VALIDATION TESTING OF RADIOACTIVE WASTE DRUM FILTER VENTS

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ABSTRACT

The minimum requirements for Drum Filter Vents (DFV's) can be met by demonstrating conformance with the Waste Isolation Pilot Plant (WIPP) Trupact II Safety Assessment Report (SAR), and conformance with U.S. Federal shipping regulations 49 CFR 178.350, DOT Spec 7A, for Type A packages.

These together address a number of safety related performance parameters such as hydrogen diffusivity, flow related pressure drop, filtration efficiency and, separately, mechanical stability and the ability to prevent liquid water in-leakage.

In order to make all metal DFV technology (including metallic filter medium) available to DOE sites, Pall launched a product development program to validate an all metal design to meet these requirements. Numerous problems experienced by DOE sites in the past came to light during this development program. They led us to explore enhancements to DFV design and performance testing addressing these difficulties and concerns.

The result is a patented all metal DFV certified to all applicable regulatory requirements, which for the first time solves operational and health safety problems reported by DOE site personnel but not addressed by previous DFV's. The new technology facilitates operations (such as manual, automated and semi-automated drum handling/re-drumming), sampling, on-site storage, and shipping. At the same time, it upgrades filtration efficiency in configurations documented to maintain filter efficiency following mechanical stress.

BACKGROUND

A great number of TRU radioactive waste packages have been generated throughout the DOE weapons complex. Condition of these packages varies widely. In addition, DOE sites continue to produce significant quantities of TRU waste, and will do so for the foreseeable future.

Hydrogen and other gasses are radiolysis products of several materials under alpha particle bombardment within the drums. This can result in flammable/explosive mixtures within the packages and/or their pressurization. The gasses must be vented while maintaining absolute containment integrity, in an environment also subject to fluctuating ambient temperature and weather conditions, and normal handling and transportation.

DOE's objective is to protect the public by consolidating these TRU waste packages in the WIPP underground repository. To meet this objective, DOE plans to ship packages in good condition, properly overpacked, with each container having at least one Drum Filter Vent (DFV), all conforming to regulatory requirements for transport and subsequent final storage. DFVs are required on all drums and boxes of TRU waste.

Several years ago, the Pall Corporation was asked by waste management personnel at the Idaho National Engineering Laboratory (INEL) to explore design possibilities of an all stainless steel DFV filter as an alternative to those in use, principally relying on a carbonaceous filter medium bonded to its mounting hardware. Availability of a qualified DFV with improved damage resistance was INELs principal objective. Pall's stainless steel filter medium at HEPA grade efficiency had been certified to a number of MIL-F-51079 performance criteria(1). It was an obvious candidate technology for use in these new designs.

DFV RATIONALE

To guide the DFV development process, Pall engineers extensively contacted DOE TRU waste management personnel. During the ensuing site visits and discussions, a number of additional concerns about existing DFV's surfaced:

1. Preliminary testing at INEL indicated that reliable head gas sampling for VOC's could not be achieved through the carbon filter medium. This was investigated by INEL because representative sampling through the filter would significantly simplify the WIPP Waste Acceptance Criteria (WAC) certification process. In order to satisfy this component of the WAC, methods were adopted in certifying waste packages which required destruction/replacement of the carbon based DFV.

2. Questions were raised concerning the effective lifetime of adhesives used in manufacturing the carbon based DFV filter medium. Compounding this concern was the varied temperature, radiation, chemical, and climatic environments to which these TRU waste packages would be exposed, in conjunction with their intended lengthy periods of service.

3. In-leakage of water through DFV's with carbon based filter medium was reported at several DOE sites. At one site, over 4,000 drums were re-processed and de-watered because of concerns arising from up to 14 gallons of water having entered each drum. Mechanism of entry: ambient temperature cycling and associated temperature/pressure variations within TRU waste drums having accumulated water on their covers (e.g. rain, or melted snow).

This in-leakage and its potential to re-occur was of concern to criticality safety personnel due to water's properties as a neutron moderator.

Liquid water in-leakage also raised questions of unseen corrosion. This is important as these packages have to be "certified" safe for transport to WIPP.

4. There was a desire, common to all of the DOE contractor personnel contacted, to maximize hydrogen diffusivity, minimize pressure drop across the DFV, and to assure HEPA level filter efficiency (≥99.97% for heat-generated monodisperse 0.3um DOP smoke).

Several sites, including Savannah River, were questioning whether to install more than one DFV per TRU package, in order to increase hydrogen dissipation rates and better prevent build-up to a flammable concentration.

