vent line was removed.

> At 0850 hours, while draining the primary system down to 26 inches, a CRUD burst occurred in the reactor coolant system.
>
> At 1420 hours, both lower steam generator manways were removed.
>
> At 1450 hours, an air sample was taken from the east steam generator platform which indicated the presence of alpha contamination.
>
> At about 1900 hours, nozzle dam installations for both east and west steam generators were completed.
>
> At 1900 to about 1930 hours, six workers from the nozzle dam installation job alarmed personal contamination monitors (PCMs) as they attempted to exit from containment. The licensee proceeded to decontaminate the individuals numerous times, including having them take multiple showers. However, only one worker successfully cleared the PCM following the decontamination efforts.
>
> At 2034 to 2154 hours, the six workers received whole body counts (WBCs). The results for two of the individuals, Workers A and B, were substantially higher

than the others. In addition, the WBC gamma spectrum for Worker A indicated the presence of Cerium-144, a fission product.

On February 21, 2002, (at 1215 hours), Workers A and B received second WBCs.

On February 28, 2002, Worker A received a third WBC.

On March 2, 2002, Worker B received a third WBC.

On March 6, 2002, Worker A received a fourth WBC.

On March 14, 2002, Worker A received a fifth WBC and Worker B a fourth WBC.

On March 22, 2002, Oconee Nuclear Station personnel notified Davis-Besse personnel that Worker A and Worker C each had a discrete radioactive particle (DRP) on their clothing upon arrival at the facility.

On April 1, 2002, Comanche Peak Nuclear Station personnel notified Davis-Besse personnel that Worker D had a DRP on his boots upon arrival at their facility.

On April 3, 2002, Oconee Nuclear Station personnel notified Davis-Besse personnel that Worker B also had a DRP on his clothing upon arrival at the facility.

Note: Additional time line information about material found in the public domain is documented in Inspection Report No. 50-346/02-06(DRS).

On June 26, 2002, air and area contamination (smear) samples obtained from four plant areas for purposes of a waste characterization pursuant to 10 CFR Part 61 were received by a laboratory that the licensee contracted to analyze the samples. (The samples were as follows: an air sample from the west steam generator (SG) upper bowl collected on February 24, a SG platform smear sample collected on February 25, a Reactor Coolant System (RCS) CRUD filter sample collected on February 28, 2002, and a D-ring smear sample taken on March 12).

On August 9, 2002, the licensee received the results of the 10 CFR Part 61 analysis which indicated the presence of TRUs.

On August 30, 2002, the licensee collected urine and fecal samples (in-vitro) from Worker A and forwarded them to a laboratory for analysis.

On September 24, 2002, the laboratory reported the in-vitro analysis results to the licensee. The results indicated that an exposure in excess of regulatory limits may have occurred. The results were later discounted by the licensee due to unacceptably high background counts on the detector used for the analysis.

On September 25, 2002, the results of a second in-vitro analysis were reported by the contract laboratory. The same detector that had high background counts was used and these results were also discounted.

On September 28 and 29, 2002, the licensee collected a second urine/fecal sample from Worker A and a sample from Worker B. Those samples were split and one-half of the sample was submitted to the same laboratory the licensee used to analyze the samples that were collected initially, and the other half of the sample was sent to a second laboratory for analysis.

On October 5-6, 2002, the licensee collected a third urine/fecal sample from Worker A and a second sample from Worker B, split the samples into equal portions, and sent the portions to a third laboratory and a fourth laboratory for analyses. The fourth laboratory was under contract to the NRC and was used for an independent assessment.

b. Findings

b1. Review of Preparations for and Conduct of The Nozzle Dam Installations

Introduction

The inspectors identified one apparent violation, preliminarily determined to have low to moderate safety significance (White), involving the failure to conduct an adequate evaluation of the radiological conditions and potential hazards inside the steam generator bowls. This finding was more than minor because it had a substantial potential to result in worker exposures to radiation in excess of applicable NRC limits.

Description

The Davis-Besse plant experienced fuel leaks in 12 of its 13 operating cycles. As a result, there has been an increasing trend in alpha emitting radionuclides in the primary RCS. This trend was identified in a licensee self-assessment conducted in May 2001. Although this was identified by the licensee, recommendations from the self-assessment to better characterize the alpha emitting isotope concentrations in the plant were not implemented and the presence of alpha emitting isotopes had not routinely been considered during the establishment of radiological controls for jobs that involved the breach of primary systems.

During the most recent operating cycle, reactor coolant iodine activity steadily increased to a level that was higher than all but one previous operating cycle. It was estimated by the licensee's nuclear fuel vendor that up to four fuel assemblies had failed. While the iodine activity level was below the threshold required for action by Technical Specifications and the RCS Specific Activity Performance Indicator remained in the licensee response (green) band, it is well known in the industry that radiological conditions in the plant can be adversely affected by fuel integrity problems. Although the relatively high primary RCS iodine levels were generally known to the licensee, this information was not adequately communicated to radiation protection personnel and was not considered by the individuals that established radiological controls for jobs requiring primary system breaches for the outage.

The radiological work controls specified in RWP 2002-5303 and the ALARA plan for steam generator nozzle dam installation were based on historical radiological conditions. The RWP specified that removable contamination levels were expected to be as high as

60 Rad/hour/smear inside the steam generators. The inspectors identified that historical contamination survey data indicated that contamination levels were only approximately 60 milliRad/hour/smear and that the technician preparing the RWP made an error entering the data (60 Rad/hour/smear) several years earlier. This error had been carried forward in the RWP for each successive outage. The RWP and ALARA plan also specified that while calculations indicated that respirators should be worn, they were not to be utilized for the SG bowl entries. This was based on the assertion that although internal contaminations may occur, the internal dose was expected to be minimal compared to the overall dose savings for performing the work without the use of respirators. However, this assertion did not take into consideration that alpha emitting radioisotopes could be present in the SG bowls.

Pressurized water reactor (PWR) radiological conditions are affected by shutdown chemistry controls. When the RCS becomes oxidized, cobalt and nickel particulate deposits from the layer that resides on inside pipe surfaces become soluble and precipitate into the coolant. If there is not adequate coolant flow and filtration, the suspended cobalt and nickel particles are transported throughout the RCS and radiation and contamination levels can significantly increase. This phenomenon is known as a CRUD burst. To control this phenomenon during PWR shutdowns, hydrogen peroxide is normally added to the primary system just after shutdown during high coolant flow and filtration conditions. The hydrogen peroxide oxidizes the RCS and induces a controlled CRUD burst. Given adequate coolant flow and filtration to remove the suspended particles from the RCS, this process has generally been effective in reducing PWR piping and component dose rates and contamination levels which reduces a plant's radioactive source term.

