# 6 OPERATIONAL CONSIDERATIONS

## 6.1 OPERATOR ACTIONS

During the extended loss of AC power condition at the Fukushima Dai-ichi units, operators faced many challenges while attempting to restore adequate core cooling in addition to complications associated with controlling containment pressure via the containment venting system. The difficulties faced by the operators related to operation of the containment venting system included the location of their vent valves, ambient temperatures and radiological conditions, loss of all alternating current electrical power, loss of motive force to open the vent valves, and exhausting DC battery power. The use of a hardened containment vent provides an important method of containment heat removal which can become necessary for an ELAP/loss of UHS event. Indirectly, an elevated containment pressure may prevent the injection from a low head water supply to the RPV. Operator actions are a vital part of normal and off-normal plant activities and are expected to play an important role in mitigation of beyond design basis external events. It is fully recognized that operator actions will be needed to implement the EA-13-109 severe accident capable HCVS; however, the licensees should consider design features for the system that will minimize the need and reliance on operator actions to the extent possible during a variety of plant conditions, as further discussed in this guideline.

The HCVS should be designed to be operated from a control panel located in the main control room or a remote but readily accessible location. The HCVS should be designed to be fully functional and self-sufficient with permanently installed equipment in the plant, without the need for portable equipment or connecting thereto, until such time that on-site or off-site personnel and portable equipment become available. At least one method of operation of the HCVS should be capable of operating with permanently installed equipment for at least 24 hours during the extended loss of AC power, unless a shorter period is justified by the licensee. The system should be deigned to function in this mode with permanently installed equipment providing electrical power (e.g., DC power batteries) and valve motive force (e.g., $N_2$/air cylinders). The HCVS operation in this mode depends on a variety of conditions, such as the cause for the extended loss of AC power (e.g., seismic event, flood, tornado, high winds), severity of the event, and time required for additional help to reach the plant, move portable equipment into place, and make connections to the HCVS. The system should be designed to function in this mode for a minimum duration of 24 hours with no operator actions required or credited to replenish electrical power and pneumatic supplies. Operator action is expected to perform system alignment and monitoring functions as needed for event mitigation. Durations of less than 24 hours will be considered if justified by adequate supporting information from the licensee. To ensure continued operation of the HCVS beyond 24 hours, licensees may credit manual actions, such as moving portable equipment to supplement electrical power and valve motive power sources.

For justifying periods less than 24 hours, the licensee should consider the number and complexity of actions and the cumulative demand on personnel resources that are needed to maintain hardened vent functionality (e.g., installation of portable equipment during the first 24 hours to restore power to the HCVS controls and/or instrumentation) as a result of design limitations. The use of supplemental portable power sources may be acceptable if the supplemental power was readily available, could be quickly and easily moved into place, and installed through the use of pre-engineered quick disconnects, and the necessary human actions were identified along with the time needed to complete those actions. Conversely, supplemental power sources located in an unattended warehouse that require a qualified electrician to temporarily wire into the panel would not be considered acceptable because its installation requires a series of complex, time-consuming actions in order to achieve a successful outcome. There are similar examples that could apply to mechanical systems, such as pneumatic/compressed air systems.

### 6.1.1 Feasibility and Accessibility

During an extended loss of AC power, the drywell, wetwell (torus or suppression pool), and nearby areas in the plant where HCVS components are expected to be located will likely experience elevated temperatures due to inadequate containment cooling combined with loss of normal and emergency building ventilation systems. In addition, installed normal and emergency lighting in the plant may not be available. Licensees should take into consideration plant conditions expected to be experienced during applicable beyond design basis external events when locating valves, instrument air supplies, and other components that will be required to safely operate the HCVS system. Components required for manual operation should be placed in areas that are readily accessible to plant operators, and not require additional actions, such as the installation of ladders or temporary scaffolding, to operate the system.

The design strategy should evaluate potential plant conditions and use acquired knowledge of these areas to provide input to system operating procedures, training, the choice of protective clothing, required tools and equipment, and portable lighting. The evaluation should include considerations such as, how temperatures would elevate due to extended loss of AC power conditions and the lighting that would be available following beyond design basis external events.

The design of the HCVS should account for radiological conditions resulting from the beyond design basis external event. During the Fukushima event, personnel actions to manually operate the containment vent valves were impeded due to the location of the valves in the torus rooms. The HCVS should be designed to be placed in operation by operator actions at a control panel, located in the main control room or in a remote location. The design of the severe accident capable HCVS system will take into account the radiological conditions that may be encountered during system operation. The use of shielding and locating components having significant source term away from system control stations where the system will be operated are the primary means available to control operational dose. Additional means of minimizing potential radiological dose to the operators may include, but are not limited to:

- Simplification of operator actions needed to initiate, control and isolate the system including replenishment of electrical power and pneumatics during the sustained operational period
- Minimizing the time operators need to spend at the vent controls during system operation during severe accident conditions
- Minimizing the number of operators needed to operate and maintain the system

functional during severe accident conditions
- Developing a strategy to rotate operators through the various venting actions to minimize the dose received by any one operator