HEPA level filter efficiency was referred to as the recognized standard for protecting public safety, and a level of performance desirable in DFV's. DFV's are not currently required by WIPP to perform to HEPA level efficiency. However, some DOE site specifications do require HEPA filter efficiency.

5. A very small fraction of existing drums at one DOE site were found with head gasses containing concentrations of HCl significant to stainless steel from a corrosion standpoint. Where encountered, this can be addressed by polymeric and/or higher alloy metallic DFV's. Our survey of DOE sites has not encountered any other drums where HCL would be expected to present a problem.

VALIDATION TESTING

Extensive DOE site survey also revealed current dimensional needs which Pall engineers effectively embodied in an assortment of hardware designs. A variety of these (below) have now been tested in accordance with the requirements, given in Table I, and shown under DOE witness and/or third party witness to meet or exceed them.

Table 1
DFV Validation Test Requirement and their Sources

	SOURCE	TEST
	Basic Regulatory Requirements	
1.	Trupact-II SAR	Hydrogen Diffusivity Pressure Drop vs. Air flow DOP Efficiency
2.	49 CFR 178.350 DOT Spec 7A, Type A	Water Spray Drum Drop Compression Rod Penetration
	Functional Requirements Identified Through DOE Site Visits	
3.	Liquid Water in-leakage Prevention	
	Pall Laboratories	In-leakage prevention limit
4.	Representative Head Gas Sampling	
	INEL	Hydrogen, methane, and VOC Transport Test (Formal Report recently completed.)

DFV'S SUBJECT TO VALIDATION TESTING

Pall all metal DFV's tested utilize the same filter medium, and comprise stainless steel filter medium and hardware. Models tested are depicted in Figure 1, attached.

DFV #1

The Standard Design (hexagonal body, 3/4 inch thread), intended for newly generated TRU waste packages. It is also employed on boxes and 85-gal drums used to repack or overpack damaged 55-gal TRU drums of retrieved waste. Also available in round body (#5R, Appendix A); choice made based on current equipment, handling fixtures and site procedures and practices.

Note: prior to commercial production this model DFV #1 was designated by its R&D code: "625exxx," where xxx is a three digit serial number. This code appears in this report where applicable.

DFV #2

This design arises from LANL's approach to remotely venting drums being retrieved from landfills on their site. The design mates with LANL equipment that remotely inserts a DFV into the retrieved drums.

DFV #3 & 4

These are INEL designs differing only in thread size, 7/16 inch and 1/2 inch self tapping. They arise from INEL's approach to remote venting of retrieved drums. These DFV's mate with the INEL equipment that inserts the DFV into a retrieved drum.

TEST METHODS AND RESULTS

All tests reported were conducted in compliance with indicated source (Table 1). What follows are functional descriptions of the tests, and test results.

Trupact-II SAR Requirements

Tests of hydrogen diffusivity and airflow resistance at between 1 and 10 psig were performed by an independent test facility, the Westinghouse Science and Technology Center, under contract by Pall Corporation (2). Methods were exactly as previously used in qualifying conventional carbon based DFV's.

Tests of DOP efficiency, and fixed flow rate pressure drop tests were performed under witness and certified by an independent third party, ETL Testing Laboratories, Inc., under contract by Pall Corporation. All DOP tests herein reported were performed using an ATI model Q127 DOP penetrometer, delivering heat-generated monodisperse 0.3um DOP smoke.

1. Hydrogen Diffusivity Test

Results are given in Table 2, below. The minimum acceptance criterion specified by WIPP is 1.90E-06 mole/sec/mole fraction.

Table 2
Diffusion Coefficients and Standard Errors for All Filters

Filter	D' mol/mole%/sec	D' mole/mole%/sec standard error	D' mole/sec/mole fraction	D' mole/sec/mole fraction standard error
625e016	5.13E-08	9.38E-10	5.13E-06	9.38E-08
625e046	5.33E-08	2.01E-09	5.33E-06	2.01E-07
625e010	4.96E-08	1.43E-09	4.96E-06	1.43E-07
Avg 625e's	5.14E-08	1.46E-09	5.14E-06	1.46E-07

2. Pressure Drop vs. Air Flow Test

Results are given in Table 3, below. The minimum specification established by WIPP is one LPM at one psi gauge pressure drop across the DFV (or 200 cc/min at one "H_2O gauge pressure drop; see also Table 5, below).