Davis-Besse has routinely added hydrogen peroxide to the RCS prior to lowering system water level during reactor shutdowns and has allowed time for coolant flow and filtration to cleanup the RCS. As a result, steam generator tubesheet dose rates had been on a downward trend for the previous three operating cycles (cycles 10 - 12). During the shutdown for the 13th refueling outage in February 2002, in an attempt to save time, the licensee changed the procedure to add hydrogen peroxide after lowering the RCS below the reactor vessel flange to the bottom of the hot leg and before raising level back up to the reactor vessel flange. The licensee suspected that radiation and contamination levels may be adversely affected by this process change; however, no contingencies were developed as part of the change should radiological conditions be adversely affected by the new shutdown method or to otherwise assess the radiological impact of this change. While draining down to the bottom of the hot leg, the licensee removed the upper steam generator bowl manways, removed the reactor head ventilation line, and vented the reactor coolant pump seals. These actions introduced oxygen into the system which caused a CRUD burst to occur during minimum RCS flow and filtration conditions. As a result, steam generator tubesheet dose rates increased to cycle 9 values and removable contamination levels inside the steam generator bowls increased from their historical values of approximately 60 milliRad/hour/smear during the last several outages to approximately 50 Rad/hour/smear. Although the licensee was aware that a CRUD burst had occurred, radiological work controls were not reevaluated prior to workers entering the steam generator bowls.

Two days prior to the start of the nozzle dam installation job, the licensee provided the workers an ALARA briefing based on the historical radiological conditions that were documented in the RWP and the ALARA work package. A similar pre-job briefing was held just before conducting the work. The inspectors viewed a tape of the initial (primary) ALARA briefing and noted that the individual conducting the radiation safety portion of the briefing was not very familiar with the work package. The individual informed the inspectors that he was unable to prepare for the briefing and instead read from the documents he was handed for the briefing. The documents that comprised the RWP and ALARA package did not adequately specify the engineering controls for the job other than the means to control the air flow inside the steam generators. These controls were left to the discretion of the radiation protection technicians (RPTs) that were assigned job coverage. No industry events or potential radiological contingencies were discussed in the briefings. Additionally, the shutdown chemistry controls for this outage were not well understood by plant personnel, including the person conducting the ALARA briefing and the RPTs covering the generator entries; therefore, the potential radiological consequences of the CRUD burst were not discussed during either briefing. The possibility of the presence of alpha emitting isotopes was also not specified in either the RWP/ALARA package or discussed during the pre-job briefings.

At approximately 0850 hours on February 20, a CRUD burst occurred. By 1500 hours, workers had removed the lower steam generator bowl manways to allow worker entry. While smear samples were collected from the east and west steam generator manway diaphragms and air samples were obtained on the steam generator platforms, no surveys were performed inside the steam generator bowls. The smear sample on the west diaphragm showed a removable contamination level of approximately 50 Rad/hour/smear when field measured using a survey instrument. The RPT covering the job and the RP containment coordinator compared this level to that specified on the RWP and mistakenly thought that this high level of contamination was expected due to the error recorded in the RWP. In reality, that contamination level was approximately 100 to 800 times higher than historically encountered during similar work in this area. The east platform air sample taken near the face of the manway was field checked and showed a derived air concentration (DAC) value of approximately 14-DAC for alpha emitters; however, this was not considered by the RP staff and containment coordinator. The west platform air sample was discounted due to the diaphragm falling to the platform which created an airborne radioactivity situation. A second air sample from the west platform several feet away from the SG manway face had very low levels of alpha contamination. The workers were then sent into the steam generator bowls at about 1830 hours without further evaluation of the radiological hazards present and without a change to the specified work controls or to the worker protective equipment. No respiratory protective equipment was used for the initial entry into the SG bowls because it was not required by the RWP/ALARA work plan. Face shields were also not required by the work plan (and were not worn upon initial SG entry) although during the pre-job briefing it was agreed that their use was desirable. Similarly, RWP 2002-5303 did not require air sampling in the workers' breathing zone; therefore, no breathing zone air samples were collected prior to or during the entry.

Subsequent to the nozzle dam installations, the licensee obtained an RCS CRUD filter sample, smear samples from the SG platform and the D-ring area, and an air sample from the upper SG bowl. Due to the potential contamination from TRUs, these samples

were sent by the licensee to an independent laboratory for isotopic analysis. The analysis results indicated varying concentrations of TRUs in all the samples. The presence of TRUs combined with the high contamination levels in the SG led to a significant internal radiological hazard. Given the previous fuel failures, the high RCS iodine levels in operating cycle 13, and the increasing trend of alpha emitting isotopes in the plant, these results were not unexpected.

Analysis

(TBD) This issue represented a performance deficiency because the licensee had several indicators of potentially degraded radiological conditions and opportunities to identify and evaluate the radiological hazards present in the steam generator bowls but failed to adequately do so prior to worker entries. These indicators included a history of fuel failures, higher than previously experienced RCS iodine levels during the most recent operating cycle, knowledge of increasing alpha emitting isotope concentrations in the plant contamination mix, knowledge of a CRUD burst just prior to steam generator bowl entries, higher than previously experienced contamination levels in the SG bowls, and a SG platform air sample indicating airborne alpha contamination.

This issue affected the occupational radiation safety cornerstone to ensure adequate protection of worker health and safety from exposure to radiation. The issue is more than minor because the failure to identify and evaluate the radiological hazards associated with steam generator nozzle dam installations resulted in the substantial potential for worker dose in excess of regulatory limits had a minor alteration of the nozzle dam work circumstances occurred. There is no current safety concern because additional controls have been established for work that requires breaching of primary systems. Using the Occupational Radiation Safety Significance Determination Process, the finding did not involve ALARA planning or work controls, was not an overexposure, did involve a substantial potential for an overexposure, did not involve a skin dose or discrete radioactive particle exposure, and did not involve work in a very high radiation area. Therefore, the finding is preliminarily determined to be White. The substantial potential for an overexposure is based on the fact that the radiological source term (TRU isotope concentrations) could have been higher which would have resulted in greater intakes. Due to the failure to conduct representative surveys, the licensee would have been unaware of a higher source term. Also, since the intakes occurred primarily from re-suspended contamination, it would only have taken a minor alteration in the physical activity performed by the SG workers to have increased the airborne radiological hazards to levels that could have caused an internal overexposure. These factors collectively or individually created a work environment that represented a substantial potential for an overexposure. Consequently, it was fortuitous that an overexposure to the workers did not occur.

Enforcement

The licensee did not make adequate radiological surveys required by 10 CFR 20.1501, as may be necessary to comply with the occupational exposure limits of 10 CFR 20.1201. 10 CFR 20.1003 defines a survey as an evaluation of the radiological conditions and potential hazards incident to, among other matters, the presence of radioactive material or other sources of radiation. When appropriate, such an evaluation

includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation or concentrations or quantities of radioactive material present.

The licensee did not conduct an adequate evaluation of the potential radiological hazards inside the steam generator bowls prior to nozzle dam installation on February 20, 2002. This included the failure to adequately evaluate the radiological hazards associated with a history of fuel failures, higher than previously experienced RCS iodine levels during the most recent operating cycle, identification of increasing alpha emitting isotope concentrations in the plant contamination mix, identification that a CRUD burst occurred just prior to steam generator bowl entries, unusually high contamination levels on the SG diaphragms, and an air sample indicating airborne alpha contamination. This resulted in the failure to adequately identify the presence of alpha emitting isotopes in the SG bowls in concentrations which caused a substantial potential exposure to workers in excess of applicable regulatory requirements.

