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Recipients:
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

June 15, 1990

Docket No. 50-333

Mr. John C. Brons
Executive Vice President - Nuclear Generation
Power Authority of the State of New York
123 Main Street
White Plains, New York 10601

Dear Mr. Brons:

SUBJECT: STAFF'S BACKFIT ANALYSES FOR JAMES A. FITZPATRICK NUCLEAR POWER PLANT REGARDING INSTALLATION OF A HARDENED WETWELL VENT (GENERIC LETTER 89-16) (TAC NO. 74868)

In SECY 89-017, "Mark I Containment Performance Improvement Program," of January 23, 1989, the staff demonstrated that hardened wetwell venting capabilities at Mark I containments would prevent the majority of severe accident sequences involving loss of decay heat removal capability (TW sequences) from resulting in core melt. The staff also demonstrated that venting through a hardened vent path from suppression pool airspace would significantly mitigate the risks to public health and safety, because substantial amounts of fission products released by core melt would be trapped in the suppression pool and would not be available for release to the environment. Some benefits are also expected because of the prevention of severe accident sequences other than TW sequences from resulting in core melt. Based on the analyses in SECY 89-017, the staff informed the Commission that the generic installation of hardened vent capabilities at Mark I containments would provide significant added benefits resulting from a reduction of severe accident risks to public health and safety.

On July 11, 1989, the Commission responded to the staff recommendations in SECY 89-017 and directed the staff to implement, on a generic basis, the installation of hardened vent capabilities at boiling water reactors (BWRs) with Mark I containments. Accordingly, on September 1, 1989, the staff issued Generic Letter 89-16 (GL 89-16). In that letter, the staff urged the affected licensees to voluntarily install hardened vent capabilities at their Mark I containments using the provisions of the Commission's rules in 10 CFR 50.59. If the licensees chose not to install the hardened vent capability on a voluntary basis, the staff requested in GL 89-16 that the licensees provide their plant-specific estimates of costs of installation of hardened vent capabilities. The licensees were informed that the staff would use the cost data to perform plant-specific backfit analyses, and to determine if hardened vent installations could be imposed as backfits in accordance with the Commission's backfit rule in 10 CFR 50.109.

B/13

By letter of October 27, 1989, you responded to GL 89-16 indicating that you had decided not to commit to install hardened vent capabilities on a voluntary basis. You also provided the staff with plant-specific cost estimates for modifications at the James A. FitzPatrick Nuclear Power Plant (FitzPatrick).

Following the receipt of your October 27, 1989 letter, the staff initiated plant-specific backfit analyses for FitzPatrick. In its analyses, the staff used the plant-specific cost estimates that you provided. The staff estimated the benefits of venting by determining the reductions in core damage frequencies (CDFs) for only the TW sequences. The benefits were calculated by using the results of the probabilistic risk assessments (PRAs) for BWRs with Mark I containments similar to FitzPatrick's. The staff then adjusted the analyses to account for recent advances in the PRA methodology (NUREG-1150). The results of the staff's analyses showed that for TW sequences alone the overall CDF for FitzPatrick can be reduced by 4.5 E-5 per reactor year. The analyses were adjusted to account for the power level of FitzPatrick, and the density of population surrounding the FitzPatrick site. The staff has calculated that for TW sequences alone, the operation of the vent would avert the expected radiological exposure to public by 65.5 man-rem per reactor year. Using 25 years of remaining plant life for FitzPatrick, the staff has estimated an averted radiological population exposure of 2408 man-rem per million dollars. The preceding results of the staff analyses demonstrate that hardened vent capabilities would provide significant benefits in the expected reduction in radiological exposure risks posed by TW sequences.

The staff has also calculated the other averted costs that would be associated with severe accidents involving TW sequences to clean the site surroundings and to replace the lost power. The averted costs of cleaning the site surroundings and replacing power, would be $786,000. Assuming that the averted costs of cleaning the site and replacing the power would offset the cost of the modification, the modification costs would be fully offset by the benefits of averted costs.

The staff has considered but not quantified the reduction in risks posed by (1) severe accidents other than TW sequences, and (2) scrubbing of the fission products in the suppression pool for accident sequences that result in significant damage to the core. These benefits provide added incentives for installation of a hardened vent capability at FitzPatrick.

Based on the preceding quantitative and qualitative discussions, the staff believes that there will be a substantial additional increase in protection to the public health and safety if a hardened vent capability is implemented at Fitzpatrick. Therefore, the staff has concluded that the backfit is justified for FitzPatrick. A copy of the staff's supporting analyses for FitzPatrick is enclosed for your information.

In your letter dated October 27, 1989, you raised several questions regarding the staff's analyses in SECY 89-017. The staff's responses to your questions are also included in Appendix B of the enclosure.

