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EA-13-109
10 CFR 50.54(f)

December 28, 2017
GO2-17-201

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: **COLUMBIA GENERATING STATION, DOCKET NO. 50-397 ENERGY NORTHWEST'S SIX-MONTH STATUS UPDATE REPORT FOR THE IMPLEMENTATION OF NUCLEAR REGULATORY COMMISSION (NRC) ORDER EA-13-109, PHASE 2 ONLY**

References:
1. EA-13-109 from E. J. Leeds (NRC) to All Operating Boiling Water Reactor Licensees with Mark I and Mark II Containments, "Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions," dated June 6, 2013 (ADAMS ML13143A334 (Pkg.)
2. Letter GO2-15-175 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Response to NRC Order EA-13-109 – Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions Phases 1 and 2, Revision 1," dated December 16, 2015 (ADAMS ML15351A363)
3. Letter GO2-17-118, from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Second Combined Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Orders EA-12-049 AND EA-13-109", dated June 27, 2017 (ADAMS ML17178A276)
4. Letter GO2-17-147 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Notification of Full Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events," dated August 17, 2017

Dear Sir or Madam,

By Reference 1 the Nuclear Regulatory Commission (NRC) issued Order EA-13-109 which required licensees to develop an overall integrated plan (OIP) and submit 6-

month update reports in regards to installation and operation of a reliable hardened containment vent capable of operation under severe accident conditions. Reference 2 provided the Columbia Generating Station's revised OIP for Phase 1 of Order EA-13-109 and the initial OIP for Phase 2 of the Order. Reference 3 transmitted the previous 6-month update report for Phase 1 and 2 of NRC Order EA-~~12~~ 13-109 which was combined with the final 6-month update for NRC Order EA-12-049. LLW 12/28/17

The certification of completion letter for NRC Order EA-12-049 was submitted in Reference 4 and Phase 1 of NRC Order EA-13-109 was completed during the spring 2017 refueling outage. Therefore, the remaining required 6-month update reports will focus on the status of Phase 2 of NRC Order EA-13-109.

The enclosure to this letter provides the required 6-month update report for the remaining Phase 2 activities and open items as of November 30, 2017.

No new commitments are being made by this letter or the enclosure. If you have any questions or require additional information, please contact Ms. L. L. Williams at (509) 377-8148.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 28th day of December, 2017.

Respectfully,

A. L. Javorik
Vice President, Engineering

Enclosure: As stated

cc: NRC RIV Regional Administrator
NRC NRR Project Manager
NRC Senior Resident Inspector/988C
CD Sonoda – BPA/1399 (email)
WA Horin – Winston & Strawn

## 1.0 Introduction

By Reference 1 of this enclosure, the Nuclear Regulatory Commission (NRC) issued Order EA-13-109 to Columbia Generating Station (Columbia). The Order contained requirements for the installation of a reliable containment hardened vent capable of operation under severe accident conditions. Reference 1 also required submittal of an Overall Integrated Plan (OIP) describing how compliance with the requirements described in the Order will be achieved and required the submittal of status reports at six month intervals. This enclosure provides Energy Northwest's six-month status report for the remaining Phase 2 milestones, open items, and any changes to the compliance method or schedule.

## 2.0 Milestone Accomplishments

As listed below.

## 3.0 Milestone Schedule Status

The following table provides a listing of the remaining reports associated with NRC Order EA-13-109 as of November 30, 2017.

**Correspondence and Reports**

| Milestone | Target Completion Date | Activity Status | Comments *(Include date changes in this column)* |
|---|---|---|---|
| 6-month update for Order EA-13-109 Phase 2 | Dec. 2017 | Complete | This Letter |
| 6-month update for Order EA-13-109 Phase 2 | June 2018 | Not Started | |
| 6-month update for Order EA-13-109 Phase 2 | Dec. 2018 | Not Started | |
| 6-month update for Order EA-13-109 Phase 2 | June 2019 | Not Started | |
| Issuance of Energy Northwest's letter of compliance with NRC Order EA-13-109, Phase 2 | Aug. 2019 | Not Started | |

The following is the status of the OIP milestones for the severe accident capable reliable hardened containment vent (HCV) as of November 30, 2017.

**HCV Phase 1 Milestone Schedule:**

Complete – no longer reported.

