QUALIFICATION LAB TESTING ON M1 ABRAMS ENGINE OIL FILTERS

FINAL REPORT
TFLRF No. 483

by
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U.S. Army TARDEC Fuels and Lubricants Research Facility
Southwest Research Institute® (SwRI®)
San Antonio, TX

for
Frank E. Margrif
U.S. Army TARDEC
Force Projection Technologies
Warren, Michigan

Contract No. W56HZV-15-C-0030 (WD11)

November 2016

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14. ABSTRACT
M1 Abrams currently has only one approved filter for use in the field for the U.S. Army Tank Automotive Material Readiness Command (USATARCOM). Purolator oil filter assembly Part Number 12286941 was qualified per Specification Number 91547-E2128, however, use of this filter is cost prohibitive. Qualifying other filters would allow more options and potentially large cost savings. Current filtration test methods were combined with Specification Number 91547-E2128 in order to address the many changes in particle counting, gravimetric, and test dust references since the specification was written. With this testing, both Donaldson Part Number 569380 and Cummins (Fleetguard) Part Number HF28202 oil filter assemblies were assessed for qualification using the already qualified Purolator oil filter assembly as a baseline.

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EXECUTIVE SUMMARY

The M1 Abrams currently has only one oil filter approved for use in the field for the U.S. Army Tank Automotive Material Readiness Command (USATARCOM). Purolator oil filter assembly Part Number 12286941 was qualified per Specification Number 91547-E2128, however, use of this filter is cost prohibitive. Qualifying additional filters would allow for more options and potentially large cost savings to the U.S. Army.

The Start of Work meeting discussion revealed that current filtration test methods needed to be combined with Specification Number 91547-E2128 in order to address the many changes in particle counting, gravimetric, and test dust references since the original specification was written. Donaldson Part Number 569380 and Cummins (Fleetguard) Part Number HF28202 oil filter assemblies were assessed for qualification using the already qualified Purolator oil filter assembly as a baseline.

The Donaldson and Fleetguard filters passed the requirements of pressure (static, proof, and burst), flow fatigue, pressure differential, material compatibility, shock, and vibration testing. Each filter also performed at least as well as the baseline Purolator filter for bubble point testing.

Compared to the Purolator baseline multi-pass efficiency and capacity test results, the Donaldson filter exhibited very high efficiencies with a significantly shorter life. The capacity was less than half of the Purolator filter's capacity, and would not be considered comparable. The Fleetguard filter showed slightly lower efficiency values at the lowest micron sizes, though otherwise performed similarly to the Purolator including comparable life and capacity values.

Both the Donaldson and the Fleetguard did not meet the 100 psid collapse requirement of Specification Number 9157-E2128. The Purolator baseline element also did not meet the collapse pressure requirement. The Fleetguard element met all physical characteristic requirements. Donaldson met Specification Number 9157-E2128 (Figure 1) requirements for physical characteristics; however, did not meet the weight or Drawing 12286941 requirements, primarily

because the filter did not have the required wrench cap that contains the square male drive opening. In addition, the Donaldson filter did not meet the maximum 3.440 inches of area requiring no paint.

Based on the above data, it is felt the Fleetguard element would be a sufficient alternative element for the M1 Abrams application.

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The authors would like to acknowledge the contribution of the TFLRF technical and administrative support staff.

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ACRONYMS AND ABBREVIATIONS

°C – degrees Celsius

deg F – degrees Fahrenheit

dyn/cm – dyne per centimeter

°F – degrees Fahrenheit

g – gram

G – acceleration relative to standard gravity

GPM – gallons per minute

Hz – hertz

ID – identification

ISO – International Organization for Standardization

kPa/min – kilopascal per minute

lbs. – pounds

mg/L – milligrams per Liter

min – minute

ms – millisecond

pph – pounds per hour

psi – pounds per square inch

psid – pounds per square inch differential

psig – pounds per square inch gauge

sec – second

SwRI – Southwest Research Institute

TARDEC – Tank Automotive Research Development and Engineering Center

TFLRF – TARDEC Fuels and Lubricants Research Facility

U.S. – United States

USATARCOM – U.S. Army Tank Automotive Material Readiness Command

µm – micron

µm(b) – micron (particle counter calibrated using NIST SRM 2806b Medium Test Dust in Hydraulic Fluid)

% – percentage

1.0 BACKGROUND AND OBJECTIVE

The M1 Abrams currently has only one oil filter approved for use in the field for the U.S. Army Tank Automotive Material Readiness Command (USATARCOM). Purolator oil filter assembly Part Number 12286941 was qualified per Specification Number 91547-E2128; however, use of this filter is cost prohibitive. Qualifying additional filters would allow more options and potentially large cost savings to the U.S. Army.

