4.2 Vent Operation and Monitoring

The importance of reliable operation of hardened vents during conditions involving loss of containment heat removal capability is well established and this understanding has been reinforced by the lessons learned from the accident at Fukushima Dai-ichi. This sub-section describes the design considerations relative to the HCVS operation and monitoring.

By nature, the ELAP creates a need to operate the vent manually (either locally or from remote stations) and the design concepts espoused in this document protect that operational capability. Due to the multiple functions provided by the vent path, a single set of passive features (e.g., Rupture Diaphragms) cannot achieve all of the operational functions, therefore operator actions are required. The challenges found in operating the vents at Fukushima have been addressed by this guidance as have the required actions to complete multiple functions (e.g. FLEX heat removal venting, normal plant venting, intermittent venting for source term control in severe accidents, post severe accident venting for combustible gas control). Based on this, the design elements proposed by this guidance (as listed below) do not require specific new requirements to minimize operator actions to address the ability to operate vents as required for ELAP and severe accident conditions.

4.2.1 Protection from Inadvertent Actuation

The design of the HCVS should incorporate features, such as control panel key-locked switches, locking systems, rupture discs, or administrative controls to prevent the inadvertent use of the vent valves.

a. The system should be designed to preclude inadvertent actuation of the HCVS due to any single active failure.

b. The design should consider general guidelines such as single point vulnerability and spurious operations of any plant installed equipment associated with HCVS.

c. Use of Administrative controls on energizing the HCVS controls can also be a part of the acceptable plan to minimize impact on Current Licensing Basis (CLB) controls.

Order Reference: 1.2.7 - The HCVS shall include means to prevent inadvertent actuation.

4.2.1.1 One or more of the following criteria are acceptable approaches for inadvertent actuation features of the HCVS.

4.2.1.1.1 Rupture disc in flowpath

4.2.1.1.2 Key lock for valve switches

4.2.1.1.3 Administrative Controls for energizing components/controls

4.2.1.1.4 Interface with Technical Specification Components (such as current primary containment isolation valve (PCIV) controls).

4.2.1.2 Meeting design features and the above criteria will show compliance with separation of controls from CLB equipment and methods to demonstrate reasonable prevention of inadvertent actuation of the system.

4.2.1.3 Prevention of inadvertent actuation, while important for all plants, is essential for plants relying on containment accident pressure (CAP) to provide adequate net positive suction head to the emergency core cooling system (ECCS) pumps. Plants that rely on CAP should have an evaluation that specifically addresses the design considerations for minimizing inadvertent actuation interaction. This evaluation can include design features and administrative controls.

4.2.2 Required HCVS Controls {Primary Control and Monitoring Location}

The preferred location for remote operation and control of the HCVS is from the main control room. However, alternate locations to the control room are also acceptable.

Order Reference: 1.2.4 - The HCVS shall be designed to be manually operated during sustained operations from a control panel located in the main control room or a remote but readily accessible location.

Order Reference: 1.2.8 - The HCVS shall include means to monitor the status of the vent system (e.g., valve position indication) from the control panel required by 1.2.4. The monitoring system shall be designed for sustained operation during an extended loss of AC power.

4.2.2.1 The control location should take into consideration the following:

4.2.2.1.1 The ability to open/close the valves multiple times during the event, i.e., sustained operations.

4.2.2.1.1.1 Licensees should determine the number of open/close cycles necessary during the first 24 hours of operation and provide supporting basis consistent with the plant-specific containment venting strategy.

4.2.2.1.1.2 Sustained operational requirements may continue beyond the capacity of the installed HCVS system motive force (air/nitrogen) make-up, power supply changes or both, i.e., beyond the first 24 hours.

4.2.2.1.1.3 Sustained operations provisions should continue until 7 days or until an alternative method of containment heat removal is put in place by using installed or portable equipment (e.g., a means of shutdown cooling aligned directly to the RPV, drywell or suppression pool).

