

Infrastructure for Testing and Qualifying Robust Radial Flow HEPA Filters

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Background

- **Waste Treatment and Immobilization Plant Need Robust Radial Flow HEPA Filter**
- **Current AG-1 Filter Designs Do Not Meet WTP Performance Requirements**
- **Filter Qualification Based on WTP Performance Requirements for Filtration Systems**

Performance Requirements

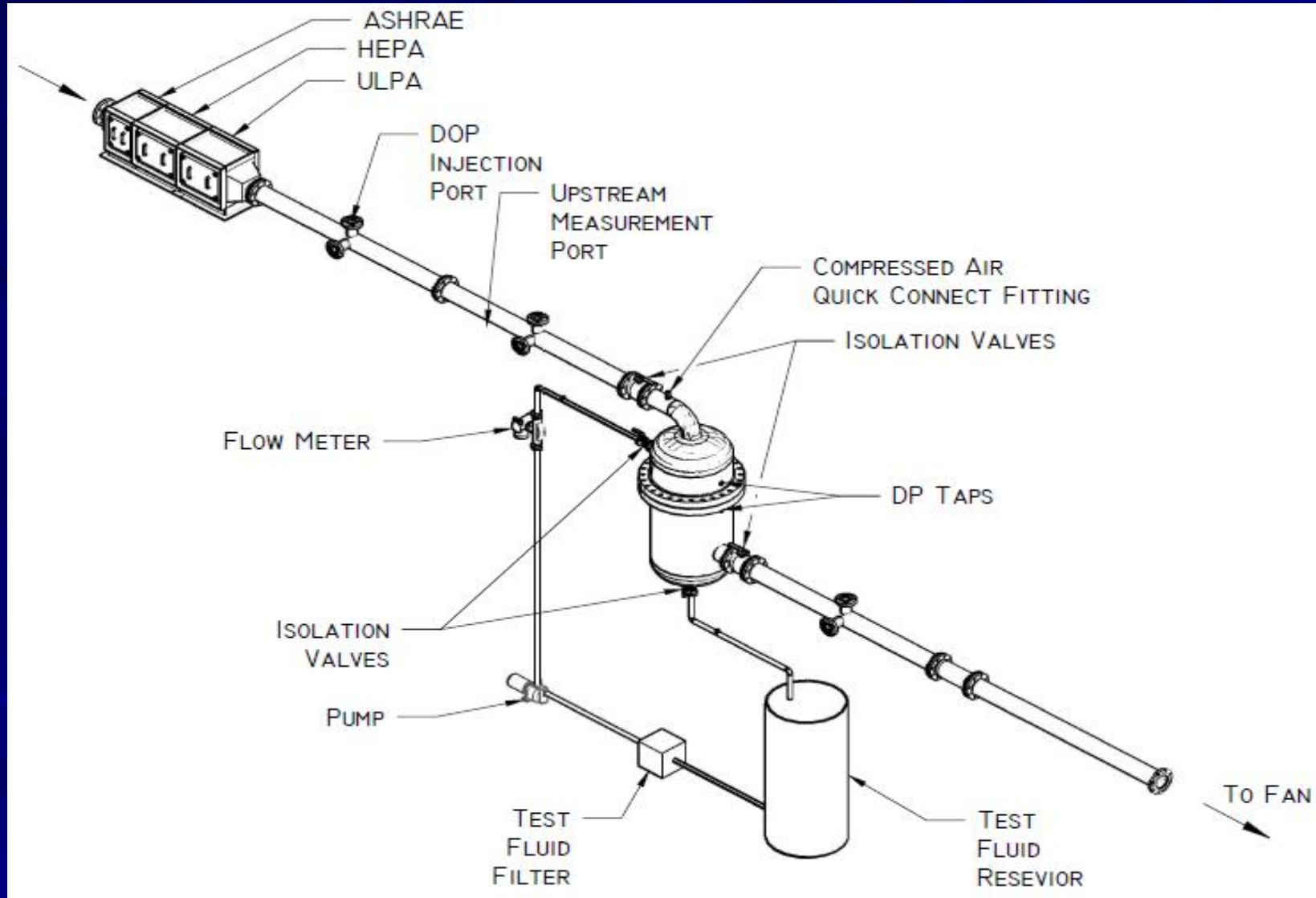
■ Performance Requirements

- 225 in w.c.
- Loaded to 4 in w.c., the Filter Needs to Withstand 170° F and 90% RH for One Hour
- Under Operational Conditions, Be Able To Load to 225 in w.c.