In response to Generic Letter (GL) 89-16, a number of facilities with Mark I containments installed vent valves in the torus room, near the drywell, or both. Licensees may continue to use these venting locations or select new locations, provided that the requirements of this guidance document are satisfied. The HCVS in conjunction with active core debris cooling improves the chances of mitigating a core damage accident by removing heat from containment and lowering containment pressure. Leakage from the HCVS within the plant and at the location of the external release could impact the event response from on-site operators and off-site help arriving at the plant. An adequate strategy to minimize radiological consequences that could impede personnel actions should include the following:

1. Provide permanent radiation shielding where necessary to facilitate personnel access to valve controls that allow manual operation of the valves at a remote manual location. Other alternatives to facilitate personnel access besides radiation shielding can be utilized, such as:

    - providing features to facilitate manual operation of valves from remote locations, as discussed further in this guidance
    - locating the vent valves in areas that are significantly less challenging to operator access/actions

2. In accordance with Requirement 1.2.10, the HCVS should be designed for pressures that are consistent with the higher of the primary containment design pressure <u>and</u> the primary containment pressure limit (PCPL), as well as including dynamic loading resulting from system actuation and hydrogen deflagration or detonation if the gases passing through the system cannot be maintained below flammability limits. In addition, the system should minimize leakage. As such, ventilation duct work (i.e., sheet metal) should not be utilized in the design of the HCVS. Licensees should perform appropriate testing, such as hydrostatic or pneumatic testing, to establish the leak-tightness of the HCVS.

3. The HCVS release to outside atmosphere should be at an elevation higher than adjacent power block plant structures. Release through existing plant metrological stacks is considered acceptable, provided the guidance under Requirements 1.2.3 and 1.2.11 are satisfied. If the release from HCVS is through a vent stack different than the plant metrological stack, the elevation of the stack should be higher than the nearest power block building or structure. The routing should be such that radiological conditions resulting from operation of the HCVS would not negatively impact on-site personnel response.

4. The required Operator actions to operate the HCVS under the design conditions required by Order items 1.1.2 and 1.1.3 at the plant specified operating locations would need to be evaluated. The operations should be feasible for the control locations for conducting the operations under the beyond design basis external event conditions. These expected conditions can be obtained from available generic or plant-specific accident analysis. The timing of the operations should be taken into consideration (e.g., operation of the equipment

during the worst source term release is not required if the station could be accessed prior to the release and after the release for control) for this accessibility/feasibility evaluation. Guidance is supplied in Appendix E of this guide for this evaluation. Elements of the evaluations can utilize NUREG 1921/1852 guidance and/or procedural controls.

### 6.1.2 Procedural Guidance

Procedures to operate, test, and maintain the severe accident capable HCVS should include the following elements:

- HCVS system operation including startup, shutdown and off-normal conditions
- HCVS system standby status verification
- System out of service controls
- location of system components and equipment lineups (may be part of other plant system procedures)
- instrumentation available during ELAP conditions that supports HCVS operation
- directions for sustained operation using portable equipment and supplies,
- storage location of portable equipment
- equipment testing and maintenance
- If applicable, the nexus between containment accident pressure (CAP) and ECCS pump net positive suction head during a DBLOCA and how an inadvertent opening of the vent valve could have an adverse impact.

HCVS procedures should be developed and implemented in the same manner as other plant procedures necessary to support the execution of the Emergency Operating Procedures (EOPs) and the severe accident guidelines (SAGs).

HCVS procedures for operation need to be validated for operator feasibility/accessibility and should address the following functional operations:

- With power on normal power sources (no ELAP)
- With backup power and from local manual location/alternate remote location during conditions of ELAP/loss of UHS with no core damage for containment heat removal AND containment pressure control (PCPL). (FLEX)
- With backup power and from local manual location/alternate remote location during conditions of ELAP/loss of UHS with core damage for containment heat removal AND containment pressure control (PCPL). (Severe Accident Capable Vent)

#### 6.1.2.1 Coordination with guidance and procedures

The Licensee should verify that the procedures for HCVS operation are coordinated with other procedures. The following relationships should be evaluated to address this coordination:

- Coordinate EOPs and SAGs with hardened containment vent operation on normal power sources (no ELAP)

- Coordinate EOPs, SAGs and FLEX Support Guidelines (FSGs) with hardened containment vent operation on normal and backup power and from primary and alternate locations during conditions of ELAP/loss of UHS with no core damage. System use is for containment heat removal AND containment pressure control
- Coordinate SAGs with HCVS operation on normal and backup power and from primary and alternate locations during conditions of ELAP/loss of UHS with core damage. System use is for containment heat removal AND containment pressure control (PCPL) with potential for combustible gases.
- Coordinate administrative controls for FLEX and HCVS equipment allowed outage times and compensatory actions

#### 6.1.2.2 Demonstration with other Post Fukushima measures

The Licensee should demonstrate procedures for HCVS operation as follows:

- Hardened containment vent operation on normal power sources (no ELAP) – demonstrate use in simulator drills AND/OR ERO drills.
- Hardened containment vent operation on backup power and from primary or alternate location during conditions of ELAP/loss of UHS with no core damage. System use is for containment heat removal AND containment pressure control – demonstrate by use in simulator drills AND/OR ERO drills during FLEX demonstrations (as required by EA-12-049).
- HCVS operation on backup power and from primary or alternate location during conditions of ELAP/loss of UHS with core damage. System use is for containment heat removal AND containment pressure control with potential for combustible gases – demonstration by use in simulator drills AND/OR ERO drills and may be in conjunction with SAG change.