This issue is considered an apparent violation (AV 50-346/02-16-01).

b2. Worker Dose Assessments

Introduction

(TBD) The inspectors identified one apparent violation, preliminarily determined to have low to moderate safety significance (White), involving the failure to take suitable and timely measurements of concentrations of radioactive materials in air or quantities of radioactive material excreted from the body in order to adequately determine internal exposure to workers. This finding was more than minor because it compromised the licensee's ability to assess dose.

Description

After SG bowl entries, the two workers who installed the SG nozzle dams were identified as having relatively high internal contamination levels. Two methods used to calculate the radiation dose to workers following an intake of radioactive material are in-vitro and in-vivo bioassay sampling. In-vivo sampling involves the use of a whole body counter to measure and analyze the amount of radioactive material in the body from the outside. In-vitro bioassay sampling involves the collection and analysis of material excreted from the body. The licensee used both methods to calculate an estimated dose received by the workers as a result of their intake of radioactive material during the nozzle dam installations.

A third method for estimating dose from an uptake of radioactive materials involves air sampling in the work area prior to, or during the job. This involves using a general area air sampler, or placing individual "lapel" air samplers on each worker which provides a breathing zone estimate of the airborne radioisotopes. The licensee failed to conduct either type of air sampling and thus was unable to provide any data that represented the actual radiological conditions that the workers were in. This lack of airborne isotopic data impaired the licensee's ability to estimate the dose to workers from an uptake of transuranic isotopes.

To calculate the dose using in-vivo means, the licensee conducted five whole body counts (WBCs) of Worker A and four WBCs of Worker B during the 22-day period following the intakes. Based on the results of the WBCs, both workers were initially estimated to have an inhalation intake of approximately 1.5 microcuries of Co-58.

The licensee's whole body counter can only detect gamma-emitters such as fission and activation products, and cannot detect alpha-emitters. Transuranic isotopes are predominately alpha-emitters. To determine the intake of TRU isotopes, those isotopes are scaled to more easily detectable activation/fission products such as Co-58. The relative concentrations of TRUs to detectable gamma emitting isotopes can accurately be determined through laboratory analysis of air samples and/or area contamination (smear) surveys and be used to assess internal exposure, provided these samples are representative of the radiological work environment. The ratios of TRU to Co-58 in breathing zone air samples is normally consistent with a worker's inhalation intake provided all the isotopes had the same particulate size. However, the licensee did not obtain breathing zone air samples during the work activities. Therefore, TRU to cobalt ratios had to be established using other survey data which were most representative of the air quality in the worker's breathing zone. To accomplish this, the licensee identified three steam generator manway/diaphragm area smear samples that were most representative of the radiological work environment and used them to establish the TRU ratios/scaling factors and to calculate worker dose.

Normally, in-vitro bioassay sampling is the most accurate way to determine the dose associated with an intake of radioactive material, especially when TRUs are involved due to the inability of WBCs to detect these isotopes and the need to indirectly calculate their presence in the body. To get the most accurate results using in-vitro sampling, it is important to obtain these samples shortly after the intake of radioactive material. The licensee did not recognize the need to assess the dose from alpha emitting radioisotopes and did not obtain timely in-vitro bioassay samples. Once the results of the waste characterization samples were received from the licensee's contract laboratory on August 9, the licensee recognized the need to collect in-vitro bioassay samples to aide in its dose assessment. In-vitro bioassay samples were collected from Workers A and B and were analyzed by four different laboratories, one of which was contracted by the NRC for an independent dose assessment. While the licensee obtained fecal and urine samples from the two most contaminated workers, these samples were not obtained until approximately 7 months after the workers' intakes. Due to variations in biological clearance times and other variables, in-vitro data becomes less reliable as time from the intake increases.

Two independent licensee contractors performed dose assessments utilizing reasonable assumptions regarding the work activities and the associated radiological conditions. One assessment utilized the in-vivo bioassay (WBC) data to determine the initial intakes, and applied TRU scaling factors derived from the three steam generator manway/diaphragm area smears. The other contractor's assessment additionally utilized the in-vitro bioassay (fecal samples) to refine (back calculate) the intake assessment and to calculate dose. The more conservative of the two independent assessments determined that the combined respirable (inhalation) and non-respirable (ingestion) dose to the maximally exposed worker was 3.4 rem to the bone surface

(CDE) and 0.43 rem whole body (CEDE), which the licensee used as its dose of record for the exposed individuals. The regulatory limit for CDE (organ) exposure is 50 rem. The regulatory limit for CEDE (whole body) exposure is 5 rem. NRC staff evaluated the licensee's dose methodology and calculations and concluded they were reasonable.

Oak Ridge Institute for Science and Education (ORISE) was contracted by the NRC to perform an independent dose assessment. The assessment used the results of the independent fecal and urine analyses coompleted by the NRC contracted laboratory and conservative assumptions were applied to determine an upper bound dose estimate. ORISE calculated a bounding dose to the maximally exposed worker from both inhalation and ingestion pathways of 48 rem to the bone surface (CDE) and 3 rem whole body (CEDE). Based on both the licensee's contractors and ORISE results, it was concluded that there was not an overexposure to any of the workers involved in the nozzle dam work.

Analysis

(TBD) This issue represented a performance deficiency because the licensee did not obtain suitable and timely measurements of concentrations of radioactive material in air in work areas, or quantities of radionuclides excreted from the body to assess the internal dose to workers who installed SG nozzle dams. The failure to obtain suitable and timely measurements compromised the licensee's ability to assess dose. The licensee's failure to adequately determine the quantity of radionuclides in the body until over 200 days after the intake event, and the failure to obtain a representative air sample in the workers' breathing zone contributed to the compromised ability to assess dose. The final dose of record was based on calculations which utilized the results of SG manway/diaphragm area smear surveys coupled with WBC results.

This issue affected the occupational radiation safety cornerstone to ensure adequate radiological protection of worker health and safety and the attribute for adequate exposure monitoring. The issue is more than minor because the failure to obtain suitable and timely measurements to assess internal dose compromised the licensee's ability to assess dose. There is no current safety concern because procedural enhancements have been made to ensure that suitable and timely measurements are obtained for workers suspected of internal contaminations. Using the Occupational Radiation Safety Significance Determination Process, this dose assessment finding did not involve ALARA planning or work controls, was not an overexposure, did not involve a substantial potential for an overexposure, but did involve a compromised ability to assess dose. Therefore, the finding is preliminarily characterized as White.

Enforcement

10 CFR 20.1204 states that, when required by 10 CFR 20.1502, for the purposes of assessing dose used to determine compliance with occupational dose limits, the licensee shall take suitable and timely measurements of concentrations of radioactive material in air in work areas, quantities of radionuclides in the body, quantities of radionuclides excreted from the body, or combinations of these measurements.

10 CFR 20.1502(b) states that each licensee shall monitor the occupational intake of radioactive material by and assess the committed effective dose equivalent to adults likely to receive, in 1 year, an intake in excess of 10 percent of the applicable annual limits of intake in Table 1, Columns 1 and 2, of Appendix B to 10 CFR 20.1001-20.2402.