Table 3
Flows versus Pressure Drop at 1.0 psig

FLOW, SLPM AIR, at ΔP = 1.0 psid		
625e016	625e010	625e046
10	11	10

Plots of pressure drop across the filters vs. flow for all filters were prepared from a series of measurements up to 10 psig. These were linear with correlation coefficients greater than 0.99 for each filter. The relationship between flow and pressure drop may also be expressed as the flow coefficient, C_f= flow/pressure drop, where flow is in standard liters per minute air and pressure drop is in psig. Since the graphs were linear, the flow coefficients are the slopes, shown in Table 4:

Table 4
Flow Coefficients for All Filters.

Filter	C_f, slpm air/psig
625e016	14.5
625e010	14.9
625e046	13.5

3. Pressure drop; DOP Efficiency.

The minimum flow capacity established by WIPP at one "H_2O gauge pressure drop across the filter is 200 cc/min. WIPP also specifies that each filter shall exhibit filtering efficiency >99.9% with 0.3 - 0.5 um particles of DOP smoke.

Filter pressure drop and aerosol Penetration were measured at 200cc/min flow of hot-generated 0.3um monodisperse DOP, and certified under third party witness: ETL Testing Laboratories, Inc. The results are given in Table 5, below.

TABLE 5
DOP Penetration and Filter Pressure Drop at Fixed flow Rate

	Filter	Flow Rate		Air ΔP, in. H_2O	% Penetration
Model	Part Number	SCCM	ACCM		
DFV #1	Log 916E #049	200	208	0.55	0.005-0.008
DFV #1	Log 916E #047	200	208	0.55	0.004-0.007
DFV #1	Log 916E #032	200	208	0.60	0.004-0.005
DFV #2	Log 180F #39	200	208	0.80	0.002-0.003
DFV #2	Log 180F #39	200	208	0.80	0.002-0.003
DFV #2	Log 180F #51	200	208	0.75	0.002-0.003
DFV #3	Log 216F #1	200	208	0.75	0.001-0.003
DFV #3	Log 216F #4	200	208	0.75	0.001-0.003
DFV #3	Log 216F #12	200	208	0.75	0.002-0.005
DFV #4	Log 215F #2	200	208	0.75	0.002-0.004
DFV #4	Log 215F #6	200	208	0.80	0.001-0.002
DFV #4	Log 215F #5	200	208	0.65	0.002-0.003

DOT Spec 7A., Type A Requirements

DOP penetration testing is not specified as a DOT Spec 7A performance requirement, however, this was performed as added demonstration of DFV robustness before and after the mechanical tests specified for Type A packages, items 2, 3, and 4, below.

1. Water Spray Test, performed under witness by: INEL personnel, and Edling & Associates, Inc.

The purpose of this test is to demonstrate that "rain" will not adversely affect the containment integrity and that there will not be any in-leakage of liquid water under rainy out-door storage conditions. It probes in-leakage resistance of the filter medium, DFV construction, and seals. Note: Passing this test has no bearing on the ability of the DFV to allow the passage of water in its gaseous or vapor state.

Four DFV's, one each of the four types tested, were installed into a drum lid, 90° from one another. Blotter paper was placed under the DFV inlet (drum contents side of lid) so that should liquid water enter the drum it would be captured by the paper, providing an easily detected, visual indication of even small quantities of liquid in-leakage. The blotting paper was affixed to the inside surface of the lid securely with standard duct tape, and drum assembly then completed. All DFV's and the lid were affixed using applicable torque as specified in the "DOT Spec 7A Evaluation Documents."

Following drum assembly per above, shower heads were used to deliver "rain" uniformly over the drum lid for a period of an hour. Upon completion of the water spray, in further accordance with test requirements, the package was allowed to stand two hours without draining or other disturbance prior to examination for in-leakage or other detrimental effect. At this point, water was standing on the drum lid to its height of overflow. A rain gauge placed on the lid during the shower showed overflow beyond its 5.5" capacity, demonstrating that "rain" had been well beyond the 2" per hour minimum required.

The water was drained off the lid, the lid removed, and the blotting paper thoroughly inspected for evidence of water. To pass this test, there must be no water detectable. Duplicate trials were run, each utilizing different drums and DFV's. Results are given in Table 6, below.

Table 6
Water Spray Test Results

DFV MODEL	PASS/FAIL TEST 1	PASS/FAIL TEST 2
DFV #1	PASS	PASS
DFV #2	PASS	PASS
DFV #3	PASS	PASS
DFV #4	PASS	PASS

2. Drum Drop Test, performed under witness by: INEL personnel, and Edling & Associates, Inc.

This tests the ability of DFV's and drums to maintain integrity/containment as an assembled unit in the aftermath of a defined free fall.