In light of the staff's backfit analyses, the staff urges that you reconsider your decision and commit to install a hardened vent capability at FitzPatrick. You are requested to inform the staff of your intent within 30 days of receipt of this letter. You may implement your commitment under the provisions of the Commission's rules in 10 CFR 50.59, provided that the modifications are in place by January 1993. In the absence of such a commitment, the staff intends to pursue the imposition of this backfit under the provisions of the Commission's backfit rule in 10 CFR 50.109.

Sincerely,

Thomas E. Murley

Thomas E. Murley, Director
Office of Nuclear Reactor Regulation

Enclosure:
Plant-Specific Backfit Analyses for FitzPatrick

cc w/enclosure:
See next page

cc:

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Plant-Specific Analysis
for the FitzPatrick Nuclear Power Plant, Regarding
Installation of a Hardened Vent

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Plant-Specific Analysis
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1.0 Background

In SECY-87-297 (Reference 1), dated December 8, 1987, the Nuclear Regulatory Commission (NRC) staff presented to the Commission its program plan to evaluate generic severe accident containment vulnerabilities in a program entitled the Containment Performance Improvement (CPI) program. The staff began this effort with the premise that there may be generic severe accident challenges to each light water reactor (LWR) containment type that should be assessed to determine whether additional regulatory guidance or requirements concerning needed containment features is warranted. The premise that such assessments are needed is based on the relatively large uncertainty in the ability of some LWR containments (for example, Mark I) to successfully survive some severe accident challenges, as indicated by NUREG-1150, dated June 1989 (Reference 2). This effort is integrated closely with the program for Individual Plant Examination (IPE) and is intended to focus on resolving hardware and procedural issues concerning generic containment challenges. In SECY-89-017 (Reference 3), dated January 23, 1989, the staff presented its findings concerning the Mark I CPI program to the Commission. One of the improvements that the staff recommended was the installation of a hardened vent capability.

The staff concluded that venting, if properly implemented, can significantly reduce plant risk. This vent capability has long been recognized as important in reducing risk caused by loss of long-term decay heat removal events. Controlled venting can prevent the long-term over-pressurization and eventual failure of containment, the failure of Emergency Core Cooling System (ECCS) pumps caused by inadequate net positive suction head, and the re-closure of the valves in the Automatic Depressurization System (ADS). Venting of the containment is currently included in the emergency operating procedures for boiling water reactors (BWRs). A vent path using existing containment penetrations currently exists in all Mark I plants. This vent path generally consists of a system of sheet metal ductwork that has a low design pressure of only a few psi. Venting under high-pressure conditions created either before or after core melt may fail this ductwork, release the containment atmosphere into the reactor building, and potentially contaminate or damage equipment needed for accident recovery. In addition, with the existing hardware and procedures at some plants, it may not be possible to open or to close the vent valves for some accident scenarios. Therefore, venting through a sheet metal ductwork path, as currently implemented at some Mark I plants, is likely to hamper or complicate post-accident recovery activities, and is, therefore, viewed by the staff as reducing the safety benefit. A hardened pipe vent capable

of withstanding the anticipated pressure loading of a severe accident would eliminate this disadvantage.

The Commission concurred with the staff's position and directed the staff on July 11, 1989 (Reference 4) to begin imposing a hardened vent capability on a plant-specific basis for each BWR with a Mark I containment. For licensees who, on their own initiative, elect to incorporate this plant improvement, the staff was directed to consider installation of a hardened vent under the provisions of 10 CFR 50.59. For the other licensees who do not intend to install a hardened vent voluntarily, the staff was to perform a plant-specific backfit analysis for each of these Mark I plants to evaluate the efficacy of requiring the installation of hardened vents.

The staff issued Generic Letter (GL) 89-16 dated September 1, 1989 (Reference 5) to BWR licensees with Mark I containments: (1) to inform them of the direction given by the Commission regarding the hardened vent issue, (2) to provide them with a generic cost estimate for the installation of a hardened vent and (3) to request that each licensee provide notification of its plan for addressing resolution of this issue. Moreover, the staff encouraged licensees to implement the design changes to install the hardened vent. For those plants not electing to voluntarily install hardened vents, the staff requested in GL 89-16 that the licensees provide a cost estimate for installation of the hardened vent. In response to the Commission's directives, the staff developed a program to meet the objectives of the Commission's directive. This program plan contains the following five tasks: (1) cost estimation, (2) plant similarity assessment (3) cost-benefit analysis, (4) environmental assessment, and (5) imposition of requirements.

2.0 Discussion

The purpose of this report is to document the results of the plant-specific backfit analysis performed by the staff for the FitzPatrick Nuclear Power Plant. This analysis complies with the backfit rule in 10 CFR 50.109 (Reference 6) and includes an assessment of the safety benefits, an estimate of the reduction in core damage frequency and public risk, and a cost-benefit analysis. From the results of this analysis, the staff concludes that the installation of a hardened vent capability will substantially increase public safety and that the results of the cost-benefit analysis support the implementation of the capability.

