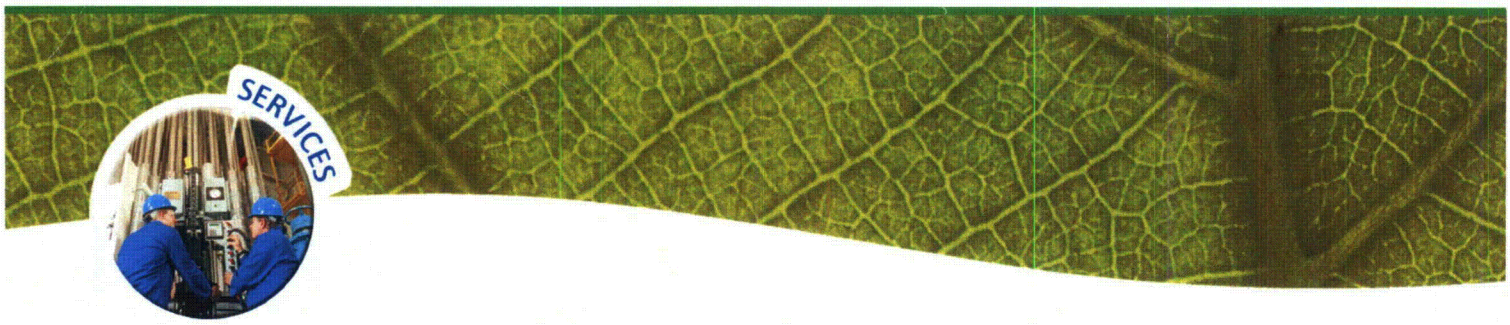
B1



Nuclear Services/Engineering Services

FILTRA-MVSS

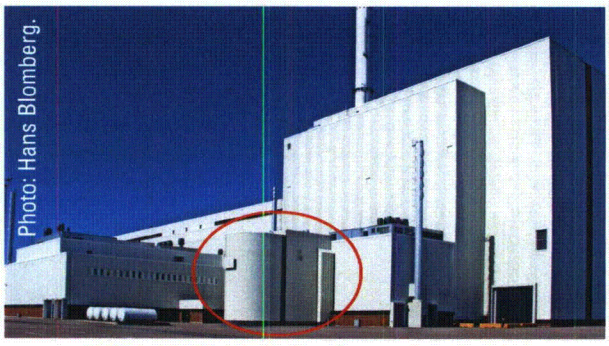
Background

Under severe accident conditions, such as core meltdown, pressure from boiling water reactor/pressurized water reactor (BWR/PWR) containments must be released to the atmosphere to maintain containment integrity. Westinghouse offers the FILTRA-MVSS system to effectively mitigate the consequences of a severe reactor accident by significantly reducing the level of radioactive release to the surrounding environment. The system has very high decontamination factors for gas-carried particles, aerosols and elemental iodine. The design is based on Swedish regulations requiring that 99.9 percent of the core inventory of radioactivity (excluding noble gases) be retained in the containment or filtered in case of venting. Westinghouse can design this flexible system to cope with a number of hypothetical scenarios and site-specific requirements.

Why Westinghouse?

Westinghouse, together with Alstom, can provide a total solution for the filtered containment vent system that can be integrated with a reliable hardened vent. Typical scope includes the definition of the functional criteria using a severe accident analysis, determination of the layout, and installation and commissioning of the system, as well as updating the plant Severe Accident Guidelines.

Westinghouse's FILTRA-MVSS is fully passive for at least 24 hours after initial venting and requires no startup time. This system has the capability to handle high decay heat loads for numerous postulated severe accident scenarios. The technological innovation behind the FILTRA-MVSS received the prestigious Swedish Polhem award.



FILTRA-MVSS (circled) at Forsmark 3, Sweden

Description

The containment-filtered, pressure-relief system offered by Westinghouse is called FILTRA-MVSS (Multi-Venturi Scrubber System). It is a passive, self-regulating system for filtered pressure relief of BWR/PWR reactor containments. The system is passively actuated by means of a rupture disc. Neither water nor electrical power is needed, and operator intervention is not necessary for at least the first 24 hours after activation of the system.

A typical design basis for the system is a total loss of AC power for 24 hours leading to loss of core cooling ability. This includes a total loss of electrical supply from both the external grid and all plant-specific power backup systems, as well as loss of the steam turbine-driven core cooling pumps. This scenario is typically chosen, as it covers other less severe conditions as well.