**HCV Phase 2 Milestone Schedule:**

| Milestone | Target Completion Date | Activity Status | Comments *(<u>Include date changes in this column</u>)* |
|---|---|---|---|
| Hold preliminary/conceptual design meeting | July 2016 | Complete | This date was changed to July 2017 in letter GO2-16-171 |
| Design Engineering On-site/Complete | July 2018 | | |
| Operations Procedure Changes Developed | Jan. 2019 | | |
| Site Specific Maintenance Procedures Developed | Jan. 2019 | | |
| Training Complete | Apr. 2019 | | |
| Implementation Outage | May 2019 | | |
| Procedure Changes Active | May 2019 | | |
| Walk Through Demonstration/Functional Test | June 2019 | | |

## 4.0 Changes/Updates to Overall Integrated Plan

### OI-HCV-03 and Phase 1 RAI 02 (Section 3.2.1) - Backup Pneumatics

The backup pneumatics for the operation of the HCV beyond the original 24 hours has been changed to use a spare nitrogen cylinder which has been installed in a previously unused holder in the HCV nitrogen bottle rack. A connection to use any available compressor remains as part of the piping system.

### OI-HCV-04 - Evaluation of DG5 Location during Severe Accident Conditions

The timing of the severe accident event for Columbia is presented in the discussion of the modified methodology for determining dose fields during a severe accident below. In a severe accident, the Columbia timeline shows that the initial vent opening will not occur for approximately 6 hours. The FLEX validation performed for placing the FLEX diesel generator (DG) in operation shows that this activity can be completed before the venting under severe accident condition occurs. Dose rate maps have been placed in the procedures used to respond to a severe accident. These maps, which reflect the Nuclear Energy Institute (NEI) white paper HCVS-WP-02 (Reference 2) method of determining dose, will be used to position the FLEX generator in the identified low dose fields. These maps may be updated to reflect the modified methodology of dose determination discussed below at a later date.

## OI-HCV-18 - Evaluation of FLEX Equipment Pathways during Severe Accident Conditions

Severe accident dose calculation, NE-02-15-06 Rev 0 determined the dose rates outside the reactor building during a severe accident. Even though there are high dose areas outside the reactor building and surrounding outside environs, the basic FLEX deployment pathways remain valid and are not being changed for the severe accident response. The end location of equipment and the stationing of personnel will take into account any building structure shielding. For example, the FLEX diesel (DG5) will be located as close to the radwaste building as possible in order to make use of the "shade" from direct shine of the HCV pipe. Further, personnel will be directed to stay in low dose areas while not directly monitoring/refueling the FLEX equipment (i.e., inside SW Pump House). A revised methodology for dose determination is presented below.

## Modified Methodology for Determining Dose Fields during Severe Accident Conditions

Energy Northwest completed the required severe accident dose assessment using the guidance in NEI white paper HCVS-WP-02 (Reference 2) to support the implementation of Phase 1 of EA-13-109. The NRC endorsed this guidance in Reference 6. Energy Northwest also assessed the radiological consequences, which address elements A.1.1.3, A.1.1.4, and A.1.2.10 of NRC Order EA-13-109, and determined that the overall dose will be able to be controlled within the limits of the Environmental Protection Agency (EPA) Manual EPA-400-R-92-001 (Reference 5). The following actions were implemented:

- Identified lower dose areas to be used in stationing equipment
- Provided guidance to operators within the FLEX response procedures on the location of low dose areas
- Provided maps of the expected dose fields in the procedures and program document, and
- Verified the survivability of the hardened containment vent system and components

Due to the high dose rates predicted using the Reference 2 methodology, Energy Northwest has undertaken an optional site specific analysis to support the implementation of Phase 2 of EA-13-109. This analysis utilizes NUREG-1465, site characteristics, and the guidance in Appendix A of the NEI white paper. As such, Energy Northwest is proposing to deviate from the guidance in Reference 2.

As requested in the NRC endorsement letter (Reference 6), Energy Northwest is providing information that demonstrates how associated requirements in NRC Order EA-13-109 will be met. The site specific analysis discussed in the justification below produces lower radiation fields in the plant areas used to respond to the event and allows for a more efficient and effective response plan and use of emergency response personnel.

The Columbia severe accident timeline is based on NEI guidance documents and was submitted as Case 3 in Attachment 2A in Reference 7.

In the Case 3 timeline, it is assumed that RCIC does not start, resulting in core damage at approximately event time +1 hour. At event time +6 hours, vessel breach occurs. The Columbia response to the severe accident begins as soon as RCIC fails and a determination is made that RCIC will not be recovered. The response focus is then directed towards severe accident water addition (SAWA) to the reactor pressure vessel (RPV) which can be accomplished before venting begins. Makeup to the spent fuel pool is secondary and can be delayed until the SAWA connection to supply the RPV is completed. Calculation NE-02-17-02 provides the time-to-200°F in the spent fuel pool in the event of a loss spent fuel pool cooling following startup for Cycle 24. The time to 200°F is 30 hours assuming the maximum heat load in the pool and a maximum starting temperature of 125°F.