2.1 Safety Benefits

The major benefit of a hardened vent is the reduction of both the core damage frequency and public risks. Probabilistic Risk Assessment (PRA) studies for BWRs indicate that accidents initiated by transients dominate the total core damage frequency (CDF) in severe accident sequences. The principal accident sequences for BWRs consist of Loss of Long-Term Decay Heat Removal (TW), Station

Blackout (SBO), and Anticipated Transient Without Scram (ATWS). The Reactor Safety Study (WASH-1400) (Reference 7) indicated that TW is the dominant accident sequence causing core damage at the Peach Bottom Atomic Power Station. Further, draft NUREG-1150 (Reference 2) indicates that SBO is the dominant contributor to core damage frequency at Peach Bottom. At Peach Bottom, it was estimated that the TW frequency has been greatly reduced because of the successful implementation of containment venting procedures. This study indicates that venting, if properly implemented, can significantly increase safety.

In SECY 89-017, the staff concluded on a generic basis for Mark I plants that the proposed hardened vent capability would provide enhanced plant capabilities with regard to both accident prevention and mitigation. A core melt, combined with reactor vessel rupture and containment failure, would release significant amounts of fission products to the environment. The addition of a hardened vent (1) prevents the majority of loss of long-term decay heat removal capability sequences (TW) from resulting in core melt, and (2) mitigates the consequences of residual sequences involving core melt where venting through the suppression pool is found necessary. The TW sequences are initiated by transient events and are followed by failure of long-term decay heat removal; the containment fails from overpressurization and causes the subsequent core melt. The installation of a hardened vent will increase the survivability of containment, reduce the likelihood of a core melt from TW sequences, and therefore reduce the risks to the public. For other sequences where core melt occurs before containment failure, venting could be effective in delaying containment failure and in mitigating the release of fission products because venting through the suppression pool would provide significant scrubbing of particulate and volatile releases.

In a BWR, containment venting is currently included in the emergency operating procedures. The existing vent path generally consists of ductwork ranging in pressure capability down to design pressure of only a few psi for most Mark I plants. The low design-pressure ductwork is inadequate for accommodating the high containment pressure following a severe accident. Consequently, venting under severe accident conditions could result in failure of the ductwork and a direct release of radioactivity into the reactor building. The discharge of high-temperature gases over an extended period of time may threaten the availability or performance of safety-related equipment. If substantial fuel damage has occurred, the discharge of hydrogen could cause hydrogen burns (or detonations) inside the reactor building. Electrical cables, motor operators on valves, relays, and control room components may fail under these environmental conditions. Adverse environmental conditions would complicate entry into the reactor building. This environment of high temperature and perhaps radiation could hamper recovery efforts by preventing personnel from entering into the reactor building if systems needed to terminate the accident need repair. As a result,

when relying on the existing ductwork, the benefits of containment venting are significantly uncertain. Therefore, hardening the vent path to withstand the anticipated pressure loading during a severe accident would eliminate this disadvantage while retaining all the benefits of containment venting.

Because of the reduced core melt frequency, reduced fission product releases, and possible reduction or elimination of a significant containment failure mode, the staff concluded that the safety benefits of venting are significant, and further improvement can be achieved by installing hardened vents. In Reference 8, the staff estimated the benefits in the reduction in CDF and in offsite risk, which are discussed in the following sections.

2.2 Reduction in Core Damage Frequency and Public Risk

To estimate the plant-specific reduction in CDF, all Mark I plants were categorized into several groups based on the similarity of the design features that are important to the accident sequences that could be affected by the installation of a hardened vent. In performing the analysis, the staff used existing Mark I PRAs along with the plant similarity assessment to estimate the reduction in CDF for each group of plants. The analysis includes only the change in the core melt frequency for the TW sequence.

2.2.1 Plant Similarity Assessment

In draft NUREG/CR-5225 (Reference 9), the three accident sequences that were identified as being affected by venting are: (1) Loss of Long-Term Decay Heat Removal (TW), (2) Anticipated Transient Without Scram (ATWS), and (3) Station Blackout (SBO). Among these sequences, the addition of a hardened vent was found to produce the greatest reduction in core damage frequency (CDF) through its effect on TW sequences. In the TW sequence, failure to remove decay heat following a transient will cause the gradual pressurization of the containment. The containment may fail from overpressurization and subsequently may lead to a core melt. In this sequence, venting can be used to allow the removal of long-term decay heat from the containment through pool boiling and therefore, reduce the likelihood of containment failure and subsequent core melt. The design features important to this sequence are the systems used for decay heat removal and containment cooling.