On February 20, 2002, the licensee failed to take suitable and timely measurements of concentrations of radioactive material in air in work areas, quantities of radionuclides in the body, quantities of radionuclides excreted from the body, or combinations of these measurements for two workers required to be monitored. Specifically, although it was known to the licensee that increasing concentrations of alpha emitting isotopes existed in the plant contamination mix over successive run cycles, that high contamination levels existed in the SGs, and that two workers received a relatively large amount of internal contamination, suitable and timely measurements were not taken of concentrations of radioactive material in the air the workers breathed and to detect the concentration of alpha emitting isotopes in the workers' bodies.

This issue is considered an apparent violation (AV 50-346/02-16-02).

4OA6 Meetings

Exit Meeting

On October 16, 2002, the inspectors conducted a preliminary public exit meeting where the initial findings were presented to Mr. Myers and other members of licensee management at the Davis-Besse Nuclear Power Plant. On December 13, 2002, Region III staff conducted a final exit meeting via telephone during which the inspectors presented the findings to Mr. Myers. The licensee representatives acknowledged the findings presented. The licensee did not identify any material reviewed during the inspection as being proprietary.

KEY POINTS OF CONTACT

Licensee
L. Myers, Chief Operating Officer
R. Pell, Radiation Protection Manager
G. Gillespie, Acting Supervisor, Technical Support

NRC Contractor
A. Boerner, ORISE

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

50-346/02-16-01	AV	Failure to adequately evaluate the radiological hazards
50-346/02-16-02	AV	Failure to obtain timely and suitable measurements

Closed

None

Discussed

None

LIST OF DOCUMENTS REVIEWED

CR 00-00737; Identification of an Airborne Radioactive Area; dated April 4, 2000

CR 02-00649; Loss of Access to Containment and Auxiliary Building Due to Contamination; dated February 20, 2002

CR 02-00659; Basic Cause Analysis Report - Shutdown Chemistry Method Utilized for 13 RFO less Effective than Anticipated; February 21, 2002

CR 02-00668; Increased Radioactivity in R.C.S.; dated February 21, 2002

CR 02-00709; Internal Dose Assessment; dated February 22, 2002

CR 02-000712; SG Nozzle Dam Installation; dated February 22, 2002

CR 02-00714; Administrative Dose Control Levels Exceeded Without Approval From the RPM; dated February 22, 2002

CR 02-00813; Unqualified Personal Completing Work Activities; dated February 25, 2002

CR 02–00815; Bartlett Technician and Deconner Master Qualification List; dated February 25, 2002

CR 02-00910; WholeBody Dosimetry Slipped Down onto Wrist; February 23, 2002

CR 02-01011; Facial Contamination While Wearing a Power Ventilation Face Shield; dated March 4, 2002

CR 02-01119; Recommended Improvements For ARP Support of Steam Generator Nozzle Dams; dated March 8, 2002

CR 02-01133; Coordination for Opening Door 300B Could Have Been Better; dated March 8, 2002

CR 02-01141; Dosimetry Investigation Criteria; dated March 11, 2002

CR 02-01205; DB-HP-01901 Procedure Not Followed; dated March 13, 2002

CR 02-01225; Higher Than Expected Dose Rates During Vacuuming of S/G Lower West Bowl; dated March12, 2002

CR 02-1226; Opening of Radiate Outside Roll up Door While Door 300 B was Open; dated March 12, 2002

CR 02-01255; Placing Dose Documentation Ahead of ALARA and Safety; dated March 14, 2002

CR 02-01362; Contamination Found on Sleeve of Clothing; dated March 22, 2002

CR 02-01429; Contaminated Shoe at Comanche Peak; dated April 1, 2002

CR 02-01438; Root Cause Analysis Report: Release of Discrete Radioactive Particles From the Davis-Basse Nuclear Station; dated April 2, 2002

CR-02-01448; OTS Lay up Conditions; dated April 3, 2002

CR 02-01518; Hot Particles Detected in Training and Welles Center; dated April10, 2002

CR 02-01540; Passing Gamma monitors with Fission Product Particles; dated April 15, 2002

CR 02-01541; Hot Particle Survey Off Site; dated April 15, 2002

CR 02-01545; Radioactive Material Found Offsite; dated April 15, 2002

CR 02-01684; Unqualified Person Assigned to Personnel Decontamination; dated April 25, 2002

CR 02-01685; Lapel Sample Not Taken During Nozzle Dam Insertion; dated April 25, 2002

CR 02-01687; Air Samples Not Taken In OTS Bowls Prior To Initial Entry; dated April 25, 2002

CR 02-01688; Incomplete Gamma Spectrum Library Used in Body Counter; dated April 25, 2002

CR 02-01714; Weaknesses Found in DB-HP-01701; dated April 26, 2002

CR 02-01716; Different Sensitivity of Portal Monitors at RTS Exit and PPF Exit; dated April 27, 2002

CR 02-01736; Positive Body Count on Incoming Worker; dated April 29, 2002

CR 02-01737; Difficulties with HEPA Filtration and Air Handling During OTS Evolutions; dated April 29, 2002

CR 02-01738; Contamination Found Offsite; dated April 29, 2002

CR 02-01763; Contamination Found on Workers Clothing During Exit Whole Body Count; dated April 30, 2002

CR 02-02432; Root Cause Analysis Less Than Adequate; dated June 7, 2002

CR 02-02606; Radiation Protection Corrective Action Program Considered Unacceptable; dated June14, 2002

CR 02-3097; Contamination and Radioactive Material Control Self-Assessment (2002-0087); dated August 11, 2002

CR 02-03365; Positive Whole Body Count; dated July 21, 2002

CR 02-03714; ALARA Review Does Not Completely Evaluate Effects of a Temporary Modification; dated August 5, 2002

CR 02-03718; Self Assessment 2002-0088 ALARA Reviews; dated August 5, 2002

CR 02-04524; Facial Contamination During Extent of Condition Inspection; dated August 19, 2002

CR 02-04850; Investigation of Long Lived Alpha Contamination; August 23, 2002

CR 02-06699; Bio-assay Results for Internal Dose Assessment of Steam Generator Workers; September 24, 2002

RWP 1998-5303; ALARA Package for Install and Remove Nozzle Dams and Nozzle Dam FME Covers and Equipment Set-up; Revision 0

RWP 2000-5303; ALARA Package for Install and Remove Nozzle Dams and Nozzle Dam FME Covers and Equipment Set-up; Revision 0

RWP 2002-5010; Primary Valve Maintenance Work; Revision 0

RWP 2002-5010; Initial Decon of Refueling Canal Prior to Rx Head Removal; Revision 1

RWP 2002-5023; Locked High Radiation Area Access for Operation Valve Line-ups; Revision 0

RWP 2002-5043; Valve Maintenance in Letdown Cooler Area (MU-1A,MU-1B and MU-64); Revision 0

RWP 2002-5127; Removal of Foreign Material From the Reactor Vessel and the Spent Fuel Pool, Revision 0

RWP 2002-5129; Rx Head Service Structure Insulation Removal, Shielding Installation and minor Clean-up to Support CRDM Nozzle Repair; Revision 0;