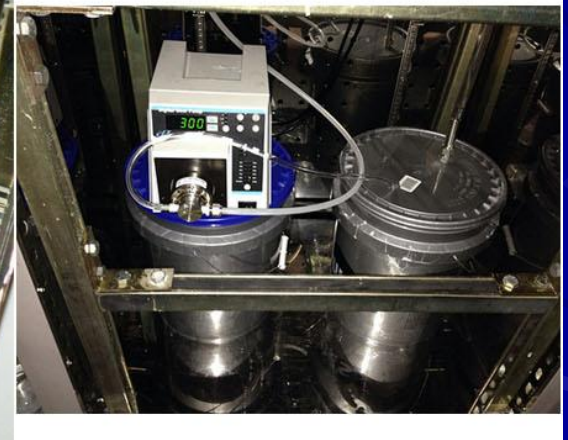
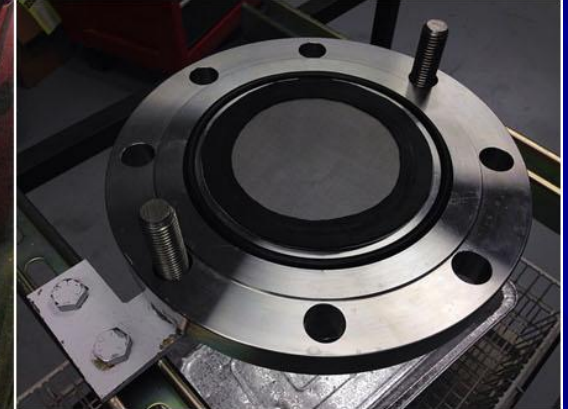
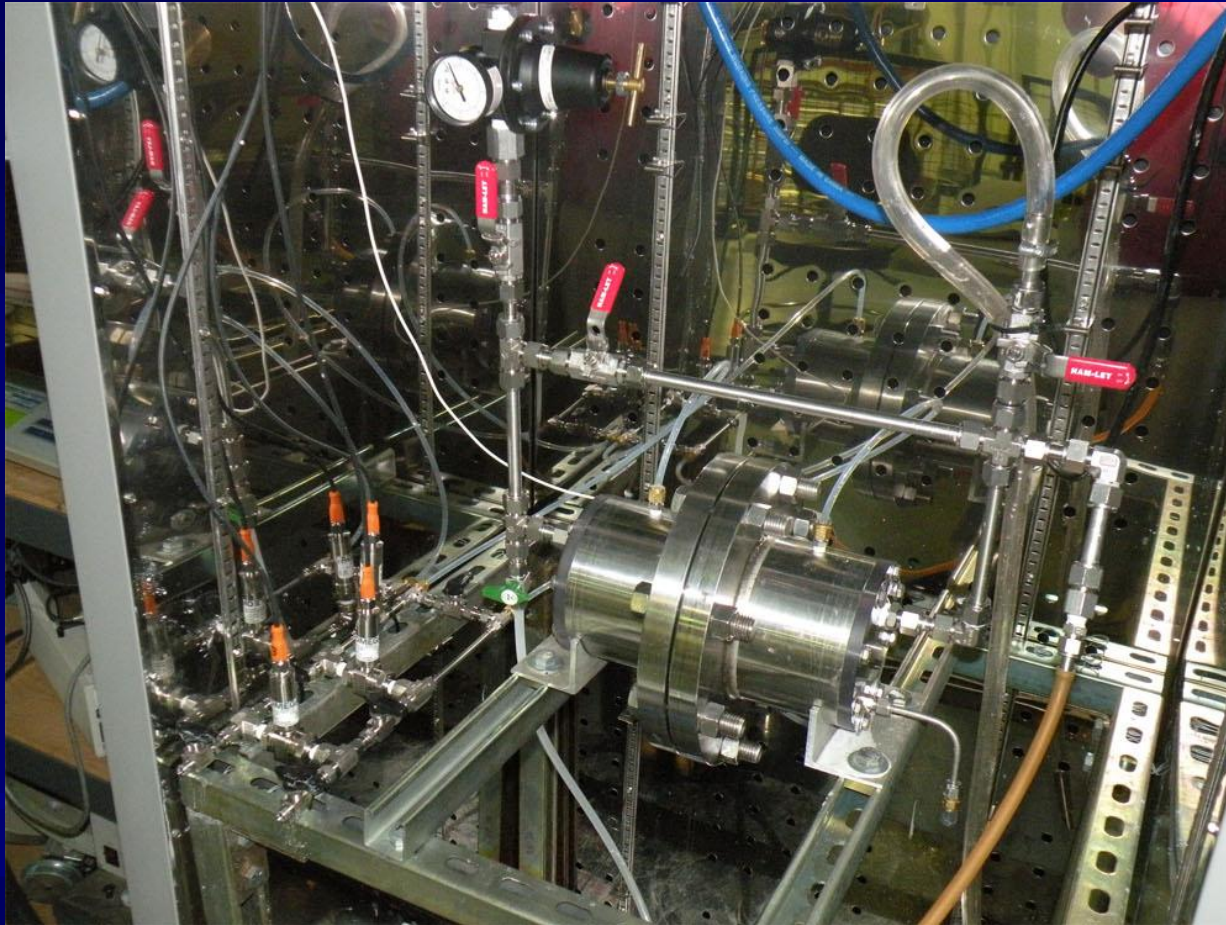
Test Criteria

Test	Criteria
Initial resistance to air	100 to 2000 cfm
Initial filter efficiency	Filter efficiency measurement using DOP at rated flow (2000 cfm)
Resistance to liquid pressure performance	Maintain 25 in w.c. to 225 in w.c. for one Hour
Rinse water capabilities	Heated water (95° F or 35° C) at 30 gpm (1.9 L/s) for 60 minutes, total 2000 gallons (7570 L)
Drying Performance	Maintain heated air supply at 100° F (38° C) over 100 to 400 cfm
Post resistance to liquid pressure filter efficiency	Filter efficiency measurement using DOP at 5 and 20 % rated flow (100 cfm and 400 cfm)
Rough Handling	¾ inch (1.9 cm) amplitude, 200 cycles per minute, for a total of 15 minutes
Post rough handling filter efficiency	Filter efficiency measurement using DOP at 5 and 20 % rated flow (100 cfm and 400 cfm)