### 6.1.3 Training

All personnel expected to operate the HVCS should receive initial and continuing training in the use of plant procedures developed for system operations when either normal or backup power is available and during ELAP/loss of UHS conditions consistent with the plants systematic approach to training. The training should be refreshed on a periodic basis consistent with the procedure control process at the plant site or when procedural related changes occur to the HCVS.

Training should also ensure that specific guidance and procedures that direct HCVS Operation is referenced and used in formulation of the training (e.g., EOPs, FSGs, SAGs,).

## 6.2 TESTING AND INSPECTION OF HCVS

The HCVS design should provide a means (e.g., drain valves, pressure and temperature gauge connections) to periodically test system components, including exercising (opening and closing) the vent valve(s).

The HCVS outboard of the containment boundary should be tested to ensure that vent flow is released to the outside with minimal leakage, if any, through the interfacing boundaries with other systems or units. The testing method can either individually leak test interfacing valves or test the overall leakage of the HCVS volume by conventional leak rate testing methods. The test volume should envelope the HCVS between the outer primary containment isolation barrier and the vent exit from the plant buildings, including the volume up to the interfacing valves. The test pressure should be based on the HCVS design pressure. Methods for testing system boundary leakage should be consistent with the licensee's design basis for these tests (e.g., permissible leakage rates for the interfacing valves should be within the requirements of American Society of Mechanical Engineers Operation and Maintenance of Nuclear Power Plants Code (ASME OM) – 2009, Subsection ISTC – 3630 (e) (2), or later edition of the ASME OM Code.) When testing the HCVS volume, allowed leakage should not exceed the sum of the interfacing valve leakages as determined by the licensee's test program (e.g., ASME OM Code).

Licensees should implement the following operation, testing and inspection requirements for the HCVS to ensure reliable operation of the system.

**Testing and Inspection Requirements**

| Description | Frequency |
|---|---|
| Cycle the HCVS valves and the interfacing system valves not used to maintain containment integrity during operations. | Once per operating cycle |
| Perform visual inspections and a walkdown of HCVS components. | Once per operating cycle |
| Test and calibrate the HCVS radiation monitors. | Once per operating cycle |
| Leak test the HCVS. | (1) Prior to first declaring the system functional;<br>(2) Once every five years thereafter; and,<br>(3) After restoration of any breach of system boundary within the buildings. |
| Validate the HCVS operating procedures by conducting an open/close test of the HCVS control logic from its control panel and ensuring that all interfacing system valves move to their proper (intended) positions. | Once per every other operating cycle |

## 6.3 Allowed out of service time for HCVS

The unavailability of equipment and applicable connection that directly performs an HCVS function should be managed such that risk to HCVS capability is minimized. The primary (1.2.4) and alternate (1.2.5) method of HCVS operation will normally be functional in Modes 1, 2 and 3.

1. If the primary or alternate method of HCVS operation is non-functional, the primary or alternate HCVS controls/indications may be out of service for periods of up to 90 days.

2. If the primary and alternate methods of HCVS operation are non-functional, the primary and alternate HCVS controls/indications may be out of service for periods of up to 30 days.

3. If the allowed out of service times described in 1 and/or 2 above are exceeded, then through the plant corrective action program determine:

    a. The cause(s) of the non-functionality,

    b. The actions to be taken and the schedule for restoring the system to functional status, and

    c. Initiate action to implement appropriate compensatory actions.

The HCVS system is functional when piping, valves, instrumentation and controls including motive force necessary to support system operation are available. Since the system is designed to allow a primary and alternate means of operation by Order criteria 1.2.4 or 1.2.5, allowing for a longer out of service time with either of the functional capabilities maintained is justified. A shorter length of time when both primary and alternate means of system operation are unavailable is needed to restore system functionality in a timely manner while at the same time allowing for component repair or replacement in a time frame consistent with most high priority maintenance scheduling and repair programs.

The system functionality basis is for coping with beyond design basis events and therefore plant shutdown to address non-functional conditions is not warranted. However, such conditions should be addressed by the corrective action program and compensatory actions to address the non-functional condition should be established. These compensatory actions may include alternative containment venting strategies needed to ensure fission product cladding integrity during design basis and beyond design basis events even though the severe accident capability of the vent system is degraded or non-functional.

Examples of non-functional equipment conditions expected to be resolved in a 30 or 90 day timeframe include pneumatic or electrical motive force, instrumentation and controls located outside the primary containment. Examples on non-functional equipment conditions that may require longer out of service times include piping and valve issues that may challenge primary containment operability that will require repair when the primary containment system is not required to be operable.

The applicability for system functional requirements is limited to startup, power operation and hot shutdown conditions when primary containment is required to be operable and containment integrity may be challenged by decay heat generation.