RWP 2002-5133; Inspect, Evaluate and Remove Nozzle #2; Revision 0

RWP 2002-5134; Inspect, Evaluate, and Remove Nozzle #11; Revision 0

RWP 2002-5135; Grind Indication and PT on Nozzle #46; Revision 0

RWP 2002-5136; Work on MOMAN; Revision 0

RWP 2002-5198; Remove Insulation from under TX Vessel and Refueling Canal; Revision 1

RWP 2002-5300; ALARA Package for Containment 632 and 565 Elevations, Upper and Lower OTS, Stage Tensioning Equipment . . . Remove Manway, Handhold Covers and Diaphragms, install, remove shield doors; Revision 0

RWP 2002-5301; ALARA Package for Set-up, Maintenance, Teardown of Eddy Current Equipment, Including Installation and Removal of Manipulator . . . in East and West Steam Generators; Revision 0

RWP 2002-5303; ALARA Package for Install and Remove Nozzle Dams and Nozzle Dam FME Covers and Equipment Set-up; Revision 0

RWP 2002-5303; ALARA Package for Install and Remove Nozzle Dams and Nozzle Dam FME Covers and Equipment Set-up; Revision 1

RWP 2002-5304; ALARA Package for Insulation Removal and Replacement East, 1-2 OTS; Revision 1

RWP 2002-5306; ALARA Package for Install and Remove Nozzle Dams and Nozzle Dam FME Covers and Equipment Set-up; Revision 0

RWP 2002-5526; CTMT Ventilation Duct Decon and Support Work Activities; Revision 0

RWP 2002-5554; Remove and Replace RCP 1-1-1 and 1-1-2 Rotating Assemblies; Revision 0

RWP 2002-5575; Pressurizer J Groove Weld Inspection and Associated Tasks; Revision 0

RWP 2002-6005; High Pressure Injection Pump Work to Include Removal and replacement of Pump and Associated Work; Revision 0

RWP 2002-6013; Replacement/Change-out of Various Filters; Revision 0

DB-HP-01104; Radiation Protection Procedure - Radiological Surveillance; Revision 05

DB-HP-01311; Radiation Protection Procedure- Portable High Efficiency Ventilation Units; Revision 01

DB-HP-01435; Radiation Protection Instrumentation Procedure - Calibration and Use of the Bicron/NE SPM 904C; Revision 00

DB-HP-01701; Radiation Protection Procedure - Personnel Contamination Evaluation and Decontamination ; Revision 04

DB-HP-01800; Radiation Protection Procedure - ALARA Review; Revision 05

DB-HP-01801; Radiation Protection Procedure - ALARA Design Review; Revision 01

DB-HP-01803; Radiation Protection Procedure - ALARA Briefs; Revision 1

DB-HP-01803; Radiation Protection Procedure - ALARA Review; Revision 06

DB-HP-01901; Radiation Protection Procedure - Radiation Work Permits; Revision 06

DB-HP-01901; Radiation Protection Procedure - Radiation Work Permits; Revision 07

DB-HP-06030; Radiation Protection Instrumentation Procedure - Calibration and Use of the PCM-1Band PCM-1C; Revision 04

DB-01115; Radiation Protection Procedure OTS Entries; Revision 00

DB-0125-0; Calibration Data Sheet - Small Article Monitor, November 29, 2001

DB-0125-0; Calibration Data Sheet - Small Article Monitor, December 5, 2001

DB-HP-01701; PCM Alarm Log; Revision 2

DB-HP-01701; PCM Alarm Log; Revision 3

ALARA Review Committee Minutes; February 25, 2002

Special ALARA Review Committee Minutes; March 2, 2002

ALARA Review Committee Minutes; March 4, 2002

Whole Body Counter Dose Level Report June 1, 1977 to September 5, 2002

Survey Number 2002-5146; Radiological Survey Form; February 24, 2002

Survey Number 2002-5221; Radiological Survey Form; February 28, 2002

Survey Number 2002-5255; Radiological Survey Form; March 2, 2002

Additional Information on Samples Taken and Whole Body Count Spectral Analysis; December 6, 2002

Additional Information on Dose Assessment Performed Externally; December 6, 2002

LIST OF ACRONYMS

ALARA	As-Low-As-Is-Reasonably-Achievable
DAC	Derived Air Concentration
DRP	Discrete Radioactive Particle
IRF	Intake Retention Fraction
PCM	Personnel Contamination Monitor
RCS	Reactor Coolant System
RWP	Radiation Work Permit
RPT	Radiation Protection Technician
SG	Steam Generator
SIT	Special Inspection Team
TRU	Transuranic
WBC	Whole Body Count

U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket No:	50-346
License No:	NPF-3
Report No:	50-346/02-06(DRS)
Licensee:	FirstEnergy Nuclear Operating Company
Facility:	Davis-Besse Nuclear Power Station
Location:	5501 North State Route 2 Oak Harbor, OH 43449-9760
Dates:	April 18 through December 13, 2002
Lead Inspector:	J. House, Senior Radiation Specialist
Inspectors:	R. Alexander, Radiation Specialist M. Mitchell, Radiation Specialist
Approved By:	John A. Grobe, Chairman Davis-Besse Oversight Panel

SUMMARY OF FINDINGS

IR 05000346-02-06(DRS), FirstEnergy Nuclear Operating Company; on 04/18 to 12/13/2002; Davis-Besse Nuclear Power Station. Special Inspection.

The report covers a special inspection by three regional inspectors that focused on compliance with NRC rules and regulations as they relate to the facts and circumstances associated with internal and external worker contamination during the steam generator nozzle dam installations in February 2002, and the transport of radioactive material offsite. One Green finding was identified. The significance of most inspection findings is indicated by their color (Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process" (SDP). Findings for which the SDP does not apply may be "Green" or be assigned a severity level after NRC management review. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

A. Inspector Identified Findings

Cornerstone: Public Radiation Safety

(Green) The licensee failed to conduct adequate evaluations (surveys) of the workers following their internal and external contamination during the steam generator nozzle dam installation job. The failure to perform adequate surveys of the workers is a violation of 10 CFR 20.1501 which requires licensees to conduct adequate evaluations to ensure compliance with the requirements for the control of licensed radioactive material as defined in 10 CFR 20.1802.

This issue has been determined to have very low safety significance (Green). The issue represented a performance deficiency because the licensee had several opportunities to conduct adequate surveys of the workers prior to releasing them from the site. The failure to conduct an adquate evaluation resulted in the uncontrolled transport of radioactive material offsite and into the public domain.

REPORT DETAILS

Summary of Plant Status: The plant was shut down for a refueling outage throughout the inspection period.

4. OTHER ACTIVITIES (OA)

4OA3 Event Follow-Up (93812)

Background and Event Overview

On February 20, 2002, several contract workers were both internally and externally radioactively contaminated while installing steam generator nozzle dams at the Davis-Besse plant. After several decontamination attempts, the workers were released from the site. In April 2002, the NRC staff became aware that four of these individuals were determined to be radioactively contaminated upon their arrival at other nuclear power plants and that the source of the contamination was potentially from their work at Davis-Besse. On April 17, the NRC dispatched a Special Inspection Team (SIT) to the Davis-Besse site and surrounding areas in accordance with NRC Management Directive 8.3, "NRC Incident Investigation Program." The SIT was chartered to assess the circumstances surrounding the release of radioactive material from the Davis-Besse facility, to assess the public dose consequences associated with the event, and to evaluate the licensee's review and response to the event.