Start of Work meeting discussion revealed that current filtration test methods needed to be combined with Specification Number 91547-E2128 in order to address the many changes in particle counting, gravimetric, and test dust references since the original specification was written. Donaldson Part Number 569380 and Cummins (Fleetguard) Part Number HF28202 oil filter assemblies were assessed for the range of full qualification testing using the already qualified Purolator oil filter assembly as a baseline. All work was performed through the U.S. Army TARDEC Fuels and Lubricants Research Facility (TFLRF), located at Southwest Research Institute (SwRI) in San Antonio, TX.

2.0 FILTRATION QUALIFICATION TEST RESULTS

The following tests were performed on Purolator, 12286941 (baseline), Fleetguard, HF28202, and Donaldson, 569380 hydraulic oil filters: bubble point, various pressure, multi-pass efficiency and capacity, flow fatigue, and collapse tests. The Fleetguard, HF28202 and Donaldson, 569380 were additionally subjected to pressure differential, material compatibility, physical characteristics, design and construction, shock, and vibration tests in order to meet qualification for use. ISO 16889 Multi-pass Efficiency and Capacity testing was used to replace Specification 91547-E2128 Average Filtration Ratio and Dirt Contaminant Capacity testing, which contained outdated references to test dust, gravimetric analysis, and current particle counter calibration and capabilities. Test data for efficiency and capacity will not correlate to current Specification 91547-E2128 requirements, and new requirements will need to be established.

2.1 BUBBLE POINT TEST RESULTS

Bubble point testing was implemented to catch any obvious manufacturing defects or flaws in the media. Bubble point testing was performed using isopropanol at 75 °F ± 5 °F having a surface tension of 21.15 dyn/cm ± 0.10 dyn/cm. The filter was immersed in isopropanol until the pores were saturated, and gas pressure was applied to the inside of the filter and slowly increased until gas bubbles emerged through the media. The gas pressure was measured when the "first bubble" appeared, which corresponded with the area containing the largest pores or holes. A summary of bubble point test results is shown in Table 1. Bubble point test results for Purolator, MFR90005 are shown in Figure 1 and Table 2. Bubble point test results for Donaldson, 569380 are shown in Figure 2 and Table 3. Bubble point test results for Fleetguard, HF28202 are shown in Figure 3 and Table 4.

Table 1. Summary of Bubble Point Test Results

SwRI Filter ID	Filter Description	First Bubble (inches of water)	First Bubble (psi)	Leak Description
FL15-2389	Purolator, MFR90005	4.8	0.17	Leaking occurred from the media, two (2) inches down from the top endcap
FL15-2328	Donaldson, 569380	5.0	0.18	Leaking occurred at top endcap
FL15-2346	Fleetguard, HF28202	9.2	0.33	Leaked from the media 1/8 inch from the bottom endcap

Figure 1. Test Filter Purolator, MFR90005 (FL15-2389) First Bubble

Table 2. Test Filter Purolator, MFR90005 (FL15-2389) Results

First Bubble (inches of water)	First Bubble (psi)	Leak Description
4.8	0.17	Leaking occurred from the media, two (2) inches down from the top endcap