The reduction in CDF for the TW sequence of each Mark I plant resulting from the installation of the hardened vent was estimated by the staff in Reference 8. To account for similarity in design, all Mark I plants were grouped according to the design of their decay heat removal and containment cooling systems - factors important in assessing the frequency of TW sequences. In determining the groups by examining individual plant features in simplified piping and instrument diagrams, the staff studied the differences between the RHR systems, isolation condensers, power conversion system, and

service water systems for all Mark I plants. In addition, the staff studied the available PRAs and failure probabilities of related components to identify any major differences and similarities in terms of CDF affected by the hardened vent capability. After careful study of the available PRAs, the staff categorized the Mark I plants into the following four groups:

(1) Plants with a residual heat removal (RHR) system consisting of two trains, with two RHR heat exchangers and two RHR pumps per train,

(2) Plants with an RHR consisting of two trains, with one RHR heat exchanger and two RHR pumps per train,

(3) Plants with an RHR consisting of two trains, with one RHR heat exchanger and one RHR pump per train, and

(4) Plants with isolation condensers.

2.2.2 Reduction in Core Damage Frequency

To estimate the reduction in CDF from the installation of a hardened vent capability, the staff looked into the sequences that require failure of containment cooling for core damage, and assumed that addition of a hardened vent would reduce these sequences by 90 percent. The estimates of CDF reduction conservatively consider only the TW sequences, and therefore, the benefits for the SBO and ATWS sequences are not included.

For FitzPatrick, the CDF was estimated using the PRA results of a plant with similar design features. To be consistent with the assumptions used in NUREG-1150, the staff incorporated several changes into the referenced PRA. These changes included the generic data used and the treatment of recovery.

The following are the principal changes to the referenced PRA study:

1. The referenced PRA study used a value of 0.5 per year for loss of main feedwater frequency (T_3B) and did not consider any other way of losing the power conversion system (PCS). The initiator of T_2T_3B, loss of PCS or of main feedwater leading to loss of PCS, has a frequency of 2.3 per year in the present study as opposed to the value of 0.5 per year in the referenced PRA study.

2. The referenced PRA study did not give credit for recovery of loss of offsite power in the TW sequences. The present study did so.

3. The probability of nonrecovery of the power conversion system was assumed to be 0.16 in 24 hours in the referenced PRA study, while it was 0.01 in NUREG-1150 study.

4. The component data and the data for common cause failures were made consistent with NUREG-1150 generic data.

5. Certain common cause failures that were not included in the referenced PRA study were included in the present study. In particular, the common cause failure of the RHR service water outlet valves for heat exchanger A (MOV-89A) and for heat exchanger B (MOV-89B) was included. The joint failure of these valves was included in the referenced PRA study, but the failure was treated as if they were independent.

6. Loss of an AC or DC bus coupled with failure of the service water outlet valve for the heat exchanger in the opposite RHR loop appears to be a valid cutset, but was not included in the referenced PRA study. This cutset was included in the present study. A cutset, consisting of loss of an AC or DC bus coupled with a service water inlet valve for the heat exchanger in the opposite loop failing closed, was included in the referenced PRA study but not in the present study. The reason for not including this cutset was its lower probability.

7. The referenced PRA study did not consider transients with two or three stuck-open relief valves, while the present study does consider this transient.

With these changes, the staff calculated that venting would produce a reduction in CDF of 4.5E-5 per reactor year. More detailed descriptions of the analysis are given in Reference 8.

2.2.3 Risk Reduction

Installation of a hardened vent will reduce the CDF and will result in a reduction in the population dose that is associated with the TW sequences. The estimate of the reduction in population dose for FitzPatrick was calculated by multiplying the reduction in CDF estimated for FitzPatrick by a scaling factor to convert the Peach Bottom population dose to the FitzPatrick population dose. The scaling factor was obtained from NUREG/CR-2723 (Reference 10) for FitzPatrick plant-specific reactor power and population density. The Peach Bottom population dose from TW sequences was derived using the insights from NUREG-1150. The resulting reduction in the population dose for FitzPatrick due to the reduction in CDF for TW sequences was estimated to be 1.46E6 man-rem. The averted population dose for FitzPatrick was calculated by multiplying the reduction in CDF by 1.46E6 man-rem to give 65.5 man-rem per reactor year. For the 25 years of operation remaining, the estimated total averted dose is 1638 man-rem. In addition, consideration of a likely 20-year operating life extension will increase the estimated total averted dose to 2948 man-rem.

The averted occupational health risk resulting from the installation of the proposed hardened vent system is discussed and calculated in Section 4.1.2.2 of Appendix A. The estimated occupational risk is approximately one to two percent of the public health risk and is not considered to be a significant contributor. Therefore, the occupational health exposures are not further considered in the cost-benefit analysis.

2.3 Cost-Benefit Analysis

The method used to calculate the cost-benefit ratio is described in NUREG/CR-3568 (Reference 11), and the plant-specific data were considered. The staff obtained plant-specific cost estimates provided by the licensee from the response to Generic Letter (GL) 89-16 and used the risk-reduction data discussed above in Section 2.2.3 to calculate the value-impact ratio in man-rem saved per million dollars.

2.3.1 Cost Estimation

GL 89-16 requested licensees to provide the staff with plant-specific cost estimates for installing a hardened vent. In response to GL 89-16, all Mark I licensees except four (with five plants) indicated that they intend to install the hardened vent under the provisions of 10 CFR 50.59.