Loss of Control of Radioactive Material Due to Inadequate Radiological Surveys

a. Inspection Scope

This Special Inspection (SI) was chartered to develop a timeline for and to assess the circumstances surrounding the release of radioactive material from the Davis-Besse facility, to assess the potential public dose consequences associated with the event, to evaluate the licensee's investigation and response to the event and to identify any associated regulatory issues.

Time Line For Worker Contamination and Transportation of Radioactive Material Offsite.

The discrete radioactive particles (DRPs) that were transported from the Davis-Besse plant by contract workers and recovered were of very low activity each ranging from less than 1 to approximately 34 nanocuries.

On March 22, 2002, a South Carolina nuclear generating plant (Oconee) notified Davis-Besse personnel that DRPs of very low activity had been detected on the clothing of two radiation workers during routine in-processing. These contract workers indicated to the South Carolina plant personnel that they had last worked at Davis-Besse.

On April 1, 2002, a Texas nuclear generating plant (Comanche Peak) notified Davis-Besse personnel that very low levels of radioactive material had been detected on a contract worker's personal clothing who had last worked at Davis-Besse.

On April 3, 2002, the same South Carolina nuclear generating plant notified Davis-Besse personnel that very low levels of radioactive material had been detected on the clothing of an additional contract worker who had last worked at Davis-Besse.

From April 5 to 8, 2002, the Davis-Besse contract workers' employer surveyed the residence of one of the contaminated workers and identified low levels of radioactive material on the worker's clothing. At the request of the worker, the worker's employer arranged for whole body counts (WBCs) on each member of the individual's family that had occupied the residence since the individual worked at Davis-Besse in February 2002. The WBCs were negative for the presence of radioactive material.

On April 8, 2002, Davis-Besse personnel surveyed temporary trailers used by the contract employer located inside the protected area of the Davis-Besse plant. No contamination was detected.

On April 9, 2002, a Davis-Besse RP supervisor was dispatched to South Carolina to conduct surveys in hotels and vehicles associated with activities of the contaminated individuals.

On April 10, 2002, the RP supervisor identified two additional DRPs on one of the individual's clothing in a motel room. On April 12, 2002, the RP Supervisor identified two additional DRPs at the individual's home in Virginia.

On April 10, 2002, additional on-site surveys at Davis-Besse identified radioactive material in the form of DRPs at the whole body counting facility and at the Wellness Center.

On April 12, 2002, the NRC was notified that radioactive material was identified in the public domain and appeared to be connected to contract workers who had last worked at Davis-Besse.

On April 13, 2002, Davis-Besse RP staff surveyed two transient housing locations used by these workers in the Davis-Besse area and identified two additional DRPs.

From April 18 to 25, 2002, the licensee's radiation protection (RP) staff surveyed additional transient housing locations used by these workers in the Davis-Besse area and identified two additional contaminated articles during NRC observed survey activities.

b. Findings

Introduction

The inspectors identified one violation which was determined to have very low safety significance (Green), involving the failure to conduct an adequate radiological evaluation in the form of surveys of the contaminated workers. This resulted in the uncontrolled release of radioactive material to unrestricted areas. This finding was more than minor because it had the potential to expose members of the public to radioactive material, and was associated with a violation of NRC requirements.

Description

On February 18, 2002, the Davis-Besse RP staff conducted an as low as is reasonably achievable (ALARA) briefing for Radiation Work Permit (RWP) 2002-5303, "Install and remove nozzle dams and nozzle dam foreign material exclusion covers and equipment set up." The brief included a discussion of protective clothing and radiological safety requirements for the work activity. There were no respiratory protection equipment requirements for this job. On February 20, at approximately 1800 hours, nozzle dam installation was started on the East Steam Generator. By 1900 hours, nozzle dam installation for both east and west steam generators was completed and the workers attempted to pass through personnel contamination monitors (PCMs) at the containment control point located within the radiologically restricted area (RRA). Because the workers were both internally and externally contaminated with radioactive material from the nozle dam installation, the PCMs at the containment control point alarmed. Station RP personnel attempted to decontaminate these workers by requiring them to shower and don clean scrubs. Repeated attempts to clear the workers through the PCMs failed and monitors alarmed indicating the presence of internal and/or external contamination. The RP staff conducted hand frisk surveys of the workers (focusing on the facial areas of the workers) and required the workers to shower again. After several attempts to decontaminate the workers at the containment control point, the RP staff assumed the remainder of activity causing the PCMs to alarm was internally deposited in the workers. The undergarments, shoes and socks of the workers were not independently surveyed for contamination and were worn each time the workers attempted to clear the PCM after showering and donning clean scrubs.

Although the workers continued to alarm the PCMs, they were cleared by the RP staff from the containment control point and proceeded to the PCMs at the RRA egress point. These PCMs also alarmed; however, the RP staff again assumed that the alarms were the result of internally deposited activity in the workers and allowed the workers to exit. The workers were then allowed to don their personal outer clothing and were escorted by RP staff from the RRA egress point, through the Personnel Processing Facility (PPF) bypassing the portal monitors located in the PPF, to the whole body counter. The whole body counter is located in the Training Building, outside of the protected area but inside the owner controlled area of the plant. Once at the whole body counter, the workers changed into clean "paper suits" and were whole body counted. Following the whole body counts the workers were released from the plant.

Subsequent to their release from Davis-Besse, it was identified that four of the workers were externally contaminated with very low levels of radioactive materials upon their arrival at other nuclear reactor facilities. This contamination was primarily in the form of DRPs having activities ranging from less than 1 to approximately 34 nanocuries. These activity levels would pose little health or safety risks to members of the public.

During follow up surveys between March 22 and April 21, the licensee identified 18 examples of radioactive material in uncontrolled areas outside of the RRA. Sixteen of the 18 examples were identified outside of owner controlled area in the public domain. A review of the circumstances surrounding the departure of the contaminated workers from Davis-Besse revealed that the licensee did not conduct adequate surveys of the workers to ensure all external contamination was removed from them. For instance, the

undergarments and/or shoes of the workers were not independently surveyed prior to their departure. In addition, the results of the first WBC compared with counts the next day indicated that external contamination was likely present when the workers were first counted, because the WBC results were inconsistent with biological intake retention models. However, no follow up surveys were initially conducted in areas the workers frequented when they left the site after the event. Once the DRPs were characterized and the workers' dwelling areas were surveyed, it became clear that the uncontrolled contamination originated at Davis-Besse and that it was primarily associated with activation and fission products (from fuel leaks).

If a member of the public would have ingested the radioactive material in the form of the DRP with the greatest activity identified, the resultant internal exposure would have been a small fraction of the regulatory limit for exposure to a member of the public which is 100 millirem. There was little potential for adverse health effects or consequences had a member of the public ingested that radioactive material.