Westinghouse

Customer 1st

The system design can be adjusted for a variety of conditions, including variations in operating pressure, location, ambient temperature, consideration of oxyhydrogen combustion, requirements for radiation shielding, amount and composition of gas and radioactive contents, and other nuclear power plant (NPP) unit-specific requirements.

For a BWR, the FILTRA-MVSS would be connected to the reliable hardened vent. The FILTRA-MVSS consists of several filtration steps, all of which are contained in a tank: the multi-venturi scrubber, a water pool, a moisture separator, and finally an optional metal fiber filter. For longer-term operation (more than 24 hours), an internal heat exchanger can be used to handle decay heat in the filter. Any low-pressure water system (e.g., fire truck, portable pump) can be used to provide cooling water to the heat exchanger.

Aerosols and elemental iodine are primarily captured by water droplets formed in the venturi scrubber. The decontamination efficiency of the FILTRA-MVSS is not dependent on the total mass flow rate, as the number of venturis in operation is determined by the actual mass flow rate. This means that the load on and efficiency of each venturi will be almost constant for a large total mass flow rate interval. The scrubber liquid is prepared to provide a very high removal efficiency of iodine, resulting in an excellent decontamination factor. The moisture separator keeps contaminated water droplets from following the gas through the exhaust duct, which further contributes to the high decontamination efficiency of the system.

Benefits

The FILTRA-MVSS reduces radioactive release in case of containment venting during severe accident conditions featuring:

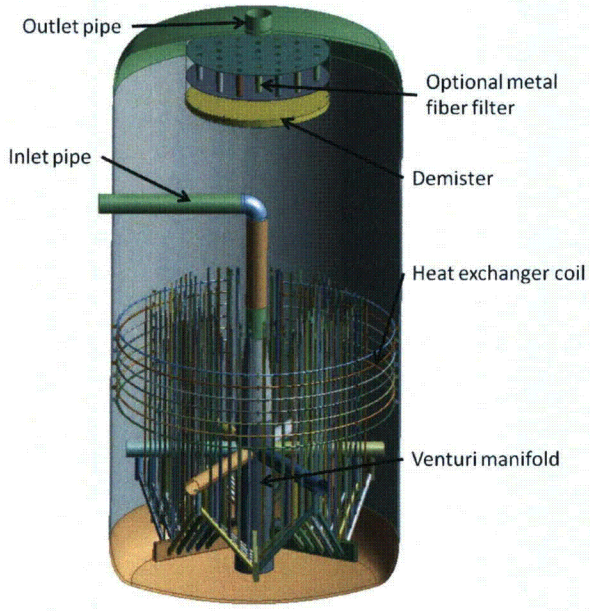
- Passive design for at least 24 hours – no operator action required to activate the system
- Very high removal efficiencies; typical FILTRA-MVSS efficiencies:
  - Aerosols: > 99.99 percent (decontamination factor [DF] > 10,000 with optional fiber filter for the smallest particles)
  - Elemental Iodine: > 99.99 percent (DF > 10,000)
  - Organic Iodine: > 80 percent (DF > 5)
  - Same DF for all flow rates
- DF for organic iodine remains the same at various and elevated venting temperatures
- Designed for high seismic loads
- Designed for a wide range of postulated severe accidents
- The ability to avoid and cope with oxyhydrogen combustion
- Adaptable to NPP unit-specific requirements
- May be used in feed-and-bleed mode for long-term core cooling

System Verification

The venturi system in FILTRA-MVSS was verified in three steps by comprehensive laboratory and full-scale testing. In step one, the individual venturi and distributor branches were tested in a full-scale test rig during all feasible conditions to verify the design as well as calculations and analysis algorithms. In step two, a scaled prototype was used in the ACE program (international reference test for venting systems) to verify the high DF of the system. Finally, a full-scale dynamic test was made at an installation at a Swedish NPP. In this test, a rupture disc was activated, and measurements of pressure and pool swell in the scrubber were used to further verify the design and analysis algorithms. The results of the verification process provide a powerful tool for system calculations and also offer a strong basis for licensing for a wide range of demands and sizes.

Experience

Westinghouse's FILTRA-MVSS is installed in 10 Swedish NPPs and one Swiss NPP. Westinghouse's FILTRA-MVSS experience covers both BWR and PWR applications.



FILTRA-MVSS system design

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