

## FILTERED CONTAINMENT VENTING SYSTEM-FCVS PLUS

Efficient Containment Pressure and Activity Release Limitation

**Framatome's FCVS allows release of excess pressure from the containment to the environment, while its robust design and extensive qualification ensure reliable filtration and comparably low activity releases due to high decontamination factors.**

### Challenge

In the event of a severe accident, the pressure inside the containment may rise excessively; in such cases, the containment as the last physical barrier for enclosed radioactivity must remain intact, to prevent significant long-term off-site land contamination.

To ensure this, it is necessary to:

- Limit excessive pressure build-up in the containment;
- Limit the off-site radiological consequences to an absolute minimum;
- Safely store or return captured fission products to the containment; and
- Control decay heat removal from the capture fission products.

### Solution

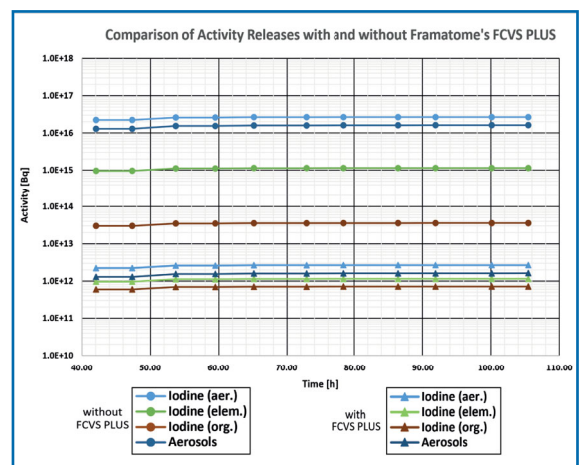
Framatome's Filtered Containment Venting System provides reliable depressurization of the containment while efficiently retaining the radio-active aerosols and elemental as well as organic iodine. It combines the advantages of a high-speed venturi scrubber (stage 1) with a highly efficient metal fiber filter (stage 2) and organic iodine retention in the molecular sieve sorbents (stage 3).

The system operates fully passive and thus does not require external power for activation or operation. The three stages are arranged inside a robust pressure vessel and ensure safe containment depressurization. During operation and depressurization, the system handles large amounts of energy released from the containment while ensuring highest fission product retention rates.

Thanks to the modular, compact design, Framatome's FCVS is easy to retrofit into existing buildings at low cost. The system can be easily adapted to any nuclear power plant type, type of containment or other design parameters without impacting the systems efficiency or qualification. Potential layout restrictions can be met by the system design dividing the sections into separate vessels (split vessel design).

Framatome's patented approach ensures high decontamination factors for iodine, large and fine aerosols in a very compact design. The process design further provides passively superheating of the vent gas to ensure high efficiency for organic iodine retention in the molecular sieve sorbents of stage 3.

The system is designed entirely as pressure equipment and provides an essential safety feature in case of postulated hydrogen deflagration.



Comparison of Activity Release with and without installation of Framatome's FCVS PLUS

### Customer benefits

- Fulfilling regulatory requirements.
- Cost effective prevention of excessive containment pressure build up.
- High retention rates for all types of fission products, aerosols and organic iodine.
- Reliably retaining activity in short & long-term conditions.
- Large scale qualification Internationally accepted.
- Compact size, high flexibility by split vessel design, tailor made for customer specific plant parameters.

## Technical information

### Stage 1: Venturi Scrubber

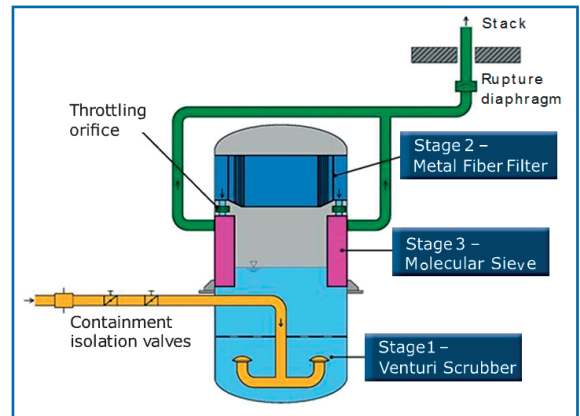
The venturi scrubber operates at a pressure close to the prevailing containment pressure. The vent gas is accelerated to high velocities in the venturi nozzles and injected into the scrubbing liquid. As it passes through the throat of the venturi nozzle, a suction is created that carries scrubbing liquid with it. The high velocity difference ensures retention of more than 99% of the aerosols and more than 99.5% of the elemental iodine are retained due to Framatome's unique process design. During the scrubbing process, the decay heat transfers to the scrubbing liquid and does not require any active measures.