4.2.2.1.1.4 During Sustained Operation, the containment barrier is manually controlled by the plant staff/ERO during containment heat removal operations (either by containment venting or alternative measures) to prevent further fuel damage. This manual containment heat removal allows RPV injection by use of RCIC or external water supplies (reduced containment pressure may be required).

4.2.2.1.1.5 Severe accident venting to remove containment heat should be stopped as soon as possible to fully restore the containment function so that the containment source term barrier is available. Thus allowing design barriers to be maintained for potential degrading core conditions.

4.2.2.1.2 The temperature and radiological conditions that operating personnel may encounter both in transit and locally at the controls.

4.2.2.1.2.1 This should include the impacts on initial release of post severe accident source term and impacts of vent piping related heat up in areas with little or no ventilation on the controls/controlling station. Alternatives may be used, such as providing features to facilitate manual operation of valves from remote locations or relocating/reorienting containment vent valves.

4.2.2.1.3 Availability of permanently installed HCVS equipment, including any connections required to supplement the HCVS operation during an ELAP (e.g., electric power, N_2/air) consistent with the staff's guidance in JLD-ISG-2012-01 for Order EA-12-049.

4.2.2.1.4 The controls/control location design should preclude the need for operators to move temporary ladders or operate from atop scaffolding to access the HCVS valves or remote operating locations.

4.2.2.1.5 HCVS valve position indication should be available at the primary controlling location.

4.2.2.1.6 HCVS valve position indicators should be capable of operating under the temperature/radiation conditions existing at the valve locations.

4.2.2.1.7 HCVS valve position indicators and indications should be powered from sources that will be available during the appropriate mission time of the HCVS system.

4.2.2.1.8 The HCVS system should include indications for the Containment Pressure and Wetwell level for determination of vent operation. These indications may be either at the controlling location for the HCVS or at another location with communication to the HCVS controlling location.

4.2.2.2 The following criteria are acceptable approaches for HCVS Primary Controls and Monitoring location:

4.2.2.2.1 Requirement for sustained operation

4.2.2.2.2 Requirements for assessment on temperature and radiological condition

4.2.2.2.3 Reasonable protection of required equipment

4.2.2.2.4 Required design criteria for indications

4.2.2.3 Meeting design features and the above criteria will show compliance with Primary Controls and Monitoring location requirements (including instrumentation).

4.2.3 Alternate Remote Operation {Alternate/Local Valve Control Location}

During an ELAP, manual operation/action from alternate control locations may become necessary to operate the HCVS. As demonstrated during the Fukushima event, the valves lost motive force including electric power and pneumatic air supply to the valve operators, and control power to solenoid valves.

a. If direct access and local operation of the valves is not feasible due to temperature or radiological hazards, licensees should include design features to facilitate remote manual operation of the HCVS valves. This could include means such as reach rods, chain links, hand wheels, alternative control locations, and portable equipment to provide motive force as needed (e.g., air/N_2 bottles, diesel powered compressors, and DC batteries).

Order Reference: 1.2.5 - The HCVS shall, in addition to the requirements of 1.2.4, be capable of manual operation (e.g., reach-rod with hand wheel or manual operation of pneumatic supply valves from a shielded location), which is accessible to plant operators during sustained operations.

4.2.3.1 The HCVS design should consider the following elements to facilitate remote manual operation:

4.2.3.1.1 An assessment of temperature and radiological conditions that operating personnel may encounter both in transit and locally at the local or alternate control location.

4.2.3.1.1.1 Include radiological conditions associated with post severe accident source terms and impacts of vent piping related heat up in areas with little or no ventilation on the local or alternate control location.

4.2.3.1.1.2 Alternatives such as providing features to facilitate manual operation of valves from remote locations or relocating/reorienting the valves may be used.

4.2.3.1.1.3 Consider that local-manual access to PCIVs for an ELAP event may not be feasible due to high temperature or radiation levels in the Reactor Building since they will be located near a containment penetration.

4.2.3.1.1.4 Reach rods and chain-operators may not be credible except when located at a short distance from the valve and with limited turns which would not be the case for most of these valves.