A new drum was loaded to 950 lb using a gravel (bottom) and sand (top) mixture, as verified by weighing. A layer of 1 - 2" of fluorescein:flour mixture at 1:20 by weight was leveled on top of the sand. The drum was now full. Prior to installation, DFV's were tested for DOP penetration. They were required by Pall to provide efficiency at ≥ 99.97% for heat-generated monodisperse 0.3 μm DOP smoke at flow rate ≥200 sccm, producing $\Delta P \leq$ 1"H_2O. The reason for selecting flow rates in some cases higher than 200 sccm is that the INEL site imposed a condition that DOP efficiency tests of DFV's for their site be run at the flow rate generating 1"H_2O. As this flow rate was higher than 200 sccm, it presented another parameter by which testing was more stringent than required by the Trupact II SAR.

After testing for DOP penetration, four DFV's, one each of the four types tested, were installed into a drum lid, 90° from one another. This lid was then sealed to the weighted drum, such that the closure ring bolt was adjacent to one of the DFV's. The drop test was repeated four times with new drums and DFV's. In each trial, a different DFV model was adjacent to the closure ring bolt.

Once filled and assembled together with the four DFV's, the drum was hoisted upward and suspended from a wire harness such that the central drum axis was at 60° to the floor. In this orientation, the closure ring bolt was at the lowest point, 40" in height from a thick steel plate bolted to the concrete shop floor. A bolt cutter with pneumatic drive was used to cut the central suspension rod of the wire harness to initiate free fall.

To pass this test, there must be "no loss of contents," as determined by a complete absence of fluorescein. A UV lamp was shown with a known sample of the flour: fluorescein mixture to cause fluorescence of the fluorescein. This lamp was used to inspect the weighted drum-DFV assembly before and after each drop. Inspection was conducted on the drum, drum lid and drop platform both directly and by the inspection of wet swipes.

Following this inspection, the DFV's were retested for DOP penetration at 200cc/min, or at ΔP = 1" H_2O where this pressure drop was produced at >200cc/min. Abrupt drum deformation on impact appeared to have caused inlet (drum) side challenge of several DFV's by a visually significant quantity of fluorescein:flour. For this reason the DFV's were reverse-flushed with filtered isopropanol and dried prior to post-drop DOP tests. Even with flushing, some loss of flow capacity generally remained. In one case, a DFV remained completely blocked to flow, despite attempted flushing. The average decrease in flow capacity not counting this DFV was of the order of 15%. The results are given in Table 7, below.

Table 7
Drum Drop Test Results

Each drum lid containing four DFV's at 90° separation.

DFV Model	Drop Pass/Fail	DOP Efficiency, Pass/Fail at 99.97% Before Drop	After Drop
DFV #1	PASS	PASS	PASS
DFV #2	PASS	PASS	PASS
DFV #3	PASS	PASS	PASS
DFV #4	PASS	PASS	PASS
DFV #1	PASS	PASS	PASS
DFV #2*	PASS	PASS	PASS
DFV #3	PASS	PASS	PASS
DFV #4	PASS	PASS	PASS
DFV #1	PASS	PASS	PASS
DFV #2	PASS	PASS	PASS
DFV #3*	PASS	PASS	PASS
DFV #4	PASS	PASS	PASS
DFV #1	PASS	PASS	PASS
DFV #2	PASS	PASS	Blocked to flow
DFV #3	PASS	PASS	PASS
DFV #4*	PASS	PASS	PASS

*At closure ring bolt (impact) position.

3. Compression Test, performed under witness by: INEL personnel, and Edling & Associates, Inc.

After testing for DOP penetration, four DFV's, one each of the four types tested, were installed into a drum lid, 90° from one another. The lid was installed on a new drum, maintained empty. A steel plate weighing 5,000lb was placed upon the drum lid for 24 hours. The DFV's were visually inspected and tested again for DOP penetration. The results are shown in Table 8, below. To pass this test, there must be no visually detectable physical distortion of the DFV's.

Before and after Compression test, the DFV's were tested for DOP efficiency at flow rate ≥ 200 sccm, producing $\Delta P \leq$ 1"H_2O.