The licensee conducted surveys of transient housing locations used by the workers while working at Davis-Besse, their permanent residences, and personal vehicles. These surveys included:

Large area smears of hard surfaces;
Direct frisk of clothing used at Davis-Besse, carpets, furniture, and bedding;
General area Micro-rem surveys; and
Micro-rem meter surveys of concentration points including vacuums, laundry traps, drain traps, ventilation filters, and trash collection points.

The inspectors observed Davis-Besse RP staff conduct a selection of these surveys. Additionally, the inspectors conducted independent surveys of Davis-Besse area transient housing used by the contaminated workers. At the request of a member of the public, the team performed an independent survey of personal effects used by the individual to clean personal property which was used as transient housing by two of the workers involved in the event. The inspectors determined that the licensee conducted comprehensive surveys to identify the extent of contamination in the public domain.

The inspectors reviewed the licensee's processes and protocols for personnel surveying, decontaminating, and dose assessment. The processes employed during the event resulted in several unsuccessful opportunities to survey and identify radioactive materials that were improperly released from the station. These surveys were either marginally performed or were completely missed. First, the RP staff relied on PCMs at the containment control point to assess whole body contamination and focused on the facial areas during frisks of the workers as part of decontamination efforts. This resulted in radioactive material of varying magnitudes not being identified at this control point. Second, the undergarments, shoes, and socks worn by the workers during the job evolution were not independently surveyed for radioactive material. The failure to survey for radioactive material on these items was most likely a transport mechanism for the radioactive materials to leave the plant. Third, the RP staffs' assumption that internal deposition of radioactive material was the sole cause of the PCM alarms at the containment and RRA egress points, resulted in a missed opportunity to survey for externally deposited radioactive material.

Analysis

This issue represented a performance deficiency because the licensee failed to perform adequate surveys and control licensed material. The failure to conduct adequate surveys resulted in the transport of radioactive material into the unrestricted area. The licensee had several opportunities to identify the external contamination on the workers. However, the licensee relied on the PCMs at the control points to assess whole body contamination and performed inadequate hand frisking. The workers undergarments, shoes and socks were not independently surveyed and the licensee assumed that internal deposition of radioactive material was the only cause of the PCM alarms.

This issue affected the public radiation safety cornerstone to ensure adequate protection of public health and safety from exposure to radioactive material released into the public domain and the attribute for radioactive material monitoring and control. Consequently the issue is more than minor. There is no current safety concern because the activity of the particles did not pose a radiological hazard to the workers or to the public. Using the Public Radiation Safety Significance Determination Process, the radioactive material control program finding was not a transportation issue. The radioactive material (particles) found offsite was of low activity and would not have produced a dose to a member of the public in excess of 5 millirem. The release of radioactive material had a common cause, in that the licensee's survey procedures and technician error led to the workers not receiving an adequate radiation survey, thus it is counted as one occurrence. Therefore the finding is Green.

Enforcement

10 CFR 20.1501 requires that each licensee make or cause to be made surveys that may be necessary for the licensee to comply with the regulations in Part 20 and that are reasonable under the circumstances to evaluate the extent of radiation levels, concentrations or quantities of radioactive materials, and the potential radiological hazards that could be present. Pursuant to 10 CFR 20.1003, *survey* means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.

As of February 20, 2002, the licensee did not perform adequate surveys to assure compliance with 10 CFR 20.1802, which requires that the licensee control and maintain constant surveillance of licensed material that is in a controlled area or unrestricted areas and that is not in storage. Specifically, on February 20, 2002, licensee surveys of workers were not adequate to control licensed material from inadvertently being carried by the workers outside of the controlled and restricted areas of the site. However, since the licensee documented this issue in its corrective action program (Root Cause Analysis Report: Release of Discrete Radioactive Particles from the Davis-Besse Nuclear Station, May 1, 2002), and because the violation is of very low safety significance, the violation is being treated as a Non-Cited Violation (NCV 50-346/02-06-01).

4OA6 Meeting(s)

Exit Meeting

On April 25, 2002, at the conclusion of the on-site inspection activities, the inspection team presented the initial assessment to Mr. R. Fast and other members of licensee management at the Davis-Besse Nuclear Power Plant. On October 16, 2002, the inspectors conducted a preliminary public exit meeting where the initial findings were presented to Mr. Myers and other members of licensee management at the Davis-Besse Nuclear Power Plant. On December 13, 2002, Region III staff conducted a final exit meeting via telephone and presented the findings to Mr. Myers. The licensee representatives acknowledged the findings presented. The licensee did not identify any material reviewed during the inspection as being proprietary.

KEY POINTS OF CONTACT

Licensee

R. Greenwood, Staff Health Physicist
R. Pell, Radiation Protection Manager
P. Shultz, Staff Health Physicist

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

50-346/02-06-01	NCV	Failure to adequately evaluate the radiological hazards

Closed

50-346/02-06-01	NCV	Failure to adequately evaluate the radiological hazards

Discussed

None

LIST OF DOCUMENTS REVIEWED

DB-0125-0; Calibration Data Sheet - Small Article Monitor (L.I. # 2.12.49); December 16, 2001

DB-0125-0; Calibration Data Sheet - Small Article Monitor (L.I. # 2.12.54); November 29, 2001

DB-0151-0; PCM Calibration Record (L.I. # 2.12.33); dated February 6, 2002

DB-0151-0; PCM Calibration Record (L.I. # 2.12.38); dated February 4, 2002

DB-0151-0; PCM Calibration Record (L.I. # 2.12.52); dated January 18, 2002

DB-0151-0; PCM Calibration Record (L.I. # 2.12.53); dated January 18, 2002

DB-0190-0; SPM-906 Calibration Record (L.I. # 2.12.55); dated October 17, 2001

DB-0265-0; PCM-2 Calibration Record (L.I. # 2.12.58); dated February 8, 2002

DBP 6027F; Radiation Monitor Setpoint - Portal Monitor (SPM-906 and SPM-904); dated December 3, 2001

DB-HP-01435; SPM-904C Calibration Record (L.I. # 2.12.48); dated July 20, 2001

DB-HP-01435; SPM-904C Calibration Record (L.I. # 2.12.47); dated July 20, 2001

DB-HP-06030; PCM/TCM Plateau Data Sheet (L.I. # 2.12.39); dated September 21, 2001

CR 2000-0737; Air Sample Taken on the 653' Elevation of Containment; dated April 3, 2000

CR 2000-0809; Radiological Concern Regarding Door 300; dated April 7, 2000

CR 02-00259; Portal Monitors at PPF Exit Catch Particle on Shoe; dated January 25, 2002

CR 02-00649; Loss of Access to Containment and Auxiliary Building Due to Contamination; dated February 20, 2002

CR 02-00712; SG Nozzle Dam Installation; dated February 22, 2002

CR 02-00714; Administrative Dose Control Levels Exceeded Without Approval from the RPM; dated February 20, 2002

CR 02-01024; Dose Estimate Revised; dated March 4, 2002

CR 02-01174; Contamination Found in the Protective Clothing Dress Out Area; dated March 10, 2002

CR 02-01362; Contamination Found on Sleeve of Clothing; dated March 22, 2002

CR 02-01429; Contaminated Shoe at Texas Facility; dated April 1, 2002

CR 02-01438; Potential Release of Hot Particles to Other Sites; dated April 2, 2002