In both HCVS-WP-02 (Reference 2) and the Energy Northwest plant-specific analysis, the dose rates are estimated starting at 6 hours after a loss of power. This is the earliest expected time that the vent would be opened. Using the bounding assumptions in Reference 2 results in high dose rates shown in Table 1 of the attachment to this enclosure, which persist for the entire coping period. This is because radioisotope decay is the only reduction mechanism credited in the white paper. The initial mitigation actions such as staging the FLEX pump for supplying water to the reactor pressure vessel for makeup or connecting the FLEX diesel generator, are not expected to be impacted as these actions occur early in the scenario before the HCV would be opened.

However, later in the scenario when activities such as water management and refueling of the FLEX equipment take place, these high dose rates are problematic to realistic and successful planning and manpower management as these resources are expected to remain limited for some time. Unexpected complications and personnel dose limitations can compound a stressful situation. The key assumption in the guidance that creates this difficulty is the assumption that the radioisotope concentration in the drywell remains constant throughout the severe accident scenario.

Energy Northwest estimates that the steam flow rate from containment through the HCV will vary from about 20,000 to 70,000 lb/hr. At a typical containment pressure of 28 psia, the volumetric flow rate is greater than 200,000 $ft^3$/hr. This is in the same order of magnitude as the containment volume (drywell + wetwell) of about 344,000 $ft^3$; and as such, the effect of dilution can be significant. Table 2 in the attachment to this enclosure provides results in a format similar to Table 1, but with dilution included based on a conservatively low vent flow rate of 20,000 lb/hr used in analysis.

Energy Northwest calculation NE-02-15-06 R1 (Reference 4), provides the dose rates from the hardened containment vent outside of the reactor building during a postulated beyond-design-basis (BDB) severe accident following an extended loss of AC power (ELAP). The calculation contains the following analyses:

- Determination of the Wet Well Vent Source Strength Parameters

  Determines the source strength parameters for the WW vent piping, while including the time dependence of the fission product decay.

- Attenuation of Gamma Radiation and Buildup Factors in Air and Concrete

  Determines the gamma radiation attenuation and buildup factors.

- Dose Rate Analysis using the HCVS-WP-02 Methodology

  Determines dose rates using the generic, bounding methodology given in the NEI white paper HCVS-WP-02 (Reference 2). This appendix does not include the effects of scrubbing in the suppression pool or dilution of the radioisotope concentration in containment as venting of steam progresses.

- Columbia Plant-Specific Dose Rate Analysis

  Provides the details of the Columbia plant-specific dilution analysis and dose rates. In addition to dilution, additional or revised assumptions made in the site specific analysis include:

  * Deposition of isotopes inside the vent piping is included since it may potentially contribute a small dose that is not reduced by dilution.
  * Deposition in the vent pipe is assumed to be present as soon as the vent is opened.
  * Deposition in the drywell is not assumed as this would reduce vent pipe dose rates.
  * Reduction of the dose rate from deposition is only reduced by isotope decay as time progresses.
  * Conservatively low vent flow rate is assumed.
  * The total free volume of the drywell and wetwell is used for dilution effects while the initial source strength from the white paper is used. The white paper only uses the drywell volume. This maximizes the radioisotope concentration in the vent pipe because it slows the effects of dilution.

- Comparison of Results of Plant-Specific Refinement of Methodology

  Shows the benefit realized by the refinements made in the Columbia plant-specific dose rate analysis.

- Evaluation of the Generic No Dilution Assumption in HCVS-WP-02

  Quantifies the "no dilution" assumption to demonstrate its effect on calculated dose rates, which justifies the effort involved in plant-specific analyses for Columbia.

- Third Party Review

  Provides the third party review of the refined, plant-specific methodology. The review was performed by MPR Associates, Inc.