Conceptual Drawing

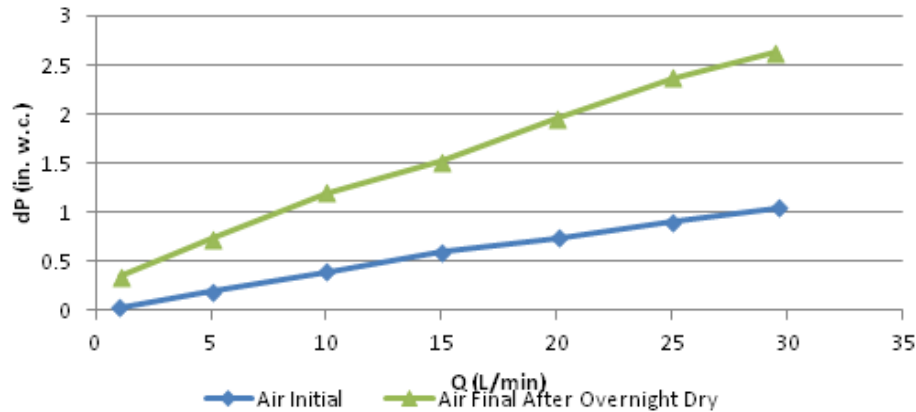


Bench Scale Testing

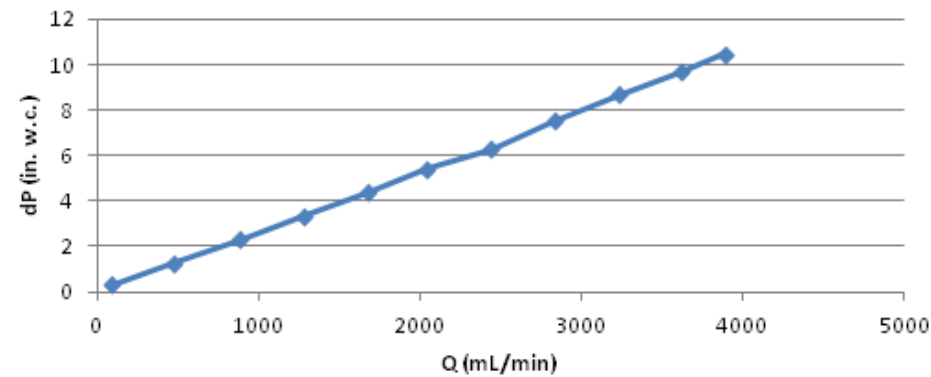


Bench Scale Testing

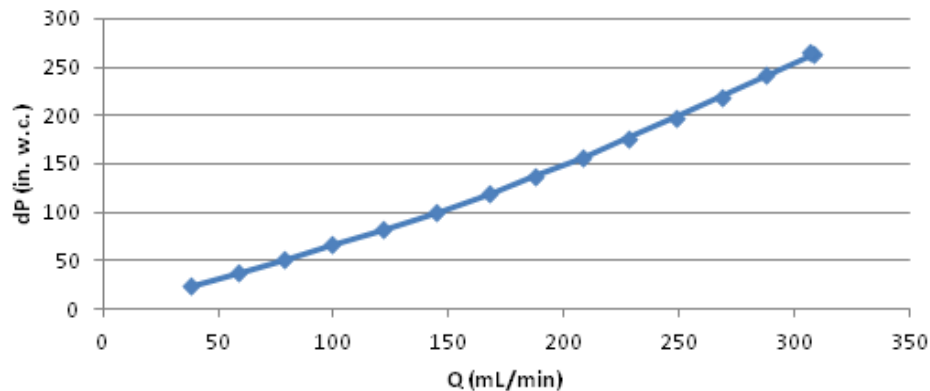
Air



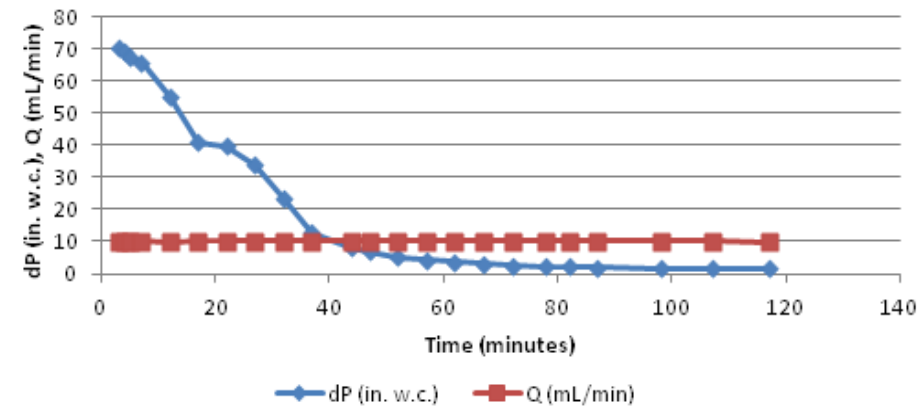
Water dP vs Q