CR 02-01518; Hot Particles Detected in Training and Wellness Center; dated April 10, 2002

CR 02-01540; Passing Gamma Monitors with Fission Product Particles; dated April 13, 2002

CR 02-01541; Hot Particle Survey Off Site; dated April 13, 2002

CR 02-01545; Radioactive Material Found Offsite; dated April 12, 2002

CR 02-01616; RP Portal Monitor Alarm at PPF; dated April 19, 2002

SMF-2002-000994-00; Individual Alarmed the PM-7 at the Primary Access Point (CR from Texas Facility); dated March 30, 2002

Access Control Records for RWP No. 2002-5303; dated February 1 - April 1, 2002

Chemistry Trend Data - Reactor Coolant System Specific Activity; dated February 1 - March 13, 2002

Chemistry Trend Data for Cycle 13 - Np-239 in Crud, Iodines, RCS Cesiums, RCS Cobalts, and Xe-133; May 2000 - dated February 2002

Gamma Spectroscopic Data for Radioactive Material Identified Outside of Davis-Besse RRA; dated March 22 - April 18, 2002

In-processing Documentation for Steam Generator Workers at South Carolina Facility; dated March 22 - April 3, 2002

Notes From the ALARA Review Committee Meeting; dated February 25, 2002

Notes From a Special ARC Meeting; dated March 2, 2002

Notes From an ARC Meeting; dated March 4, 2002

RCA Exclusion Reports from Access Control Database; dated February 20 - March 7, 2002

Re-analyzed Whole Body Count Data for All Refueling Outage Workers Requiring Internal Dose Analyses; dated April 22 - 27, 2002

Steam Generator Worker Dose Assessment Documents, including Whole Body Count Data; dated February 20 - March 15, 2002

Technical Position Paper - Passive Internal Monitoring Program at Davis-Besse NPS

RWP/ALARA Package No. 2002-5303 Install and Remove Nozzle Dams and Nozzle Dam FME Covers and Equipment Setup; Revisions 0 and 1

Portal Monitor Model SPM-904 Operating and Service Manual; dated October 14, 1994

Portal Monitor Model SPM-906 Operating and Service Manual; dated November 27, 2000

DB-HP-00000; Radiation Protection Program Administration; Revision 04

DB-HP-00003; Radiological Surveillance Program; Revision 03

DB-HP-01108; Hot Particle Detection and Control; Revision 05

DB-HP-01320; Operation of Whole Body Counters; Revision 05

DB-HP-01322; Body Counter Calibration and Performance Testing; Revision 02

DB-HP-01435; Calibration and Use of the Bicron/NE SPM 904C; Revision 00

DB-HP-01447; Small Article Monitor Calibration; Revision 02

DB-HP-01701; Personnel Contamination Evaluation and Decontamination; Revision 04

DB-HP-01706; Release of Material from Radiologically Restricted Areas; Revision 05

DB-HP-01800; ALARA Review; Revision 06

DB-HP-01901; Radiation Work Permits; Revision 06

DB-HP-06030; Calibration and Use of the PCM-1B and PCM-1C; Revision 04

DB-HP-06122; Calibration and Use of the PCM-2; Revision 00

DB-HP-10000; Radiation Monitor Setpoint Control; Revision 04

RPAI-050; RP Administrative Instruction - Control of Door 300 During Refueling and Maintenance Outages; Revision 0

Letter from Texas Facility to Davis-Besse Documenting Survey of Worker D's Transient Housing; dated April 23, 2002

SL-1290-1; Survey of Worker A's Residence (Performed by Worker's Employer); dated April 4, 2002

Survey No. 032802-6; Survey of Worker B's Personal Vehicle (Performed by South Carolina Facility); dated March 26, 2002

Survey No. 2002-00016; Routine Survey of Training Building Whole Body Count Room; dated January 3, 2002

Survey No. 2002-01319; Survey of Protected Area Temp. Trailers; dated April 8, 2002

Survey No. 2002-01336; Survey of Areas Outside of RRA (Training Center and Wellness Center); dated April 10, 2002

Survey No. 2002-01356; Survey of Storage Building Outside of Protected Area; dated April 12, 2002

Survey No. 2002-01357; Direct Frisk Survey of Dosimetry and RP Conference Rooms; dated April 12, 2002

Survey No. 2002-1366; Survey of Worker A's Transient Housing in Ohio; April 13, 2002

Survey No. 2002-1367; Survey of Workers B's and F's Transient Housing in Ohio; dated April 13, 2002

Survey No. 2002-1431; Survey of Worker G's Transient Housing in Ohio; dated April 17, 2002

Survey No. 2002-1433; Survey of Workers C's and D's Transient Housing in Ohio; dated April 19, 2002

Survey No. 2002-1440; Survey of Laundry Facilities at Worker A's Transient Housing in Ohio; dated April 20, 2002

Survey No. 2002-1464; Survey of Radioactive Material Containers and Areas Outside of RRA at Davis-Besse; dated April 23, 2002

Survey No. 2002-1465; Survey of Laundry Facilities at Workers C's and D's Transient Housing in Ohio; dated April 17, 2002

Survey No. 2002-1466; Additional Survey of Laundry Facilities at Workers C's and D's Transient Housing in Ohio; dated April 18, 2002

Survey No. 2002-1467; Survey of Worker E's Transient Housing in Ohio; dated April 20, 2002

Survey No. 2002-1470; Survey of Worker D's Residence; dated April 19, 2002

Survey No. 2002-1471; Survey of Worker G's Transient Housing in South Carolina; dated April 19, 2002

Survey No. 2002-1472; Survey of Worker E's Residence; dated April 20, 2002

Survey No. 2002-1473; Additional Survey of Worker E's Residence; dated April 20, 2002

Survey No. 2002-1474; Survey of Worker E's Personal Vehicle; dated April 20, 2002

Survey No. 2002-1475; Survey of Worker C's Residence; dated April 20, 2002

Survey No. 2002-1476; Survey of Worker C's Personal Vehicle; dated April 20, 2002

Survey No. 2002-1477; Survey of Worker G's Residence; dated April 21, 2002

Survey No. 2002-1478; Survey of Worker F's Residence; April 21, 2002

Survey No. 2002-1482; Survey of Worker A's Transient Housing in South Carolina; dated April 10, 2002

Survey No. 2002-1483; Additional Survey of Worker A's Transient Housing in South Carolina; dated April 11, 2002

Survey No. 2002-1484; Survey of Worker A's Residence; dated April 12, 2002

Survey No. 2002-1485; Survey of Worker B's Residence; April 13, 2002

LIST OF ACRONYMS

ALARA	As-Low-As-Is-Reasonably-Achievable
CEDE	Committed Effective Dose Equivalent
CFR	Code of Federal Regulations
DRP	Discrete Radioactive Particle
IMC	Inspection Manual Chapter
NRC	Nuclear Regulatory Commission
PCM	Personnel Contamination Monitor
PPF	Personnel Processing Facility
RP	Radiation Protection
RRA	Radiologically Restricted Area
RWP	Radiation Work Permit
SDP	Significance Determination Process
SI	Special Inspection
SIT	Special Inspection Team
WBC	Whole Body Count