Table 8
Compression Test Results

DFV Model	Compression Pass/Fail	DOP Efficiency, Pass/Fail at 99.97% Before Compression Test	After Compression Test
DFV #1	PASS	PASS	PASS
DFV #2	PASS	PASS	PASS
DFV #3	PASS	PASS	PASS
DFV #4	PASS	PASS	PASS

4. Penetration Test (Dropped Rod), performed under witness by: INEL personnel, and Edling & Associates, Inc.

DFV's were installed on a drum prepared as for the Drum Drop Test, above, and evaluated in the following manner for physical penetration (damage) under the mechanically localized impact of a free falling steel rod.

A steel bar weighing 13.2 pounds was dropped from a height of 40 inches so that it impacted in the center of the "rain hat" of the DFV. This impact point was chosen because it represents the weakest point, as required in the DOT regulations.

In each case only an insignificant dent resulted from impact. Dents ranged from visually undetectable to a maximum depth of approximately 0.060".

To pass the test, there must be no "loss of contents" through the DFV. This was assessed as in the Drum Drop Test, above.

As a test beyond DOT Spec 7a., Type A requirements, DOP efficiency was measured before and after this Penetration Test at a flow rate ≥ 200 sccm, producing $\Delta P \leq$ 1"H_2O. The results are shown in Table 9, below.

Table 9
Penetration Test Results

DFV Type	Penetration Test (Dropped Rod) Pass/Fail	DOP Efficiency, Pass/Fail at 99.97% Before Rod Drop	After Rod Drop
DFV #1	PASS	PASS	PASS
DFV #2	PASS	PASS	PASS
DFV #3	PASS	PASS	PASS
DFV #4	PASS	PASS	PASS

Liquid Water in-leakage Prevention.

Pall Laboratories: In-leakage prevention limit.

The "rain hats" were removed from the DFV's to be tested, revealing an unobstructed view of the outside surface of the filter medium. The DFV being tested was installed filter throughput direction vertical at the bottom opening of a J-tube, the long leg of which extended upward for ready measurement of hydrostatic head. The J-tube was filled gradually with water to a hydrostatic head of 75"H_2O. After a 3 minute waiting period, if no liquid flow occurs, hydrostatic head is slowly increased to the first visual penetration. This is a sensitive test because once the liquid water in-leakage pressure is exceeded, flow is maintained and liquid droplet(s) accumulate on the filter medium.

The results are shown in Table 10, below.

Table 10
Liquid Water In-Leakage Prevention Test

DFV Model	No Leakage at 75" H_2O Pass/Fail	No Leakage at 85" H_2O Pass/Fail	Min. Pressure of Initial Flow, "H_2O
DFV #1	PASS	PASS	89*
DFV #2	PASS	PASS	N/A
DFV #3	PASS	PASS	89*
DFV #4	PASS	PASS	N/A

*Witnessed by INEL personnel.

INEL Selective VOC and other Gas transport.

INEL recently tested Pall all metal DFV's on the basis of hydrogen, methane, and VOC transport. A formal report is to be issued, soon. Personal communications indicate the report to confirm the all-metal filters as transparent to the cited compounds, consistent with non-adsorptive properties expected of stainless steel. Testing was performed consistent with requirements of the WIPP Quality Assurance Project Plan (QAPP).

DISCUSSION AND RECOMMENDATIONS

Test results show Pall all-metal DFV's to exceed Trupact II SAR requirements for hydrogen diffusivity, air flow ΔP, and DOP penetration. At the specified flow rate of 200cc/min, per Trupact II DOP test conditions, the all metal filters are at $\Delta P < 1$" H_2O, and efficiency >99.97% for hot-generated monodisperse 0.3um DOP smoke. These results were documented and submitted to WIPP in October, 1995.

Test results also verify conformance of Pall all metal DFV's to DOT Spec 7A, Type A.

DOP penetration measurements were added before and after the DOT test sequences. Mechanical shocks or other stress to DFV-drum assemblies will affect the rate of radiolysis and other chemical processes within sealed drums by promoting remixture of their contents. The affect will be largely unpredictable, but hydrogen evolution and/or other pressure producing reactions could be accelerated. For this reason, we recommend pre- and post-DOT test DOP/pressure drop measurements in validating DFV designs. The test data support a conclusion that the mechanical stresses specified by DOT Spec 7A produced no breach in filter integrity of the all-metal DFV's.

Liquid water in-leakage prevention results indicate minimum ΔP required to produce water flow is reliably at >85" H_2O. Ideal gas law calculations show a ΔP of 85" H_2O as corresponding to a temperature swing of 123F^O in the waste drum environment (drum temperature at 130^{O}F dropping to +7^{O}F, lid flooded), well beyond that expected by DOE facilities. It is recommended that new DFV designs be certified to such a standard of liquid water in-leakage, as environmentally non-inducible.