FitzPatrick is one of the five Mark I plants. The Power Authority of the State of New York (the licensee) has decided not to voluntarily install the hardened vent capability. By letter dated October 27, 1989 (Reference 12), the licensee of FitzPatrick responded to GL 89-16 with a cost estimate of $680,000 for the installation of a hardened vent, and incremental costs of $70,000 for an AC-independent power source.

2.3.2 Value-Impact Assessment

The value-impact ratio is calculated in the regulatory analysis (Appendix A) using the method described in NUREG/CR-3568 (Reference 11) to support the backfit decision. The benefits to public risk reduction in man-rem were calculated in Section 2.2.3. The averted population dose for FitzPatrick was calculated in Section 2.2.3 to be 65.5 man-rem per reactor year. For the 25 years of operation remaining, the estimated total averted man-rem is 1638. The cost of installation of the hardened vent capability was estimated in Section 2.3.1 as $680,000. The value-impact ratio, not including the averted onsite cost, is calculated to be 2408 man-rem saved per million dollars.

The averted cost associated with prevention and mitigation of an accident can be discussed as five separate costs: replacement power, cleanup, onsite occupational health impacts, offsite health impacts,

and onsite property damage. The details of each of these items are discussed in Appendix A Section 4.1.2.2. If the savings of $786,578 to FitzPatrick from accident avoidance (cleanup, repair of onsite damages, and replacement power) were included, the overall value-impact ratio would be -15366 man-rem saved per million dollars. The negative number indicates that the averted costs exceed the installation costs, which means that it is economically cost-effective. Consideration of a likely 20-year operating life extension will increase the averted population dose to 2948 man-rem.

2.4 Alternatives Considered and Impacts on Other Programs

Other alternatives considered and their associated value-impact ratios are discussed in Section 3.0 and 4.0 of the Regulatory Analysis in Appendix A, Regulatory Analysis. The effect of the addition of the hardened vent capability on other requirements including IPE, Improved Plant Operations (IPO), Severe Accident Research Program (SARP), External Events, and Accident Management are discussed in Section 4.2 of Appendix A. A summary of the compliance to the backfit rule (10 CFR 50.109(c)) is also included in Attachment 1 to Appendix A.

2.5 Environmental Assessment

The staff performed a generic environmental assessment (EA) concerning the installation of the hardened vent at Mark I plants. Concurrent with this plant-specific analysis, a draft EA is being sent out for public comments. In the draft EA, the staff concluded that the installation of a hardened vent capability will have no significant radiological or non-radiological impact on the environment.

The installation of the hardened vent capability will prevent and mitigate severe accidents. During normal plant operations or design-basis accidents, the hardened vent will not be used, and therefore, will not result in any changes in amounts of radioactivity released to the atmosphere from the plant. Venting during severe accidents will reduce the CDF and will reduce the radiological environmental risks. For venting sequences, the hardened vent connected to the plant stack could reduce dose consequences more effectively by approximately a factor of two than venting through the ductwork. This reduction is due to a greater effectiveness of atmospheric dispersion resulting from controlled elevated release compared to an uncontrolled ground level release from ductwork. Furthermore, venting through the suppression pool would provide scrubbing of non-noble-gas fission products with an effective decontamination factor of about 100. The addition of a hardened vent will greatly reduce the occupational doses for personnel that need to enter and work in the reactor building and that could be exposed to the containment environment.

The staff has concluded that this generic EA applies to FitzPatrick

and the installation of the hardened vent will, therefore, reduce the dose consequences and will not result in an adverse environmental impact. Plant-specific design features will have an effect on the degree of the environmental benefits, but not on the conclusion concerning no significant environmental impact.

3.0 Conclusions and Recommendations

Based on the safety benefits discussed in Sections 2.1, 2.2, and 2.3 for FitzPatrick and in SECY 89-017 for generic Mark I plants and supported by the plant-specific cost-benefit analysis, the staff believes that the installation of a hardened wetwell vent at FitzPatrick is warranted.

3.1 Rationale for the Recommendation

In SECY 89-017, the staff concluded on a generic basis for Mark I plants that the proposed hardened vent capability would provide enhanced plant capabilities with regard to both accident prevention and mitigation. The addition of a hardened vent (1) prevents the majority of TW sequences from resulting in core melt, and (2) mitigates the consequences of residual sequences involving core melt where venting through the suppression pool is found to be necessary. In TW sequences, the containment fails before the core melt occurs; therefore, significant releases could result. A core melt, combined with a reactor vessel and containment failure, would release significant amounts of fission products to the environment. The survivability of the containment, which acts as the last barrier for an uncontrolled release of radiation, would increase with venting. The installation of a hardened vent greatly reduces the likelihood of a core melt from TW sequences and therefore reduces the risks to the public. For other sequences where core melt is predicted, venting could be effective in delaying containment failure and in mitigating the release of fission products. Although venting of the containment is currently included in BWR emergency operating procedures, it generally uses ductwork with a low design pressure. Venting under high-pressure severe accident conditions could fail this ductwork, release the containment atmosphere into the reactor building, and damage equipment, or contaminate equipment needed for accident recovery. Venting through this ductwork will probably hamper or complicate post-accident recovery activities, and is therefore viewed as reducing the safety benefit. The installation of a reliable hardened wetwell vent allows for controlled venting through a path with significant scrubbing of fission products to the plant stack and would prevent damage to equipment needed for accident recovery.