PEG dP vs Q

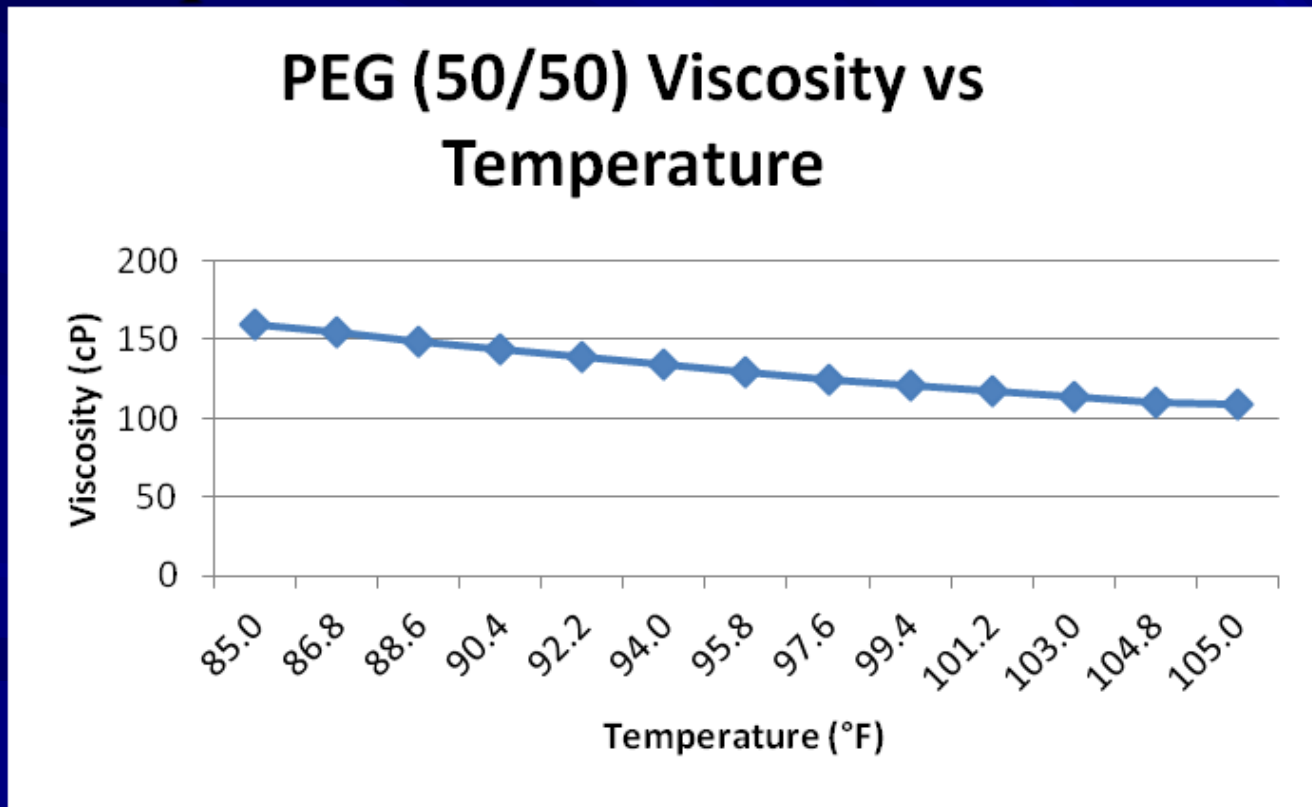


Air Final Flow and dP vs Time

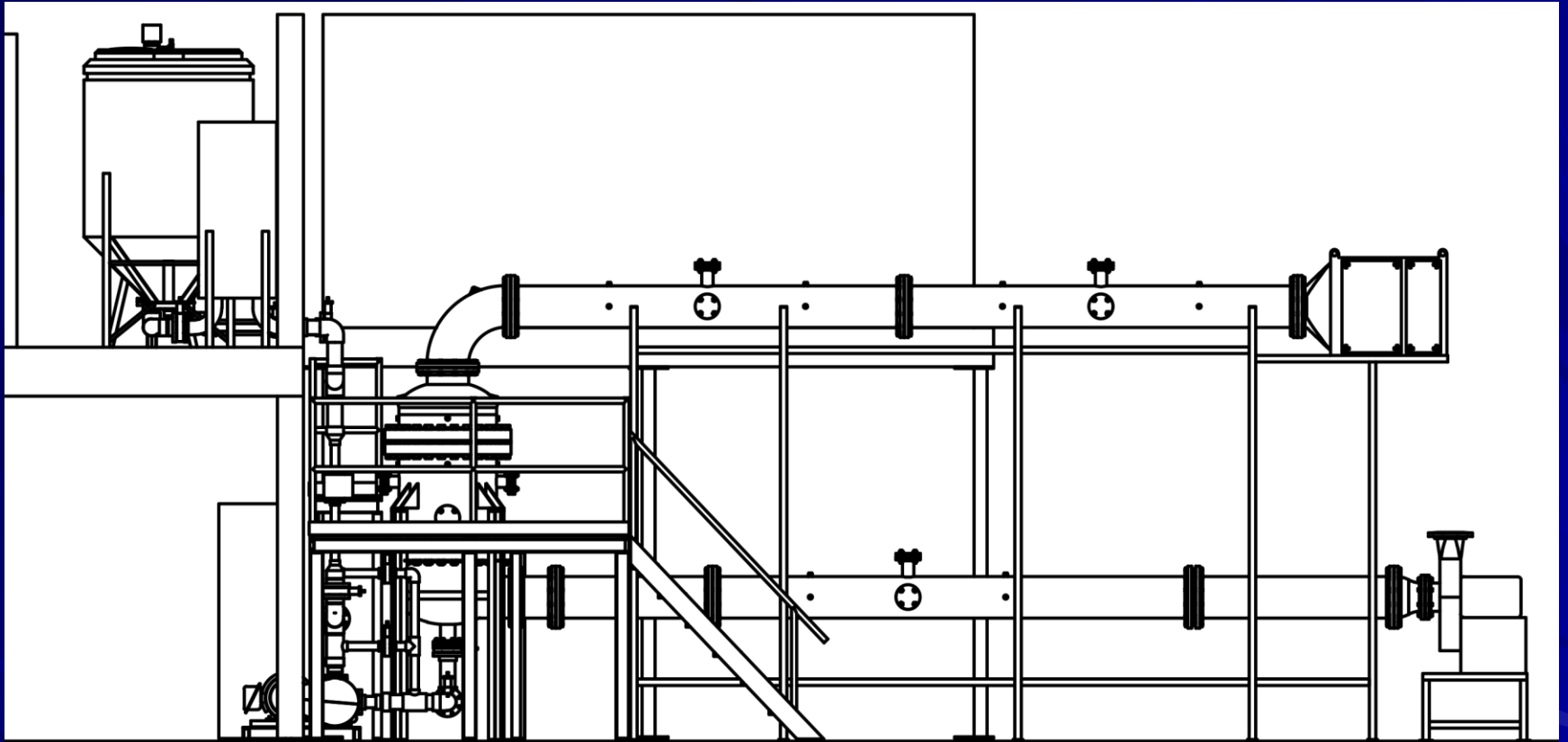


Test Fluid

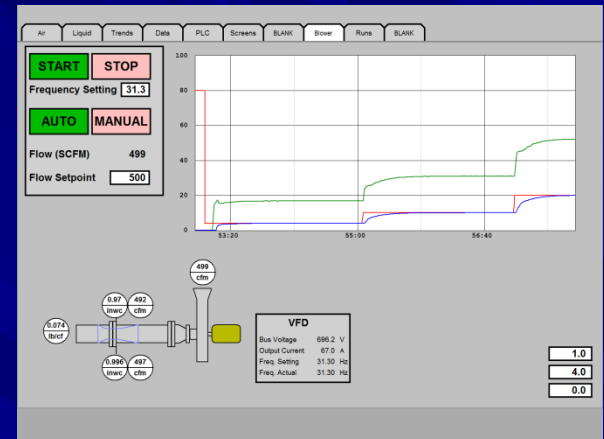
- Dow Chemical Carbowax™ Polyethylene Glycol (PEG) 8000
- 50:50 Aqueous solution



