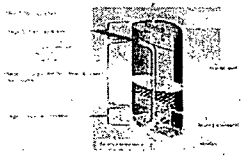
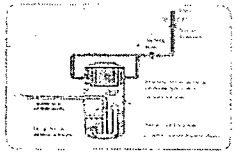
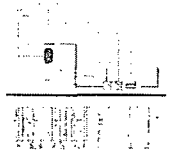
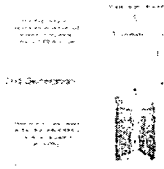
Comparison of Filtered Containment Venting Systems, March 2012

Supplier	CCI	AREVA	Westinghouse Dry	Westinghouse Wet - Metal fiber
Attribute				
Aerosol DF (.2 micron to 1 micron diameter)	>10,000 at prototypical aerosol concentrations days of operation	>10,000 at low aerosol concentration, limited aerosol load capacity	>10,000 limited aerosol load capacity	>1,000 limited aerosol load capacity
Iodine (elemental) DF	>1000	>100	>3300, if molecular sieve preheated, otherwize <20	>1000 (expected)
Iodine (organic) DF	>1000	>5	>38	No test data
Re-suspension	droplet separator eliminates release	entrainment of droplets through the Metal Fiber	entrainment of droplets through the Metal Fiber	No test data
Re-volatilization	chemical stable binding of iodines	re-volatilization under irradiation	no test data	re-volatilization under irradiation
Clogging - Hot Spot	None, all fission products in water	Local clogging / hot spot in Metal Fiber	Local clogging / hot spot in Metal Fiber	Local clogging / hot spot in Metal Fiber
Long term retention	Sized to contain total content of aerosols and iodine in vessel until final site cleanup (1 year)	Limited by re-volatilization. Needs emptying to containment. Potential release from Metal fiber	Potential release from Metal Fiber	Limited by re-volatilization. Potential release from Metal fiber
Early Venting DF (low pressure)	>10,000 (mixing element and recirculation)	Dependent on Metal Fiber Filter only, low inlet pressure reduces effectiveness of venturi for aerosol de-contamination	Dependent on Metal Fiber Filter	Dependent on Metal Fiber Filter only, low inlet pressure reduces effectiveness of venturi for aerosol de-contamination
Filtration Process	Sparger assemblies, co-current scrubber, re-circulation zone, droplet separator, chemical reduction and retention of iodines	Venturi and Metal Fiber Filter (Metal Fiber Filter, Primary), chemical reduction of iodines	Metal Fiber Filter, and molecular sieve	Venturi and Metal Fiber Filter (Metal Fiber Filter, Primary), chemical reduction of iodines
Filter pressure ratio Qualification	approx. 4	approx. 2	approx. 1	approx. 1
Process Pressure Operation	Sliding, pressure drop taken across nozzles, no separate throttling required	Sliding requires throttling in outlet piping resulting in narrow pressure range enabling constant flow venturi operation	Unknown	Sliding pressure operation is a function of different submersion levels of the venturis; system operates in narrow pressure range
3rd Party Qualification	Paul Scherer Institute Tests performed through 2008, typical test druation 4 hours Facility available for further test	ACE/JAVA ACE Testing completed in the 1980s, test duration ~1/2 hour JAVA Testing completed in the 1990s, test duration reported as "hours" Facilities dismantled, not available for testing	ACE, without molecular sieve Testing completed in the 1980s, test duration ~1/2 hour Facility dismantled, not available for testing	ACE, venturi only Testing completed in the 1980s, test duration ~ 1/2 hour Facility dismantled, not available for testing
Chemicals in scrubbing liquid	Sodium Hydroxide Sodiumthiosulphate Aliquat	Sodium Hydroxide Sodiumthiosulphate	N/A	Sodium Hydroxide Sodiumthiosulphate
Decay Heat Capacity	High (right sized vessel)	High (right sized vessel)	None	High (right sized vessel)
Operating Time without intervention	Selectable, vessel size and water inventory dictate	Selectable, vessel size and water inventory	Selectable, dependent on capacity of metal fiber filter, and moleculare sieve	Selectable, vessel size and water inventory
Venting duration	Fulfilling customer specifications and ability to makeup to vessel, expected to be > 1 year	Limited by design, Metal Fiber Filter capacity and need for recirculate to containment	Limited by Metal Fiber Filter capacity	Limited by design and Metal Fiber Filter capacity

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Conclusions	- Full filtration efficiency for low to high pressures. - Unique technology of filtration and retention of iodines - No activitity release during venting, multiple venting and post venting up to 1 year	- Very Dependent on performance of Metal Fiber Filter: capacity, clogging, hot spots - Re-volatilization of iodines requires emptying pool back to containment - Per Fauske, venturi system has narrow range of effectiveness therefore venting at low pressure not adressable with filter sized for high pressure	- Iodine retention system requires pre-heating - No decay heat capacity, other systems need to remove the decay heat	- Very Dependent on performance of Metal Fiber Filter: capacity, clogging, hot spots - Re-volatilization of iodines not adressed - Per Fauske, venturi system has narrow range of effectiveness therefore venting at low pressure not adressable with filter sized for high pressure

References

ACE	Advanced Containment Experiments (EPRI/DOE Sponsors)
AREVA Reference	AREVA publication ANP:U-352-V1-11-ENG
Westinghouse Dry Ref	Westinghouse "Flysheet" NS-IMS-0054
Westinghouse Wet Ref	MVSS Public Documents & Westinghouse "Flysheet" NS-ES-0207
CCI	Internal IP and Proprietary Data
JAVA	Containment Venting test facility constructed by Siemens at Karlstein
21st DOE/NRC Conf	Paper Containment Venting Sliding Pressure Venting Process for PWR and BWR Plants (KWU Group Siemens AG)
21st DOE/NRC Conf	Paper.Investigations into the Design of a Filter System for PWR Containment Venting (KfK, Germany)
Fauske & Associates	Modeling of the venturi Scrubber for the FILTRA-MVSS System
CSNI Report 148, 1988	Specialist meeting on filtered containment venting systems