With the installation of the hardened vent capability, the staff estimated that the total plant CDF for FitzPatrick can be reduced by 4.5E-5 per reactor year because of the reduction in the probability of TW sequences. Implementation of the proposed hardened vent modification will significantly reduce the total risk to the health and safety of the public. The averted population dose of 65.5 man-

rem per reactor year was calculated for FitzPatrick from the installation of hardened vent capability. For 25 years of remaining operating life the total averted population dose would be 1638 man-rem, and the value-impact ratio, not including the averted costs, would be 2408 man-rem averted per million dollars. If the averted cost associated with an accident is included, the calculated value-impact ratio for FitzPatrick is -15366 man-rem saved per million dollars. Because the value-impact ratio is defined as the ratio of the averted population dose and the cost differential between the installation of the hardened vent and the averted cost, the negative number indicates that the averted costs exceed the installation costs. Thus, at FitzPatrick the installation cost is justified even when considering the economic benefit alone without considering the safety benefit. In addition, consideration of a likely 20-year operating life extension will increase the total averted population dose to 2948 man-rem, which demonstrates additional benefit for the installation of the hardened vent capability. Additional benefits of venting, not quantified, include source term reduction and the delay in containment failure for some of the scenarios that lead to core melt.

Based on both the qualitative and quantitative benefits discussed herein and the supporting plant-specific cost-benefit analysis, the staff believes that there will be a substantial increase in the overall protection of the public health and safety by implementing the hardened vent capability for FitzPatrick. Therefore, the staff believes that this backfit is justified.

4.0 References

1. SECY-87-297, U.S. NRC, "Mark I Containment Performance Program Plan," V. Stello to NRC Commissioners, December 8, 1987.

2. NUREG-1150, Second Draft, U.S. NRC, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," June 1989.

3. SECY-89-017, U.S. NRC, "Mark I Containment Performance Improvement Program, " V. Stello to NRC Commissioners, January 23, 1989.

4. Memorandum from S. J. Chilk to V. Stello, "SECY-89-017 - Mark I Containment Performance Improvement Program," July 11, 1989.

5. U.S. NRC, Generic Letter 89-16, "Installation of a Hardened Wetwell Vent," September 1, 1989.

6. Backfit Rule, Code of Federal Regulation, 10 CFR 50.109.

7. WASH-1400, U.S. NRC "Reactor Safety Study," October 1975.

8. Memorandum from Brian W. Sheron to Ashok C. Thadani, October 19, 1989, "Reduction in Risk From the Addition of Hardened Vents in BWR Mark I Reactors."

9. NUREG/CR-5225, draft, "An Overview of Boiling Water Reactor Mark I Containment Venting Risk Implications," October 1988.

10. NUREG/CR-2723, "Estimates of the Financial Consequences of Nuclear Power Reactor Accidents," September 1982.

11. NUREG/CR-3568, "A Handbook for Value-Impact Assessment," December 1983.

12. Letter From John C. Brons (New York Power Authority) to U.S. NRC, October 27, 1989, "James A. FitzPatrick Nuclear Power Plant Response to Generic Letter 89-16, Installation of a Hardened Vent."

Doerflein, Lawrence

From: Knutson, Ed
Sent: Tuesday, April 17, 2012 4:21 PM
To: Doerflein, Lawrence
Subject: RE: TI-183 IR

Backwards through the SBGT suctions in the reactor building (except the refuel floor). The lineup has the inlets to the SBGT trains closed, and then opens the vent/purge valves from the torus. I can send drawings and the procedure if you would like (drawings would take some time).

From: Doerflein, Lawrence
Sent: Tuesday, April 17, 2012 2:13 PM
To: Knutson, Ed
Subject: RE: TI-183 IR

Thanks – however that raises a new question. What's the path to vent form PC to secondary containment?

From: Knutson, Ed
Sent: Tuesday, April 17, 2012 1:51 PM
To: Doerflein, Lawrence
Subject: RE: TI-183 IR

CR-JAF-2011-01529 was initiated, "Based on review of INPO IER-11-1 recommendation 1 the following gap was identified: TSG-9 does not address hydrogen considerations during primary containment venting activities."

The corrective action was to change the procedure, Technical Support Guideline (TSG)-9, "Primary Containment Venting Without AC Power," to include in the considerations, "Venting primary containment to secondary containment is likely to be an irreversible action since it will result in discharge of steam and non-condensable gas (potentially containing fission products and hydrogen) to the reactor building creating an environment with severe thermal, radiological, and combustible/explosive conditions."