Final Drawing



RLPTS – Air



RLPTS - Liquid



Filter Tubesheets



Rinse Water System



Aerosol Instrumentation

Instrument	#/cc (min)	#/cc (max)	Particle Size Distribution (μm)
Scanning Mobility Particle Sizer (SMPS) <ul style="list-style-type: none"> • TSI Model 3080 Electrostatic Classifier • 37.4 inch (95 cm) Custom Differential Mobility Analyzer (DMA) • TSI Model 3775 Condensation Particle Counter (CPC) 	2	1×10^8	0.008 - 1
TSI Model 3321 APS (with TSI Model 3302A Diluter)	1	1×10^3 (1×10^5)	0.3 – 20
TSI Model 3340 LAS	<0.02	1.8×10^3	0.09 – 7.5

Testing Sequence

- Seal Leak Test
- Resistance to Airflow
- Initial Filter Efficiency
- Resistance to Liquid Pressure with PEG
- Rinsing Filter
- Drying Filter
- Pre-Rough Handling Filter Efficiency
- Rough Handling
- Final Filter Efficiency

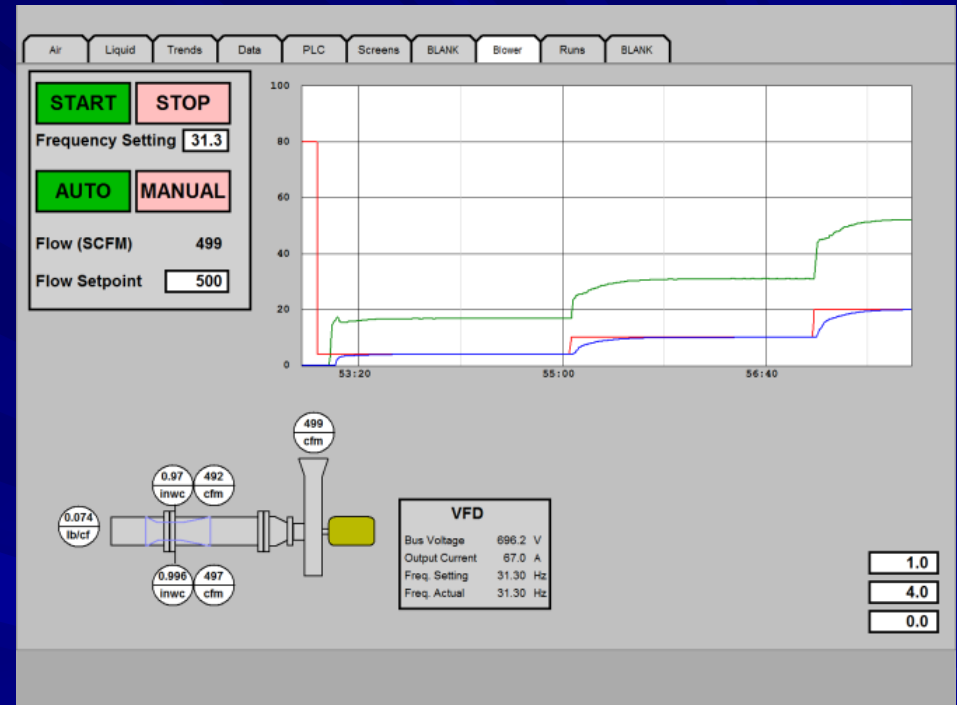
Seal Leak Test

- Use Bladder to Blind Filter Pack
- Seal Top Section of Housing
- Pressurize Housing to 240 in w.c.
- Observe Pressure Drop Over 1 Hour