## 5.0 Need for Relief/Relaxation and Basis for the Relief/Relaxation

None

## 6.0 Open Items from Overall Integrated Plan, Interim Staff Evaluation, and Audits

The following tables provide an update of the status of the remaining open items as of November 30, 2017.

| List of Overall HCV Integrated Plan Open Items | | | |
|---|---|---|---|
| **HCV OIP Open Item** | **Action** | **Status** | **Comment/Update** |
| OI-HCV-03 | Determine the location of the portable air compressor and evaluate for accessibility under Severe Accident HCVS use.<br>Including connection point(s)<br>Including refueling operations | CLOSED | Due to the dose rates expected during a severe accident, the use of the portable air compressor has been replaced by installing a spare N2 bottle in the instrument pneumatics rack. |
| OI-HCV-04 | Evaluate the location of the FLEX DG for accessibility under Severe Accident HCVS use.<br>Including connection point(s)<br>Including refueling operations | CLOSED | As documented in Reference 3, FLEX equipment is deployed with sufficient fuel to operate for 10 hours. Also, an additional refueling method, which significantly reduces operator exposure, has been implemented in plant procedures. |

| List of Overall HCV Integrated Plan Open Items | | | |
|---|---|---|---|
| **HCV OIP Open Item** | **Action** | **Status** | **Comment/Update** |
| OI-HCV-07 | Complete the evaluation to determine accessibility, habitability, staffing sufficiency, and communication capability of the ROS. | CLOSED | The sound powered phone equipment to connect to the DG-2 room phone outlet is stored in FLEX Building 82 and included in the building inventory procedure. A validation plan was developed to verify time critical actions. TM-2195 verified accessibility and habitability of the ROS. |
| OI-HCV-09 | Equipment qualifications will include temperature, pressure, radiation level, and total integrated dose radiation from the effluent vent pipe at local and remote locations. | CLOSED | TM-2196 provides an evaluation of the major HCV components and instrumentation under severe accident conditions. This TM is supplemented by a spreadsheet identifying the equipment qualifications of all components associated with the HCV operation. |
| OI-HCV-10 | Provide site-specific details of the EOPs when available. Develop procedures for SAWA and SAWM | OPEN | Phase 1: No EOP procedure changes are required. Phase 2: In review. |
| OI-HCV-12 | SAWA/SAWM flow is controlled using hose-installed valves and mechanical flow elements (EA-12-049 actions). Location of these valves and flow elements will need to be considered per HCVS-FAQ-12. | OPEN | |
| OI-HCV-13 | Reconcile the out-of-service provisions for HCVS/SAWA with the provisions documented in Columbia's PPM 1.5.18, Managing B.5.b and FLEX Equipment Unavailability. | OPEN | |
| OI-HCV-14 | Complete the evaluation to determine accessibility, habitability, staffing sufficiency, and communication capability during SAWA/SAWM | OPEN | |
| OI-HCV-15 | Perform MAAP analysis for NEI 13-02 figures C-2 through C-6 and determine the time sensitive SAWM actions | OPEN | |
| OI-HCV-16 | Develop procedure for line-up and use of HCVS | CLOSED | Complete (PPM 5.5.14 Rev. 8) |

| List of Overall HCV Integrated Plan Open Items | | | |
|---|---|---|---|
| **HCV OIP Open Item** | **Action** | **Status** | **Comment/Update** |
| OI-HCV-18 | Evaluate deployment pathways for severe accident capable criteria | CLOSED | See Section 4.0 above. |
| OI-HCV-19 | Develop required training and frequency IAW the SAT process | CLOSED | Closed in letter GO2-17-147 |
| OI-HCV-20 | Incorporate approved language of OIP Attachment 2.1.D into site SAMG procedure(s) | OPEN | |

| **Response to the Phase 1 Request for Additional Information** | | | |
|---|---|---|---|
| **RAI Number ISE Report Section** | **Action** | **Status** | **Comment** |
| 02<br>Section 3.2.1 | Make available for NRC staff audit the location of the portable air compressor. | CLOSED | Update provided above in Section 4.0 above. Due to the dose rates expected during a severe accident, the use of the portable air compressor has been replaced by installing a spare N2 bottle in the instrument pneumatics rack. |
| 04<br>Section 3.2.1<br>Section 3.2.2.4<br>Section 3.2.2.5<br>Section 3.2.2.10<br>Section 3.2.4.1<br>Section 3.2.4.2<br>Section 3.2.5.2<br>Section 3.2.6 | Make available for NRC staff audit an evaluation of temperature and radiological conditions to ensure that operating personnel can safely access and operate controls and support equipment. | CLOSED | The HCV is operated from the main control room or the remote operating station located in the diesel generator building. TM-2195 evaluated these locations under severe accident conditions and found both accessible and habitable. Therefore, both locations are also accessible and habitable to support early (anticipatory) venting. Additional evaluations of the areas used during severe accident for water addition and water management are being evaluated under Phase 2 RAIs 1 and 2 which remain Open. |