INEL has completed testing of VOC transport through Pall all metal DFV's. We understand from personal communications that it validates the all metal DFV's as providing VOC transport representative of head gas concentrations. This will mean that head gas sampling can for the first time be performed through the filter non-destructively, including such sampling to meet WIPP QAPP requirements..

Another result of Pall's ongoing contact with DOE site personnel is further design refinement. We opted to revise the designs and increase the variety of models available that adapt to a tool facilitating easy, non-destructive head gas sampling through the DFV. While performing this design evolution, we also found ways to improve producibility of our all metal DFV's. The updated designs are described in Appendix A, and depicted in Figure 2, both attached. No change in filter medium has been made since the testing herein described and, in some cases, design is so similar that the new models (Appendix A) may prove certified by existing test results. Pall is pleased to perform validation testing of design variants, where required.

CONCLUSIONS

In comprehensive discussion with personnel at DOE sites, we confirmed the regulatory requirements for DFV validation, and further identified practical problems hampering daily site operation and generating additional costs. In the course of testing new DFV designs for certification, we responded both to current regulatory requirements and to the practical needs presented to us for more economic site operation while maintaining public/worker safety.

As a result of this test program, we are pleased to point out that for the first time a rugged, all metal DFV is available to DOE sites which will:

1. Meet all applicable WIPP Trupact II SAR, and U.S. government DOT requirements.
2. Provide HEPA efficiency and pressure drop at the rated flow
3. Reduce criticality risk by providing a new level of liquid water in-leakage prevention.
4. Enable direct head gas sampling non-destructively through the DFV (INEL testing, to be reported). This is expected to reduce both operating and DFV replacement costs.

ACKNOWLEDGMENT

The authors gratefully acknowledge the DOE and M&O Contractor engineers who contributed their comments and time to this effort, and thank the members of Pall's DFV Team and Support personnel for their many contributions.

REFERENCES

1. Report No. 529719, "Tests of Single Stage Metal Fiber HEPA Filter Media and Filter Elements, ETL Testing Laboratories, Inc., Rendered to Pall Corporation, June 18, 1993.

2. Report No. 95-2TD2-PFILT-R1, "Evaluation of Filters for Flow and Hydrogen Diffusion Characteristics," Westinghouse STC, April 24, 1995.

Appendix A
Updated Designs of All Metal DFV's, Comprising Stainless Steel Filter Medium and Hardware

DFV #1H

The Standard Design (hexagonal body), intended for newly generated TRU waste packages. It is also employed on boxes and 85-gal drums used to repack or overpack damaged 55-gal TRU drums of retrieved waste. Also available in round body (#5R, below); choice made based on current equipment, handling fixtures and site procedures and practices.

DFV #2L

This design arises from LANLs approach to remotely venting drums being retrieved from landfills on their site. The design mates with LANL equipment that remotely inserts a DFV into the retrieved drums.

DFV #3R & 4R

These are INEL designs differing only in thread size. They arise from INEL's approach to remotely venting retrieved drums. These DFV's mate with the INEL equipment that inserts the DFV into a retrieved drum.

DFV #5R

This round body design is intended as standard design for newly generated TRU waste packages. It is also used on boxes and 85-gal drums used to repack or overpack damaged 55-gal TRU drums of retrieved waste. Also available in hexagonal body as #1H, referenced above.

The round body designs (suffix "R") mate with a sampling fixture allowing head gas samples to be taken non-destructively through the stainless steel DFV, as often as needed.