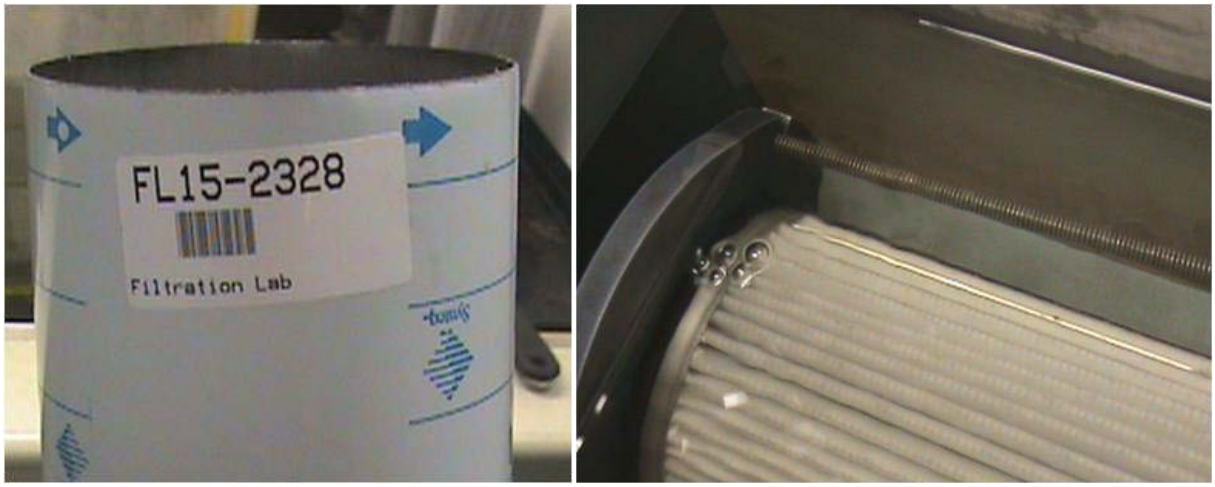


Figure 2. Test Filter Donaldson, 569380 (FL15-2328) First Bubble

Table 3. Test Filter Donaldson, 569380 (FL15-2328) Results

First Bubble (inches of water)	First Bubble (psi)	Leak Description
5.0	0.18	Leaking occurred at top endcap

Figure 3. Test Filter Fleetguard, HF28202 (FL15-2346) First Bubble

Table 4. Test Filter Fleetguard, HF28202 (FL15-2346) Results

First Bubble (inches of water)	First Bubble (psi)	Leak Description
9.2	0.33	Leaked from the media 1/8 inch from the bottom endcap

2.2 STATIC, PROOF, AND BURST PRESSURE TEST RESULTS

Pressure tests were conducted to demonstrate the filters ability to withstand the maximum pressure the filters might see in use, and where any weak points or failure might occur. Pressure tests were performed using AeroShell Turbine Oil 560 (Classification HTS), conforming to MIL-PRF-23699, at ambient temperature. The filter was filled with test fluid, and all air was bled from the system. Pressure was increased to no greater than 690 kPa/min above 50% of the expected burst pressure until either the filter failed and allowed leakage of fluid, or the filter reached or surpassed the recommended pressure values. A summary of pressure test results are shown in Table 5.

Table 5. Summary of Pressure Test Results

SwRI Filter ID	Filter Description	Static Pressure	Proof Pressure	Burst Pressure
FL15-2392	Purolator, MFR90005	Passed	Passed	Passed
FL15-2331	Fleetguard, HF28202	Passed	Passed	Passed
FL15-2316	Donaldson, 569380	Passed	Passed	Passed

The test filters performed as follows during pressure testing:

- Static pressure passed with the maximum applied pressure of 100 psig for all three (3) test filters.
- Proof pressure passed the 250 psig requirement in all three (3) test filters.
- None of the three (3) test filters ruptured below 400 psig during the burst tests.

2.3 MULTI-PASS EFFICIENCY AND CAPACITY RESULTS

ISO 16889 Multi-pass Efficiency and Capacity testing was used to replace Specification 91547-E2128 Average Filtration Ratio and Dirt Contaminant Capacity testing. The ISO 16889 (modified) procedure tested the filtration performance of oil filter elements. The tests were performed with continuous contaminant injection in a multi-pass flow loop and filtration efficiency was determined by particle counting. The capacity of retained contaminant was recorded once the filter reached the agreed upon terminal differential pressure (19 psid). Differential pressure as a function of contaminant loading was also recorded. Test parameters are shown in Table 6 and a summary of the test results can be seen in Table 7. Test data sheets are included in Appendix A.