From: Doerflein, Lawrence
Sent: Tuesday, April 17, 2012 1:20 PM
To: Knutson, Ed
Subject: TI-183 IR

Ed,

The IR discusses the licensee identified that current procedures did not address hydrogen considerations during primary containment venting.

Has that been fixed?

Larry

B/34

Doerflein, Lawrence

From:	Doerflein, Lawrence
Sent:	Friday, May 13, 2011 2:05 PM
To:	Screnci, Diane; Sheehan, Neil; McNamara, Nancy; Miller, Chris; Roberts, Darrell
Cc:	Williams, Christopher; Arner, Frank
Subject:	summary of inspection issues
Attachments:	Summary of Issues with Context added .docx
Follow Up Flag:	Follow up
Flag Status:	Flagged

FYI, attached is a summary of the issues identified in the TI 183 inspections.

They are broken down by section (03.01, 03.02), then by plant.

TI 2515/183
REGION I SUMMARY OF OBSERVATIONS

TI Section 03.01 **Assess the licensee's capability to mitigate conditions that result from beyond design basis events, typically bounded by security threats, committed to as part of NRC Security Order Section B.5.b issued February 25, 2002, and severe accident management guidelines and as required by Title 10 of the Code of Federal Regulations (10 CFR) 50.54(hh).**

Site	Issue Summary
Outside of Scope	
FitzPatrick	The licensee identified that a PM requirement for periodic hydrostatic testing of staged B.5.b hoses and periodic testing of staged nozzles did not exist.
	The licensee identified that the annual PM contract on the fire engine pumper truck did not specify the required maintenance actions.
	The licensee identified that the primary containment venting procedure did not address hydrogen concentrations.
	The licensee identified that some agreements were required to be established with local volunteer fire departments.
	The inspectors identified that the current licensing basis does not require the licensee to have a hardened wet well vent installed as part of their Mark I containment program improvements. While the decision to not install the hardened vent received regulatory approval, it may be appropriate to reevaluate the adequacy of the existing wet well vent strategy and configuration.
	The inspectors identified that the SAMGs reference procedure EP-6, "Post Accident Containment Venting and Gas Control," when containment venting is required, however, this procedure assumes that electrical power is available.
	CONTEXT HYDROGEN VENTING FROM CONTAINMENT **The licensee identified an apparent beyond design and licensing basis vulnerability, in that current procedures do not address hydrogen**

considerations during primary containment venting. This issue was documented in CR-JAF-2011-01529. As an immediate corrective action, the licensee revised TSG-9 to provide a caution for operators to consider the presence of hydrogen.

The inspectors identified a beyond design and licensing basis vulnerability, in that FitzPatrick's current licensing basis did not require the plant to have a primary containment torus air space hardened vent as part of their Mark I containment improvement program. The NRC has established an agency task force to conduct a near term evaluation of the need for agency actions, which includes containment venting, following the events in Japan.

Outside of Scope

Outside of Scope

Outside of Scope

Outside of Scope

TI Section 03.02	**Assess the licensee's capability to mitigate station blackout (SBO) conditions, as required by 10 CFR 50.63, "Loss of All Alternating Current Power," and whether station design is functional and valid.**
Site	**Issue Summary**
	Outside of Scope
FitzPatrick	The licensee identified that an auto-transformer did not have any associated PM tasks assigned.
	The licensee identified a vulnerability, in that AOP-49A contained contingency actions using the decay heat removal system in an attachment that directed operators to use normal operating procedures. The normal operating procedure for starting decay heat removal included unnecessary steps for a SBO situation and did not include workable provisions for starting decay heat removal with the system drained.
	The licensee identified an apparent beyond design and licensing basis vulnerability, in that current procedures do not address hydrogen considerations during primary containment venting.
	The inspectors identified a beyond design and licensing basis vulnerability, in that FitzPatrick's current licensing basis did not require the plant to have a hardened torus vent as part of their Mark I containment improvement program.
	CONTEXT: The inspectors found that Fitzpatrick meets their existing licensing and design bases. However, The NRC has established an agency task force to conduct a near term evaluation of the need for

agency actions such as adding further requirements in the area of containment venting operations, following the events in Japan.

Outside of Scope

Outside of Scope

Outside of Scope

Outside of Scope

TI Section 03.03	Assess the licensee's capability to mitigate internal and external flooding events required by station design.
Site	**Issue Summary**

Outside of Scope

FitzPatrick	None.