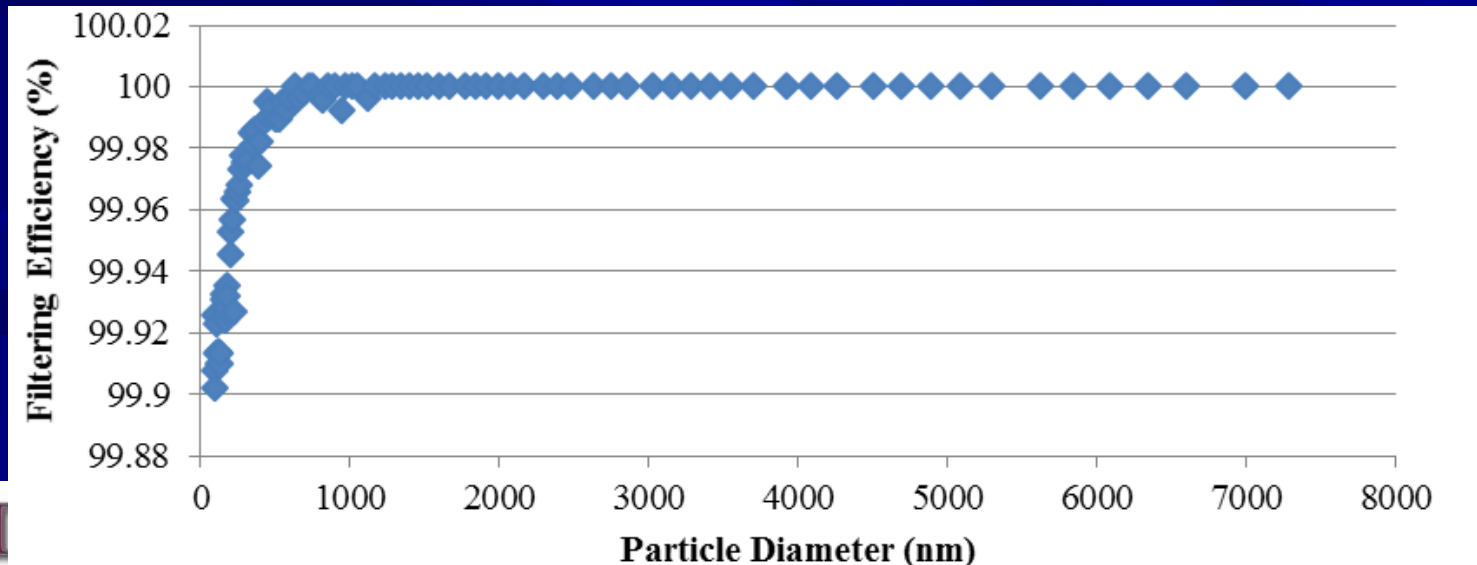
Resistance to Air Flow

- Air Flow is Ramped From 0 cfm to 2,000 cfm
- 250 cfm Increments
- One Minute Intervals at Each Interval

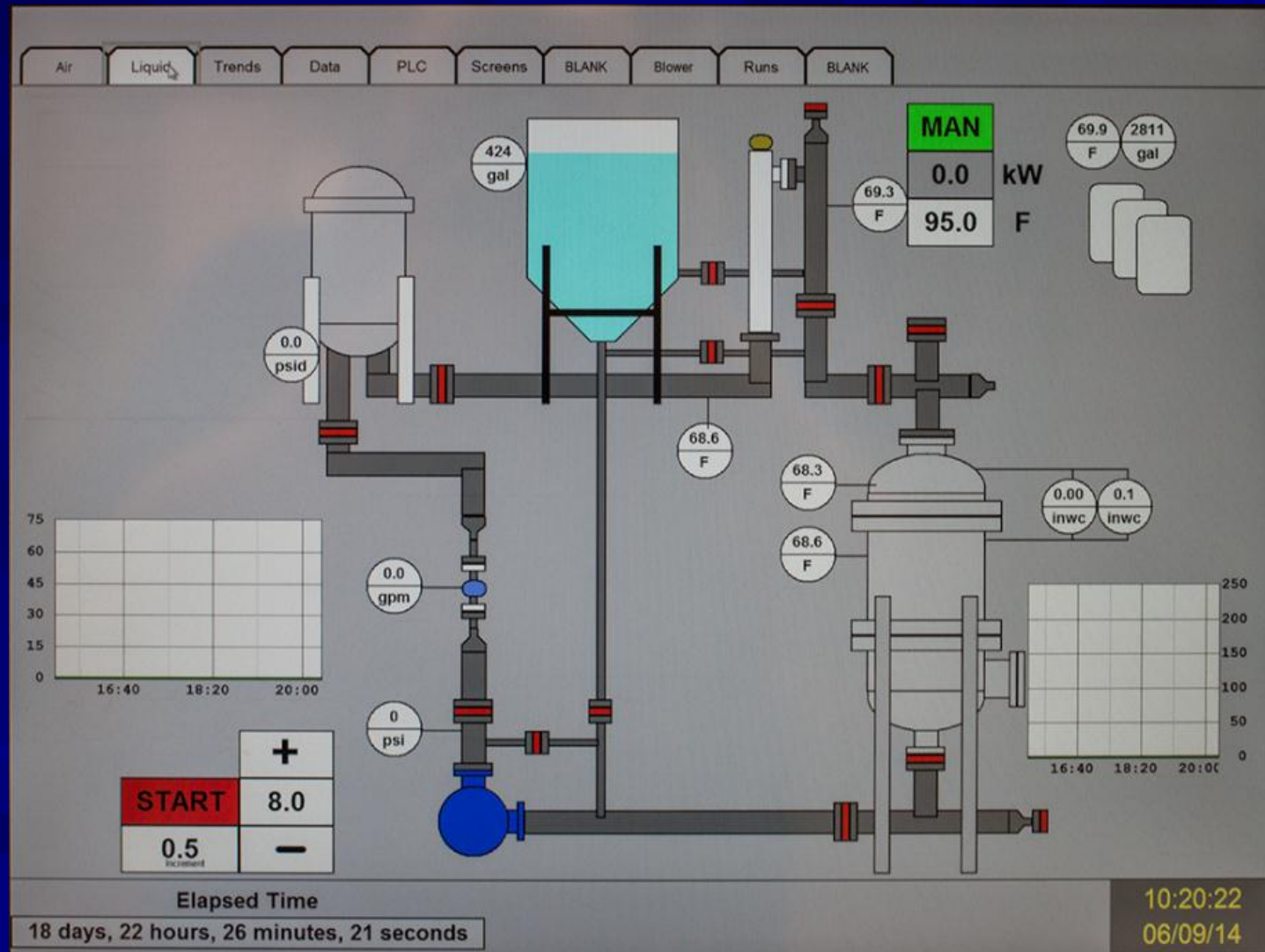


Initial Filter Efficiency

- ASME AG-1 Section FK Article FK-5120
- 2,000 cfm
- DOP (TDA-6C)
- 5 Sets of Data (75 sec each)