| Response to the Phase 1 Request for Additional Information | | | |
|---|---|---|---|
| **RAI Number ISE Report Section** | **Action** | **Status** | **Comment** |
| 06<br>Section 3.2.2.3<br>Section 3.2.2.5<br>Section 3.2.2.9<br>Section 3.2.2.10 | Make available for NRC staff audit the descriptions of local conditions (temperature, radiation and humidity) anticipated during ELAP and severe accident for the components (valves, instrumentation, sensors, transmitters, indicators, electronics, control devices, etc.) required for HCVS venting including confirmation that the components are capable of performing their functions during ELAP and severe accident conditions. | CLOSED | This information is available for NRC audit. |

| Response to the Phase 2 Request for Additional Information | | | |
|---|---|---|---|
| **RAI Number ISE Report Section** | **Action** | **Status** | **Comment** |
| 1<br>Section 3.2.1 | Licensee to determine the location of the FLEX hose-installed valves and flow elements, which will be used to control SAWA/SAWM flow. | OPEN | See OI-HCV-12 |
| 2<br>Section 3.3.2.3 | Licensee to evaluate the SAWA equipment and controls, as well as ingress and egress paths for the expected severe accident conditions (temperature, humidity, radiation) for the sustained operating period. | OPEN | |
| 3<br>Section 3.3.3 | Licensee to demonstrate that containment failure as a result of overpressure can be prevented without a drywell vent during severe accident conditions. | OPEN | |
| 4<br>Section 3.3.3.1 | Licensee shall demonstrate how the plant is bounded by the reference plant analysis that shows the SAWM strategy is successful in making it unlikely that a drywell vent is needed. | OPEN | |
| 5 | Licensee to demonstrate that there | OPEN | OI-HCV-14 |

| Response to the Phase 2 Request for Additional Information | | | |
|---|---|---|---|
| **RAI Number ISE Report Section** | **Action** | **Status** | **Comment** |
| Section 3.3.3.4 | is adequate communication between the MCR and the operator at the FLEX pump during severe accident conditions. | | |
| 6 Section 3.3.3.4 | Licensee to demonstrate the SAWM flow instrumentation qualification for the expected environmental conditions. | OPEN | |

## 7.0 References

1. EA-13-109 from E. J. Leeds (NRC) to All Operating Boiling Water Reactor Licensees with Mark I and Mark II Containments, "Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions," dated June 6, 2013 (ADAMS ML13143A334 (Pkg.))

2. NEI white paper, "HCVS-WP-02: Sequences for HCVS Design and Method for Determining Radiological Dose from HCVS Piping," Revision 0, dated October 23, 2014 (ADAMS No. ML 14358A038)

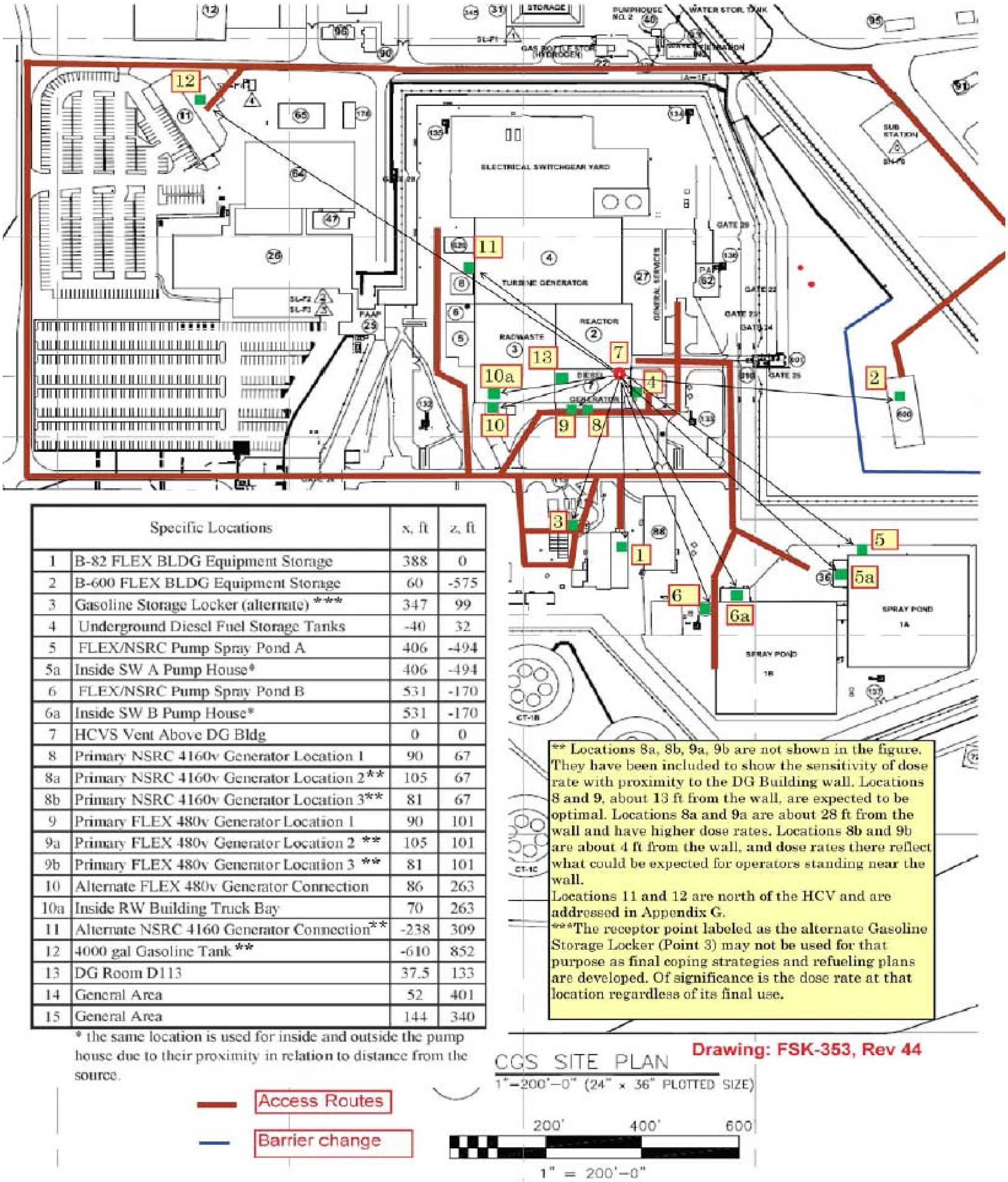
3. Letter GO2-17-147 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Notification of Full Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events," dated August 17, 2017