### Stage 2: Metal Fiber Filter

The second stage consisting of metal fiber filters retains the hard to retain micro-aerosols and scrubbing water droplets still contained in the vented gas flow downstream of stage 1. Furthermore, the metal fiber elements capture re-suspended aerosols. Crucial for effectiveness of this stage is the removal of droplets and condensate, which is ensured by the optimized filter design. The combination of stage 1 and stage 2 provides retention rates for aerosols of more than 99.99%.

### Stage 3: Molecular Sieve

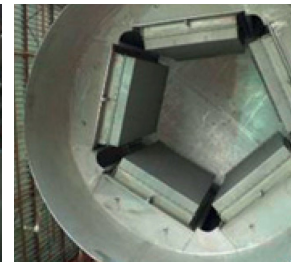
The third stage consists of a zeolite which is doped with silver, which captures the gaseous organic iodine, especially the difficult to retain organic iodine, by reacting with the silver to form stable silver iodide that is bonded to the porous structure of the molecular sieve sorbents. This additional stage can be included in the initial system design or added separately to an already existing Filtered Containment Venting System that already includes stage 1 and stage 2. In this case, it is referred to as **Enhanced Organic Iodine Retention (I-CATCH)**, which further minimizes the potential biological impact from the release of organic iodine in particular.



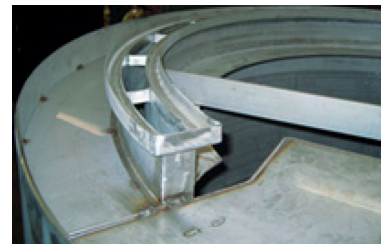
Schematic of Framatome's FCVS Plus



Example of Stage 1  
Venturi Scrubber



Example of Stage 2  
Metal Fiber Filter



Example of  
Stage 3  
Molecular Sieve

## References

Filtered Containment Venting System applications are installed in more than **100** PWR, BWR, CANDU, ABWR and PHWR reactors worldwide.

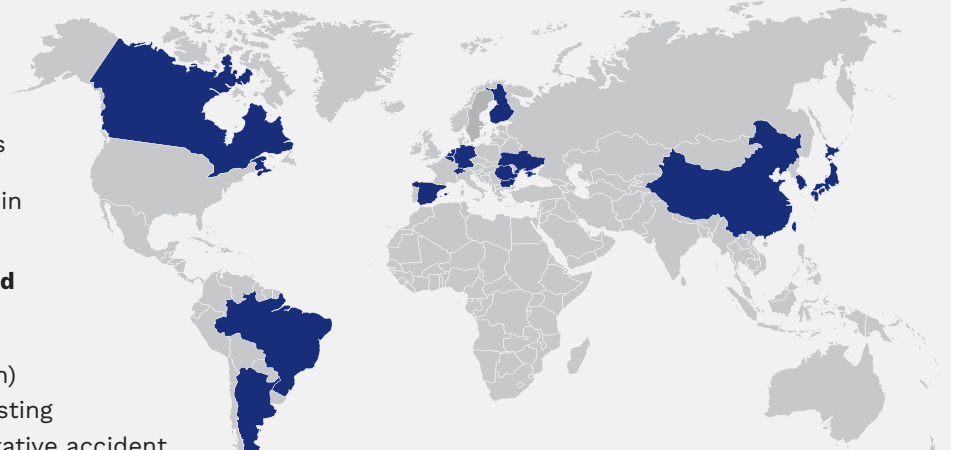
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### Licensing

Framatome has broad experience on licensing and supports utilities by an extensive qualification and large scale verification data base in the discussion with regulators.

### Extensive process qualification and performance verification

- Full scale process section tests (JAVA Plus Test Facility Karlstein)
- Third party and international testing
- Tests performed with representative accident aerosols at high pressure and temperatures
- Retention tests with gaseous iodine (elemental and organic iodine)
- Seismic Qualification (up to 8 g (peak) respectively 5 g (rigid body))



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