Pall's Stainless Steel Drum Filter Vents Subject to Validation Testing

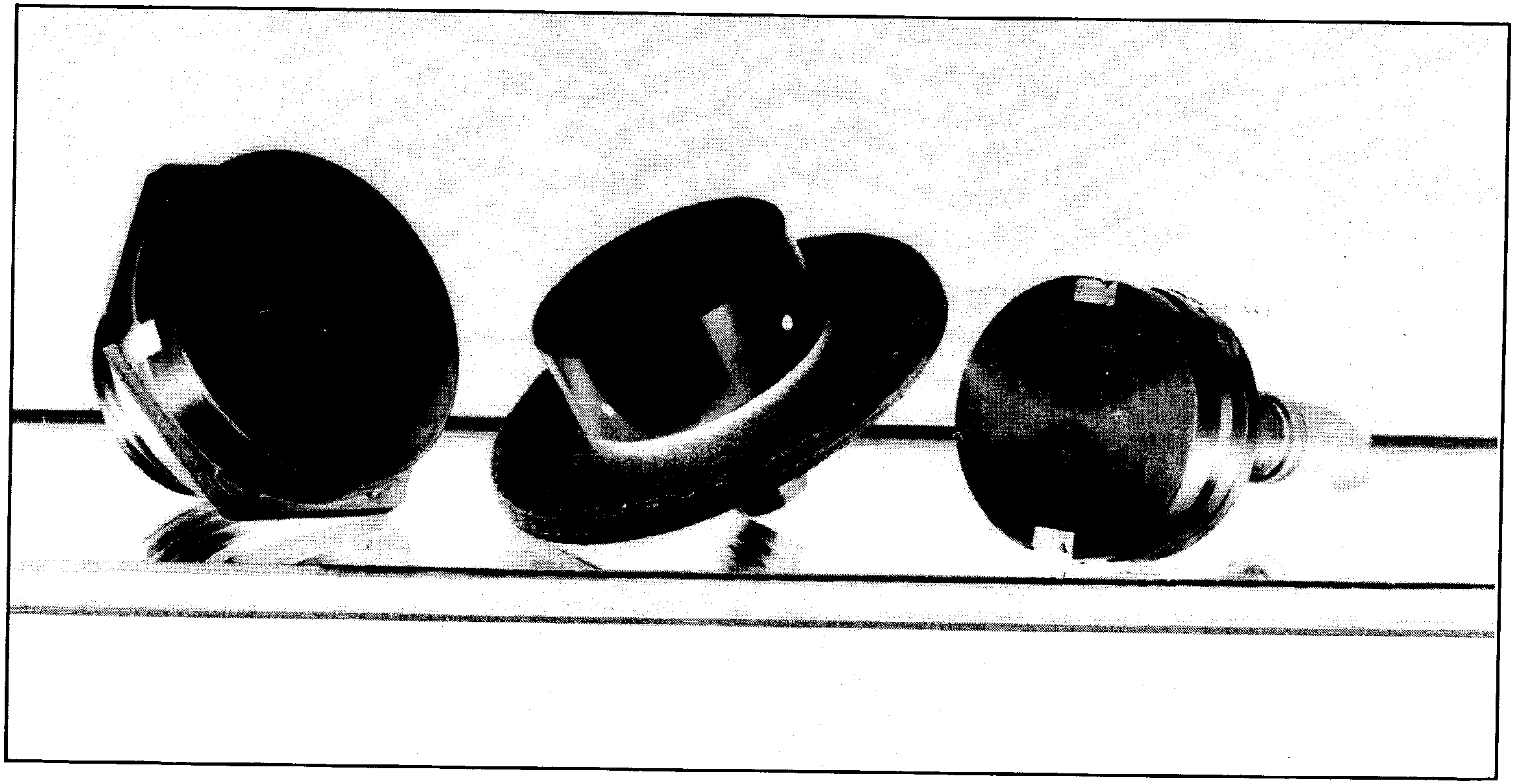
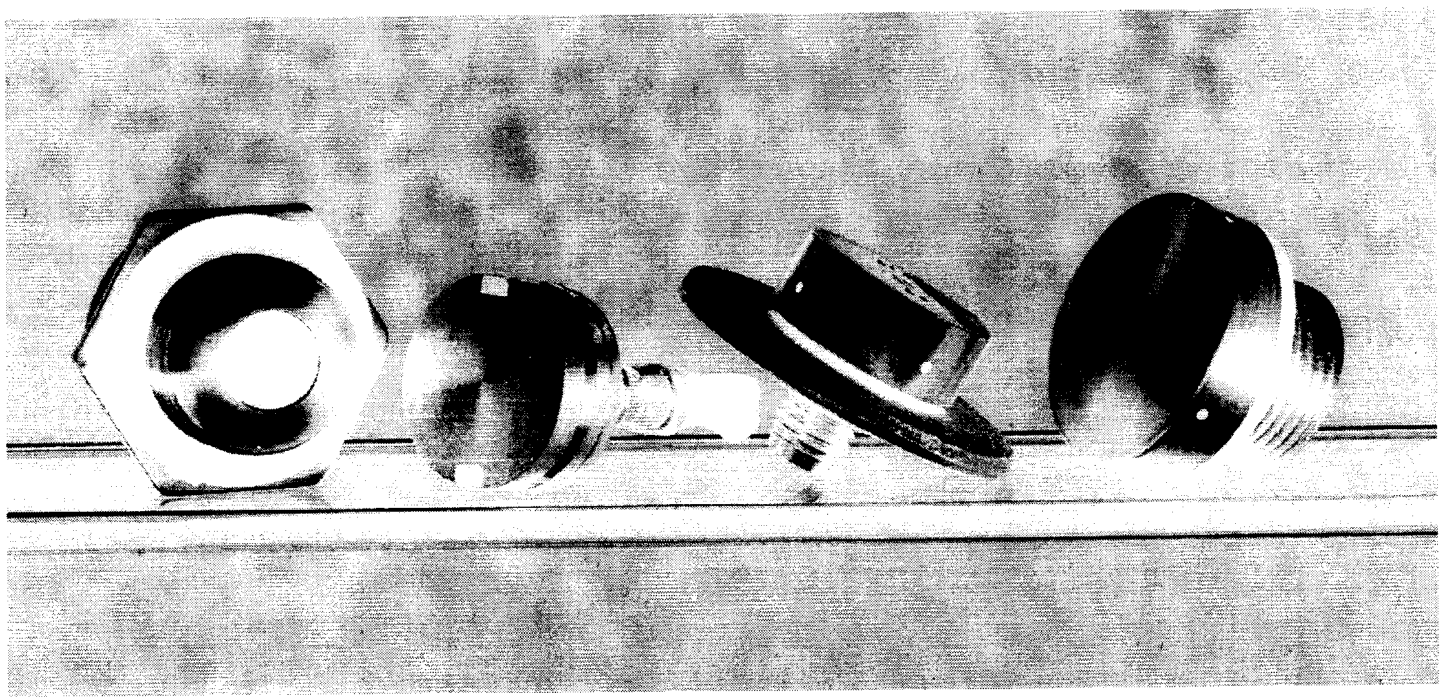