4. Energy Northwest calculation NE-02-15-06, "Dose Rates from the Hardened Containment Vent (HCV) Outside the Reactor Building during a Postulated Beyond Design Basis (BDB) Severe Accident Following an Extended Loss of AC Power (ELAP)," Revision 1

5. EPA Manual EPA-400-R-92-001 May 1992, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents"

6. Letter from J. R. Davis (NRC) to J. E. Pollock (NEI) dated February 5, 2015

7. Letter GO2-15-175 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Response to NRC Order EA-13-109 – Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions Phases 1 and 2, Revision 1," dated December 16, 2015




| | Specific Locations | x, ft | z, ft |
|---|---|---|---|
| 1 | B-82 FLEX BLDG Equipment Storage | 388 | 0 |
| 2 | B-600 FLEX BLDG Equipment Storage | 60 | -575 |
| 3 | Gasoline Storage Locker (alternate) *** | 347 | 99 |
| 4 | Underground Diesel Fuel Storage Tanks | -40 | 32 |
| 5 | FLEX/NSRC Pump Spray Pond A | 406 | -494 |
| 5a | Inside SW A Pump House* | 406 | -494 |
| 6 | FLEX/NSRC Pump Spray Pond B | 531 | -170 |
| 6a | Inside SW B Pump House* | 531 | -170 |
| 7 | HCVS Vent Above DG Bldg | 0 | 0 |
| 8 | Primary NSRC 4160v Generator Location 1 | 90 | 67 |
| 8a | Primary NSRC 4160v Generator Location 2** | 105 | 67 |
| 8b | Primary NSRC 4160v Generator Location 3** | 81 | 67 |
| 9 | Primary FLEX 480v Generator Location 1 | 90 | 101 |
| 9a | Primary FLEX 480v Generator Location 2 ** | 105 | 101 |
| 9b | Primary FLEX 480v Generator Location 3 ** | 81 | 101 |
| 10 | Alternate FLEX 480v Generator Connection | 86 | 263 |
| 10a | Inside RW Building Truck Bay | 70 | 263 |
| 11 | Alternate NSRC 4160 Generator Connection** | -238 | 309 |
| 12 | 4000 gal Gasoline Tank ** | -610 | 852 |
| 13 | DG Room D113 | 37.5 | 133 |
| 14 | General Area | 52 | 401 |
| 15 | General Area | 144 | 340 |

* the same location is used for inside and outside the pump house due to their proximity in relation to distance from the source.

** Locations 8a, 8b, 9a, 9b are not shown in the figure. They have been included to show the sensitivity of dose rate with proximity to the DG Building wall. Locations 8 and 9, about 13 ft from the wall, are expected to be optimal. Locations 8a and 9a are about 28 ft from the wall and have higher dose rates. Locations 8b and 9b are about 4 ft from the wall, and dose rates there reflect what could be expected for operators standing near the wall.
Locations 11 and 12 are north of the HCV and are addressed in Appendix G.
***The receptor point labeled as the alternate Gasoline Storage Locker (Point 3) may not be used for that purpose as final coping strategies and refueling plans are developed. Of significance is the dose rate at that location regardless of its final use.