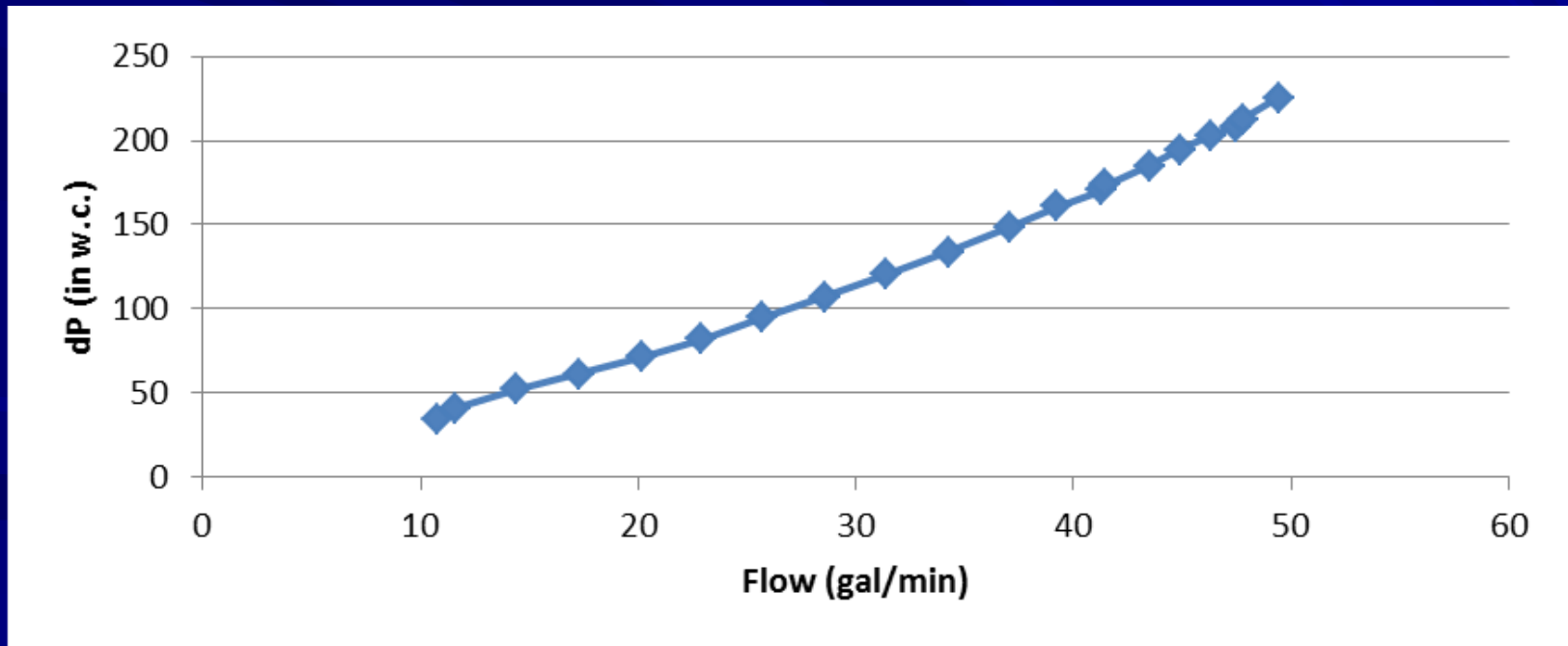


RLPTS Control System



Resistance to Liquid Pressure Test

- Ramp from 0 to 225 in w.c.
- 10 Inch Increments
- Maintain 225 in w.c. for 60 minutes



Washing

- Washing
 - 100° F Water
 - 30 gallons/min
 - 60 min total or 2000 gallons



Drying

■ Drying

- 100 cfm to 400 cfm depending on dP
- 400 cfm is maintained once capable
- Flow maintained until dP reaches minimum