Outside of Scope

Outside of Scope

TI Section 03.04	Assess the thoroughness of the licensee's walkdowns and inspections of important equipment needed to mitigate fire and flood events to identify the potential that the equipment's function could be lost during seismic events possible for the site.
Site	**Issue Summary**

Outside of Scope

Outside of Scope

FitzPatrick	The inspectors identified that significant areas of the plant would have reduced fire fighting capability following a design basis seismic event since the majority of the fire water system is not seismically qualified, nor likely to survive such an event. In addition, internal flooding caused by ruptures following a design basis seismic event would require operators to walkdown areas, identify the source(s), and take prompt actions to secure the source(s) of flooding. Given a design basis seismic event followed by significant fire(s) and internal flooding, there would likely be insufficient personnel to effectively deal with these events simultaneously. In particular, the fire brigade consists of operations personnel on shift and is capable of dealing with a single fire only while maintaining minimum control room staffing.
	CONTEXT: These issues are beyond design bases type considerations which the NRC Task Force will continue to review and evaluate if future actions are required.
	The inspectors identified a beyond design and licensing basis vulnerability, in that the licensee had not implemented vendor recommended periodic fire fighting foam concentrate testing for on-site portable fire fighting foam tanks.

Outside of Scope

Outside of Scope

Outside of Scope

Outside of Scope

Outside of Scope

Outside of Scope

From:	Lane, John
To:	Dennig, Robert
Cc:	Correia, Richard; Beasley, Benjamin; Bettle, Jerome; Notafrancesco, Allen; Lee, Richard; Sheron, Brian; Basu, Sudhamay; Karipineni, Nageswara; Collins, Timothy; Sienel, Beth
Subject:	Not all Mark I"s have GL-grade hardened vents
Date:	Tuesday, March 13, 2012 7:22:00 PM

Fitzpatrick Mark I doesn't have a hardened vent.

In response to GL 89-16, Fitzpatrick, a Mark I, begged off installing a hardened vent in deference to the upcoming IPE program. The GL applied to already identified generic severe accident vulnerabilities at Mark I's while IPE's were essentially our second bite of the apple going after plant specific severe accident vulnerabilities. Fitz needed the 24" vent line from the wetwell to get the job done. What they had going for them was the unusual situation that the SGTS is (b)(4) (b)(4) and so the piping to that point was good for 150 psig. Beyond that, the vent system did not meet the GL, specifically, because (1) it couldn't contain hydrogen, there were ignition sources in the SGTS room which could cause combustion and damage backwards into the reactor building, and (2) the SGTS sheet metal piping was no good at the higher pressures so it would blow resulting in, not a stack release, but a ground level one, both deviations from the GL spec. On top of that, the licensee only analyzed operator response using the 2" line, not the required 24" line, and the system required remote manual valve actuations.

We bought their argument (microfiche address 56551:237-247).

In their subsequent IPE submittal NYPA stated:

"While containment venting through either the torus or drywell paths (20- or 24-in. lines) will **rupture the transition piece** from the hard piping portion of the vent path and the SGTS ductwork, the failure of this piece on high pressure venting **will not damage other plant equipment**, because the piece is located outside the reactor building pressure boundary. **Therefore, the survivability of vital plant equipment are not compromised by releases within the reactor building that result from primary containment venting."** (boldface is mine)

Our IPE team found it necessary to do a Tier 2 review, a more detailed review of the Fitz IPE submittal due to IPE quality concerns, and we generally found that they resisted other CPI fixes as well, like the backup firewater supply to the Rx vessel. Oh, and they rejected our hardened vent backfit analysis too.

We stated in our SER in response to the IPE submittal:

"The FitzPatrick IPE addressed containment venting as a means by which the conditional probability of containment failure (and subsequent core damage) can be reduced, in addition to supporting mitigation of severe accidents. Containment venting reduced the core damage frequency at FitzPatrick by an estimated factor of 14.

Containment venting procedures require hard pipe venting of the wetwell air space anytime the containment pressure exceeds 44 psig. The vent path at FitzPatrick utilizes piping from the containment to the inlet transition piece of the Standby Gas Treatment System (SBGT) filter train. Because the transition piece is located outside the reactor building pressure boundary, failure of the transition piece upon containment venting is limited to the SBGT system. **The survivability and accessibility of vital plant equipment is, therefore, not compromised by failure of the transition piece.**

Wetwell venting will normally be initiated at the primary containment and purge (PCP) panel

located in the relay room. **For accident sequences in which motive power is unavailable to the valves, the operators are expected to locally hand-wheel the valves open (as our Japanese colleagues would likely say, good luck with that!).** Venting of the containment is accomplished using AOP-35 "Post Accident Venting of the Primary Containment." This procedure instructs the operator to **vent the containment regardless of the radiological consequences.** The procedure (for which operators have been trained) is entered from EOP-4 "Primary Containment control" before the containment pressure exceeds 44 psig.
During the plant visit, the staff reviewed the modeling of wetwell venting in the IPE, examined AOP-35 and EOP-4 with plant operations personnel and walked through the process of implementing AOP-35 from both the PCP panel and locally at each valve. The staff concludes that the wetwell venting function is appropriately modeled in the licensees IPE analysis."

So, in summary, there are GL-hardened vents and there are Fitz-hardened vents.

jcl