Figure C-1 - Plant Staff Access Locations

**Location of Points of Interest**

The following table provides the dose rates at the various key locations following the methodology prescribed in Reference 2.

Table 1 Summary of Dose Rates using HCVS-WP-02 Methodology

| Specific Locations | | x, ft | z, ft | Zone | Dose Rate, rem/hr | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 6 hr | 8 hr | 12 hr | 18 hr | 24 hr | 36 hr | 48 hr | 72 hr |
| 1 | B-82 FLEX BLDG Equipment Storage | 388 | 0 | 1 | 11.89 | 11.65 | 9.99 | 8.96 | 8.10 | 7.24 | 6.38 | 5.58 |
| 2 | B-600 FLEX BLDG Equipment Storage | 60 | -575 | 1 | 7.40 | 7.25 | 6.22 | 5.58 | 5.04 | 4.51 | 3.97 | 3.48 |
| 3 | Gasoline Storage Locker (alternate) | 347 | 99 | 1 | 13.02 | 12.75 | 10.93 | 9.81 | 8.86 | 7.93 | 6.99 | 6.11 |
| 4 | Underground Diesel Fuel Storage Tanks | -40 | 32 | 1 | 68.92 | 67.51 | 57.88 | 51.90 | 46.91 | 41.95 | 36.99 | 32.35 |
| 5 | FLEX/NSRC Pump Spray Pond A | 406 | -494 | 1 | 6.60 | 6.46 | 5.54 | 4.97 | 4.49 | 4.02 | 3.54 | 3.10 |
| 5a | Inside SW A Pump House* | 406 | -494 | 6 | 0.03 | 0.03 | 0.021 | 0.019 | 0.017 | 0.015 | 0.014 | 0.012 |
| 6 | FLEX/NSRC Pump Spray Pond B | 531 | -170 | 1 | 7.72 | 7.56 | 6.48 | 5.81 | 5.25 | 4.70 | 4.14 | 3.62 |
| 6a | Inside SW B Pump House* | 531 | -170 | 6 | 0.03 | 0.03 | 0.025 | 0.022 | 0.020 | 0.018 | 0.016 | 0.014 |
| 7 | HCVS Vent Above DG Bldg | 0 | 0 | NA | NA | NA | NA | NA | NA | NA | NA | Na |
| 8 | Primary NSRC 4160v Generator Location 1 | 90 | 67 | 2 | 12.03 | 11.78 | 10.10 | 9.06 | 8.19 | 7.32 | 6.46 | 5.65 |
| 8a | Primary NSRC 4160v Generator Location 2 | 105 | 67 | 2 | 31.10 | 30.46 | 26.12 | 23.42 | 21.17 | 18.93 | 16.69 | 14.60 |
| 8b | Primary NSRC 4160v Generator Location 3 | 81 | 67 | 3 | 4.63 | 4.54 | 3.89 | 3.49 | 3.15 | 2.82 | 2.49 | 2.18 |
| 9 | Primary FLEX 480v Generator Location 1 | 90 | 101 | 2 | 10.83 | 10.61 | 9.09 | 8.15 | 7.37 | 6.59 | 5.81 | 5.08 |
| 9a | Primary FLEX 480v Generator Location 2 | 105 | 101 | 2 | 27.55 | 26.99 | 23.14 | 20.75 | 18.75 | 16.77 | 14.79 | 12.93 |
| 9b | Primary FLEX 480v Generator Location 3 | 81 | 101 | 3 | 3.98 | 3.90 | 3.34 | 3.00 | 2.71 | 2.42 | 2.13 | 1.87 |
| 10 | Alternate FLEX 480v Generator | 86 | 263 | 2 | 5.34 | 5.23 | 4.49 | 4.02 | 3.64 | 3.25 | 2.87 | 2.51 |
| 10a | Inside RW Building Truck Bay | 70 | 263 | 4b | 0.024 | 0.023 | 0.020 | 0.018 | 0.016 | 0.015 | 0.013 | 0.011 |
| 13 | DG Room D113 | 37.5 | 133 | 4a | 0.019 | 0.019 | 0.016 | 0.014 | 0.013 | 0.012 | 0.010 | 0.009 |
| 14 | General Area | 52 | 320 | 3 | 1.56 | 1.53 | 1.31 | 1.17 | 1.06 | 0.95 | 0.84 | 0.73 |
| 15 | General Area | 144 | 340 | 1 | 12.65 | 12.40 | 10.63 | 9.53 | 8.61 | 7.70 | 6.79 | 5.94 |
| 16 | RB/DG Bldg Corridor | 5 | 80 | 4 | 0.88 | 0.87 | 0.74 | 0.67 | 0.60 | 0.54 | 0.48 | 0.42 |