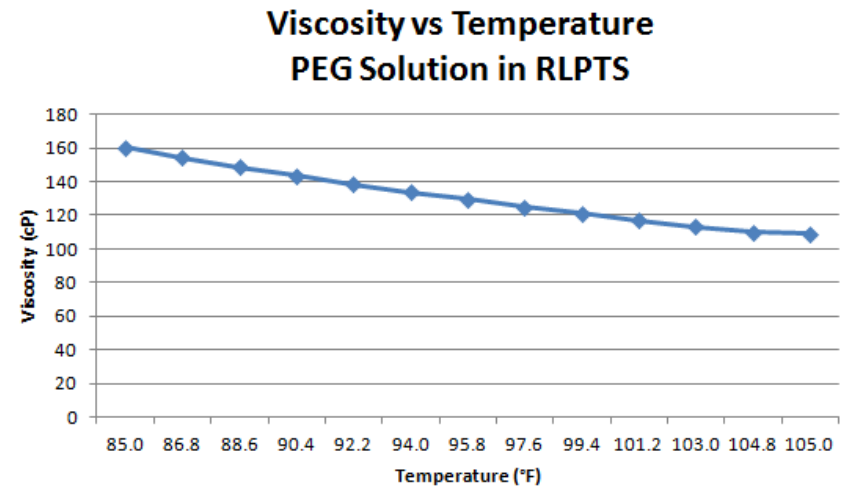
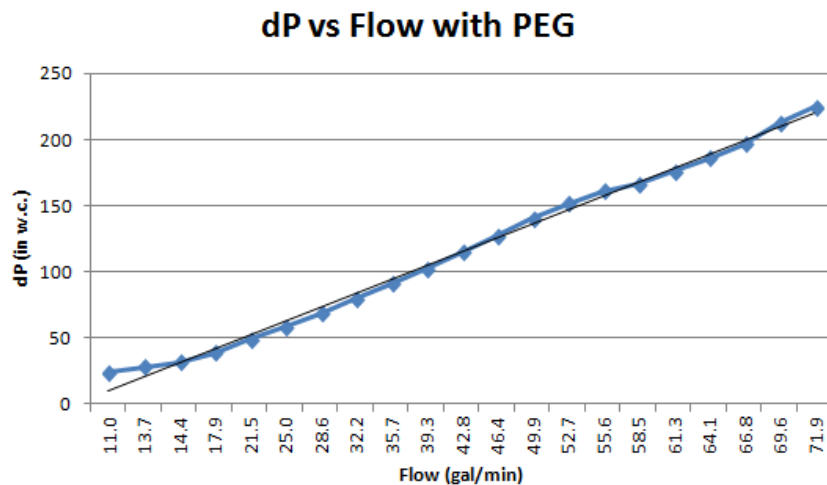
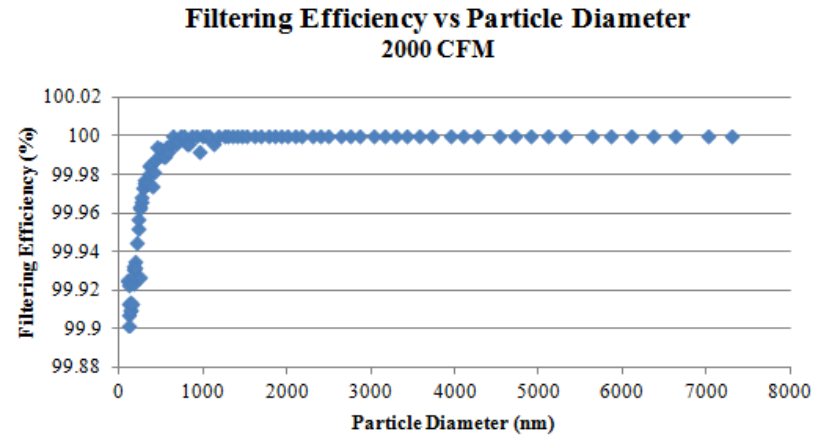
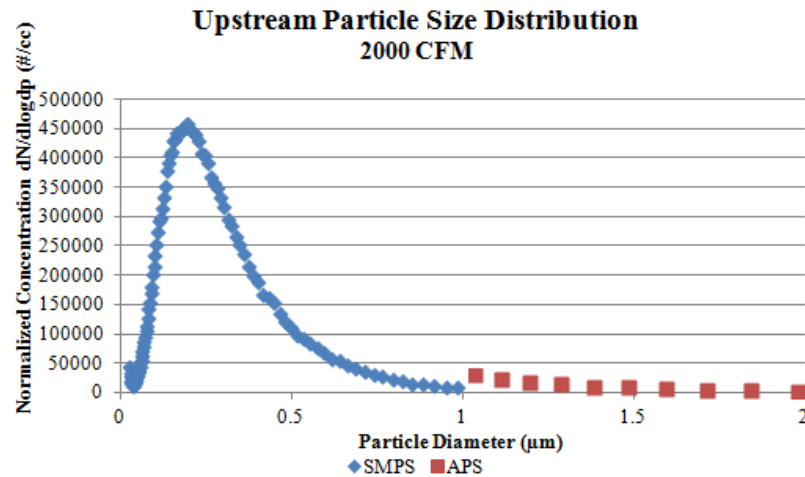
■ Filter Efficiency at 20% rated flow



Rough Handling

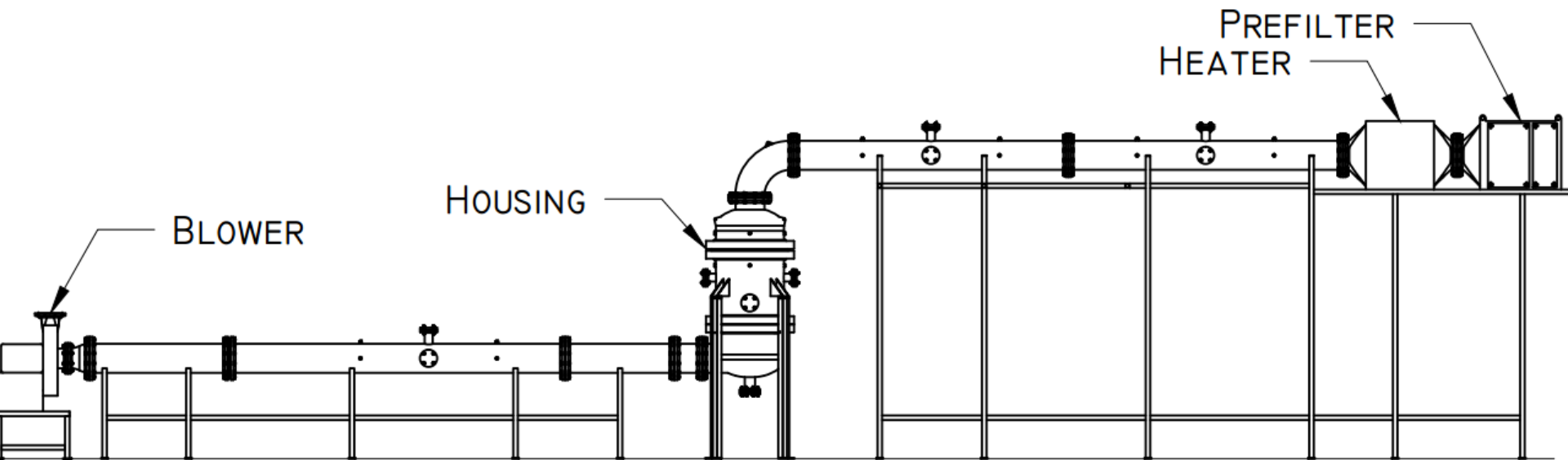


Data Analysis



Heated Air Test Stand

- Capable of Performing Resistance to Heated Air at 700° F in Accordance with ASME AG-1 Section FK article FK-5150



Phase 2 Testing

- Phase I Testing
- Filter Loading Test
- Elevated Temperature and Humidity Test



Conclusion

- **Developed Unique Test Stand for Evaluation of ASME AG-1 Section FK Radial Flow Filters**
- **RLPTS Designed and Built for Performing High Differential Pressure Testing**
- **Test sequence for filter evaluations**