Figure 1

Pall Corporation's Family of All Stainless Steel HEPA Efficiency Drum Filter Vents for DOE Rad Waste Containers



The Pall part numbers are (L to R): DFV #1H, DFV #2L, DFV #3R & 4R, DFV #5R

Figure 2

DISCUSSION

DERDERIAN: Would you discuss the simulant that you use to pressurize the drum contents?

WEBER: The simulant is specified by the DOT and the applicable CFR. It is one part fluorescein to twenty parts cooking flour by weight. The flour serves to dilute the fluorescein because there is plenty there for ultraviolet light to pick up.

DERDERIAN: But it does not pressurize the inside of the drum, is that correct or not?

WEBER: By itself, no, but when you drop the drum from a height the impact momentarily gives you quite a burst of pressure.

SCRIPSICK: Did you look at airborne fluorescein in the test? The test procedure calls for you to look on the floor. It is quite possible the dust hasn't settled yet. If you go back a week later you might find some.

WEBER: That is an interesting thought. The DOT standard used to certify the filter does not address that possibility. The DFV itself is mounted so close to the lid of the drum that you would see evidence of it from inertial impaction if it were to be true. We did not.

SCRIPSICK: On the upstream side? I assume the upstream side of the filter was coated with fluorescein.

WEBER: Yes, very much so. We saw it there and we also saw some increased resistance to flow after the test. You could also look inside to the part of the DFV that faces the contents of the drum and you could see the stuff in there. There were no measurable amounts outside.

SCRIPSICK: One of the things we found was that it is very difficult to seal up pipe threads. I wonder if the tests that you did considered that seal because it would be part of the in-place test.

WEBER: The tests were done in conformance with the existing specifications so what was tested was the assembled unit of the DFV, the drum lid, and the drum. The fact that there was no loss of contents by that test indicates that the pipe joint was not a weak point. That could be an area for additional investigation. The main seal to the drum lid is by a gasket. A lot has to do with the strength that you need to make a seal and not rip the drum lid.

MONROE: Have you done any studies on the plugging rate during normal service of these filter vents?

WEBER: We do not yet have any normal service experience with the filter vents because we have just gotten them certified. That will be a very important parameter to follow. Service does not call for extended periods of flow so I am predicting a very low plugging rate. The primary function of the filter is to dissipate by diffusion and pressure the hydrogen that is generated thermally from radiolysis inside the drum.

CONKLIN: In Washington State, drum vents that are used at Hanford must meet HEPA efficiency requirements according to Washington State regulations.

WEBER: What regulation in particular?

CONKLIN: The Washington State Clean Air Act that requires best available radionuclide control technology.