The following table shows the dose rates expected at the same locations when applying the revised methodology discussed above. Although the dose rates at Time +6 hours are the same, the conservative dilution assumed in the revised methodology significantly reduces the expected dose beginning at T+8 hours.

Table 2 Summary of Dose Rates using Columbia Plant-Specific Methodology

| Specific Locations | | x, ft | z, ft | Zone | Dose Rate, rem/hr - Time is After LOOP - Vent Open @ 6 hrs | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 6 hr | 8 hr | 12 hr | 18 hr | 24 hr | 36 hr | 48 hr |
| 1 | B-82 FLEX BLDG Equipment Storage | 388 | 0 | 1 | 11.893 | 2.354 | 0.260 | 0.179 | 0.162 | 0.145 | 0.128 |
| 2 | B-600 FLEX BLDG Equipment Storage | 60 | -575 | 1 | 7.403 | 1.465 | 0.162 | 0.112 | 0.101 | 0.090 | 0.079 |
| 3 | Gasoline Storage Locker (alternate) | 347 | 99 | 1 | 13.020 | 2.576 | 0.285 | 0.196 | 0.177 | 0.159 | 0.140 |
| 4 | Underground Diesel Fuel Storage Tanks | -40 | 32 | 1 | 68.916 | 13.637 | 1.509 | 1.038 | 0.938 | 0.839 | 0.740 |
| 5 | FLEX/NSRC Pump Spray Pond A | 406 | -494 | 1 | 6.598 | 1.306 | 0.144 | 0.099 | 0.090 | 0.080 | 0.071 |
| 5a | Inside SW A Pump House | 406 | -494 | 6 | 0.025 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 |
| 6 | FLEX/NSRC Pump Spray Pond B | 531 | -170 | 1 | 7.715 | 1.527 | 0.169 | 0.116 | 0.105 | 0.094 | 0.083 |
| 6a | Inside SW B Pump House | 531 | -170 | 6 | 0.030 | 0.006 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 |
| 7 | HCVS Vent Above DG Bldg | 0 | 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| 8 | Primary NSRC 4160v Generator Location 1 | 90 | 67 | 2 | 12.027 | 2.380 | 0.263 | 0.181 | 0.164 | 0.146 | 0.129 |
| 8a | Primary NSRC 4160v Generator Location 2 | 105 | 67 | 2 | 31.733 | 6.282 | 0.731 | 0.486 | 0.438 | 0.386 | 0.341 |
| 8b | Primary NSRC 4160v Generator Location 3 | 81 | 67 | 3 | 4.634 | 0.917 | 0.101 | 0.070 | 0.063 | 0.056 | 0.050 |
| 9 | Primary FLEX 480v Generator Location 1 | 90 | 101 | 2 | 10.828 | 2.143 | 0.237 | 0.163 | 0.147 | 0.132 | 0.116 |
| 9a | Primary FLEX 480v Generator Location 2 | 105 | 101 | 2 | 0.000 | 5.452 | 0.603 | 0.415 | 0.375 | 0.335 | 0.296 |
| 9b | Primary FLEX 480v Generator Location 3 | 81 | 101 | 3 | 3.977 | 0.787 | 0.087 | 0.060 | 0.054 | 0.048 | 0.043 |
| 10 | Alternate FLEX 480v Generator | 86 | 263 | 2 | 5.342 | 1.057 | 0.117 | 0.080 | 0.073 | 0.065 | 0.057 |
| 10a | Inside RW Building Truck Bay | 70 | 263 | 4b | 0.024 | 0.005 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 |
| 13 | DG Room D113 | 37.5 | 133 | 4a | 0.019 | 0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14 | General Area | 52 | 320 | 3 | 1.559 | 0.309 | 0.034 | 0.023 | 0.021 | 0.019 | 0.017 |
| 15 | General Area | 144 | 340 | 1 | 12.653 | 2.504 | 0.277 | 0.191 | 0.172 | 0.154 | 0.136 |
| 16 | RB/DG Bldg Corridor | 5 | 80 | 4 | 0.884 | 0.175 | 0.019 | 0.013 | 0.012 | 0.011 | 0.010 |