4.2.3.1.1.5 The connections between the valves and portable equipment should be designed for quick deployment.

4.2.3.1.1.6 If a portable motive force (e.g., air or N_2 bottles, DC power supplies) is used in the design strategy, licensees should provide reasonable protection of that equipment consistent with the staff's guidance in JLD-ISG-2012-01 for Order EA-12-049.

4.2.3.1.1.7 The Local Controls/Alternate Valve Control Location design should preclude the need for operators to move temporary ladders or operate from atop scaffolding to access the HCVS valves or remote operating locations.

4.2.3.1.1.8 The HCVS system should include indications for the Containment Pressure and Wetwell level for determination of vent operation. These indications may be either at the local

controls/alternate control location for the HCVS systems or at another location with communication to the Local Controls/Alternate Valve Control Location.

4.2.3.2 The following criteria are acceptable approaches for HCVS Local Controls/Alternate Valve Control Location:

4.2.3.2.1 Supply an alternate method of HCVS valve operation

4.2.3.2.2 Assessment on temperature and radiological condition

4.2.3.2.3 Reasonable protection of required equipment

4.2.3.2.4 Required design criteria for indications

4.2.3.2.5 Criteria for manual opening of AOVs

4.2.3.2.6 Criteria for operation of MOVs

4.2.3.3 Meeting design features and the above criteria will show compliance with local controls/alternate control location requirements (including instrumentation).

4.2.4 Vent Monitoring

Plant operators must be able to readily monitor the radiological conditions that exist during venting operations of the HCVS at all times.

Order Reference: 1.2.9 - The HCVS shall include a means to monitor the effluent discharge for radioactivity that may be released from operation of the HCVS. The monitoring system shall provide indication from the control panel required by 1.2.4 and shall be designed for sustained operation during an extended loss of AC power.

4.2.4.1 The HCVS design should provide a means to allow plant operators to readily determine, or have knowledge of, the following system parameters:

4.2.4.1.1 HCVS vent valves position (open or closed).

4.2.4.1.2 HCVS vent pipe radiation levels. The range of the instrument should be consistent with the dose rates anticipated during severe accident venting.

4.2.4.1.3 Other important information includes the status of supporting systems, such as availability of electrical power and pneumatic supply pressure.

4.2.4.1.3.1 Monitoring by means of permanently installed gauges or meters that are at, or nearby, the HCVS control panel or in the Control Room with communication to the HCVS control panel is acceptable.

4.2.4.1.3.2 Alternative approaches for system status instrumentation may be considered provided a justification for alternative approaches must be provided.

4.2.4.1.4 The HCVS system should include indications for the Containment Pressure and Wetwell level for determination of vent operation. These indications may be either at the local controls/alternate control location for the HCVS systems or at another location with communication to the Primary Controls location or local controls/alternate control location.

4.2.4.2 The means to monitor system status should support sustained operations during an ELAP, and be designed to operate under potentially environmental conditions that would be expected following a loss of containment heat removal capability and an ELAP. “Sustained operations” may include the use of portable equipment to provide an alternate source of power to components used to monitor HCVS status.

Note: Additional instrumentation required to comply with Order EA-12-049 as discussed in NEI 12-06 may be useful in support of HCVS operation, but are not required for HCVS functionality.

4.2.4.3 Instrument reliability should be demonstrated via an appropriate combination of design, analyses, operating experience, and/or testing of channel components for the conditions described in Section 2 of this guide.

4.2.4.4 The following criteria are acceptable approaches for HCVS monitoring:

4.2.4.4.1 Need to monitor HCVS vent pipe conditions including radiological releases, vent pipe pressure and temperature.

4.2.4.4.2 Sustained operation of HCVS vent pipe condition instrumentation and other required indications during an ELAP condition (limiting analysis).

4.2.4.4.3 Requirements for assessment of radiological, temperature and pressure conditions in the area of HCVS monitoring instruments.

4.2.4.5 Meeting design features and the above criteria will show compliance with HCVS monitoring.

4.2.5 Operational Hazards

Order Reference: 1.1.2 - The HCVS shall be designed to minimize plant operators' exposure to occupational hazards, such as extreme heat stress, while operating the HCVS system.

Order Reference: 1.1.3 - The HCVS shall also be designed to account for radiological conditions that would impede personnel actions needed for event response.

4.2.5.1 HCVS controls should be located in areas where sustained operation is possible accounting for expected temperatures and radiological conditions in the HCVS vent pipe and attached components without extreme heat stress or radiological over exposure to the operators.

4.2.5.1.1 HCVS operation must be possible without placing the operators in dose fields above those allowed by the ERO guidance to conduct local equipment operation.

4.2.5.1.2 HCVS operating locations (Primary/Alternate) must account for the expected lack of ventilation that is encountered during an ELAP event.

4.2.5.1.3 HCVS operating locations should not place the operators in areas above the safe entry points in the applicable plant safety manual/guidance.

4.2.5.1.4 HCVS controls should be located in areas where sustained operation is possible accounting for radiological conditions in the HCVS vent pipe and attached components within allowed doses per the ERO guidance to the operators for non-heroic actions. These conditions should include estimation of the impact during an ELAP event and following core damage required vent operations.

4.2.5.1.5 The HCVS vent pipe routing must be considered for other actions required of the plant staff/ERO during the event should venting be required during severe accident conditions. Guidance for the allowable dose fields/dose during required actions with the source term in the HCVS vent pipe would be the limits prescribed in the ERO guidance.

Note: Any deviation from the above can be considered provided justification is submitted.

4.2.5.2 The following criteria are acceptable approaches for HCVS operational hazards at local controls/primary and alternate control locations:

4.2.5.2.1 Temperature conditions at the HCVS proposed operating stations meet plant safety manual/guidance or justification is provided to the Staff.

4.2.5.2.2 Radiological conditions at the HCVS proposed operating stations meets ERO allowable dose guidance or justification is provided.

4.2.5.2.3 Other plant actions required by the plant staff/ERO should account for the expected radiological conditions caused by HCVS vent pipe routing with severe accident source term release through the HCVS vent pipe. The expected limits imposed on the dose/dose field from the ERO guidance should be used for these actions.

4.2.5.3 Meeting design features and the above criteria will show compliance with HCVS operational hazards at Primary Controls and Local/Alternate Valve Control Locations.

4.2.6 Designed to minimize Operator Actions

HCVS system should be designed to maximize the probability of successful operator action to operate vents when required.

Order Reference: 1.1.1 - The HCVS shall be designed to minimize the reliance on operator actions.

4.2.6.1 Design features consistent with this approach include:

4.2.6.1.1 Environmental considerations

4.2.6.1.1.1 Heat stress impact on ability to vent

4.2.6.1.1.2 Radiological condition impact on ability to vent

4.2.6.1.2 Sustained operational capability

4.2.6.1.2.1 Independent 24 hour electrical and pneumatic supplies.

4.2.6.1.2.2 The system will be capable of multiple valve cycles during the first 24 hour period without the need to recharge pneumatic or electrical power supplies.

4.2.6.1.3 Ease of vent valve operation

4.2.6.1.3.1 Readily accessible under all operational conditions (e.g., accessible location without need for ladders or scaffolds)

4.2.6.1.3.2 Operation achievable at a localized location.

4.2.6.1.3.3 Operation does not require the use of jumpers or lifted leads to defeat valve interlocks.

4.2.6.1.3.4 System comprised of installed equipment. No need for system or component disassembly/reassembly.

4.2.6.2 The following criteria are acceptable approaches for HCVS minimize operator actions that could prevent vent operations when required:

4.2.6.2.1 Compliance with other sections of this guidance as listed above.

4.2.6.3 Meeting design features and the above criteria will show compliance with HCVS to minimize operator actions that could prevent vent operations when required.