Table 6. ISO 16889 (modified) Test Parameters

Flow Rate (GPM)	3
Base Upstream Gravimetric Level (mg/L)	10
Test Dust	ISO 12103-1, A3 Medium
Terminal Differential Pressure (psid)	19
Test Fluid	MIL-H-5606 (Aeroshell Fluid 4)
Temperature (°F)	100
Particle Sizes (µm)	4; 5; 6; 7; 10; 12; 14; and 20

Table 7. Summary of ISO 16889 (modified) Multi-pass Test Results

SwRI Filter ID		FL15-2329	FL16-2390	FL15-2326
Filter Type		Fleetguard, HF28202	Purolator, MFR90005	Donaldson, 569380
	4 µm(b)	65.1	98.4	98.3
	5 µm(b)	78.7	99.5	99.3

Average Efficiency (%)	**6 µm(b)**	88.0	99.8	99.6
	7 µm(b)	92.5	99.9	99.7
	10 µm(b)	98.9	99.9	99.8
	12 µm(b)	99.7	99.9	99.8
	14 µm(b)	99.9	99.9	99.8
	20 µm(b)	100	99.9	99.8
Retained Capacity (g)		71.42	80.71	27.20
Test Time (min)		204.2	202.1	80.7

2.4 FLOW FATIGUE TEST RESULTS

Flow fatigue testing was performed to simulate the cyclic flow a test article sees while in use, and was used to determine if any cracks formed in the media that would allow oil to pass through. Test articles were placed under test for 7500 flow cycles comprised of zero Gallons Per Minute (GPM) up to 8.2 GPM and back to zero GPM on a contaminated filter with 22 to 25 psid pressure across the element during flow. This testing implemented using AeroShell Turbine Oil 560 (Classification HTS), conforming to MIL-PRF-23699, at 85 °F with a cycle rate of 23 cycles per minute. Flow fatigue test measurements for Donaldson, 569380 are shown in Figure 4 and Figure 5. Flow fatigue test measurements for Purolator, MFR90005 are shown in Figure 6 and Figure 7. Flow fatigue test measurements for Fleetguard, HF28202 are shown in Figure 8 and Figure 9.

Table 8. Summary of Flow Fatigue Test Results

Filter Description	Flow Fatigue
Donaldson, 569380	Passed
Purolator, MFR90005	Passed
Fleetguard, HF28202	Passed

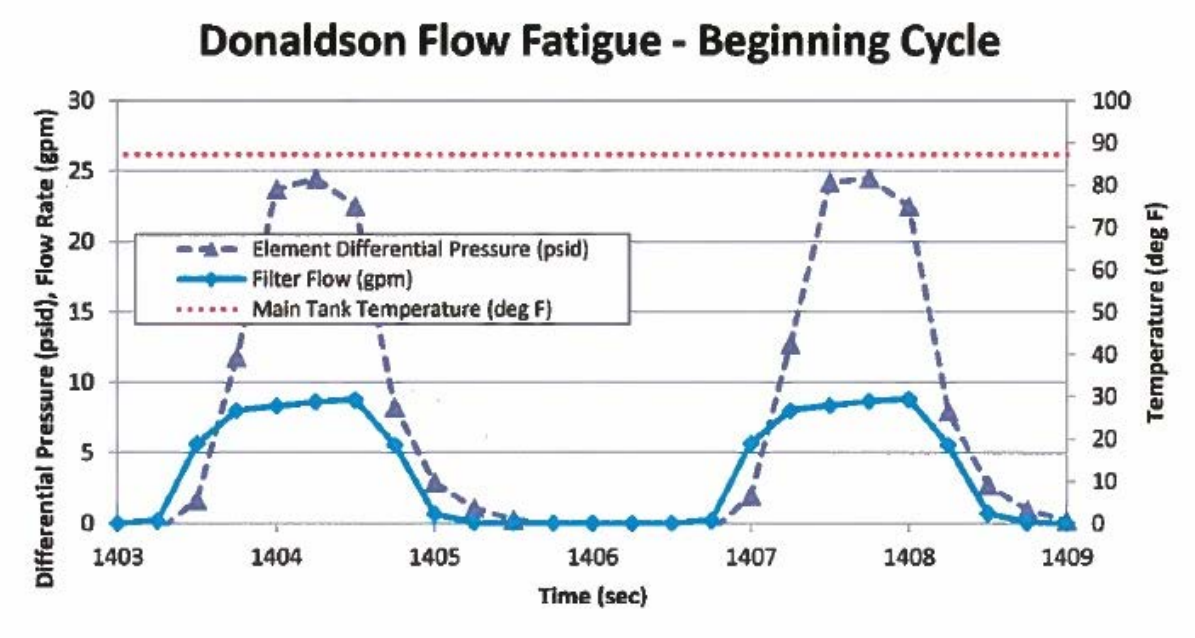


Figure 4. Flow Fatigue Filter Performance for Donaldson, 569380 at Beginning of Test

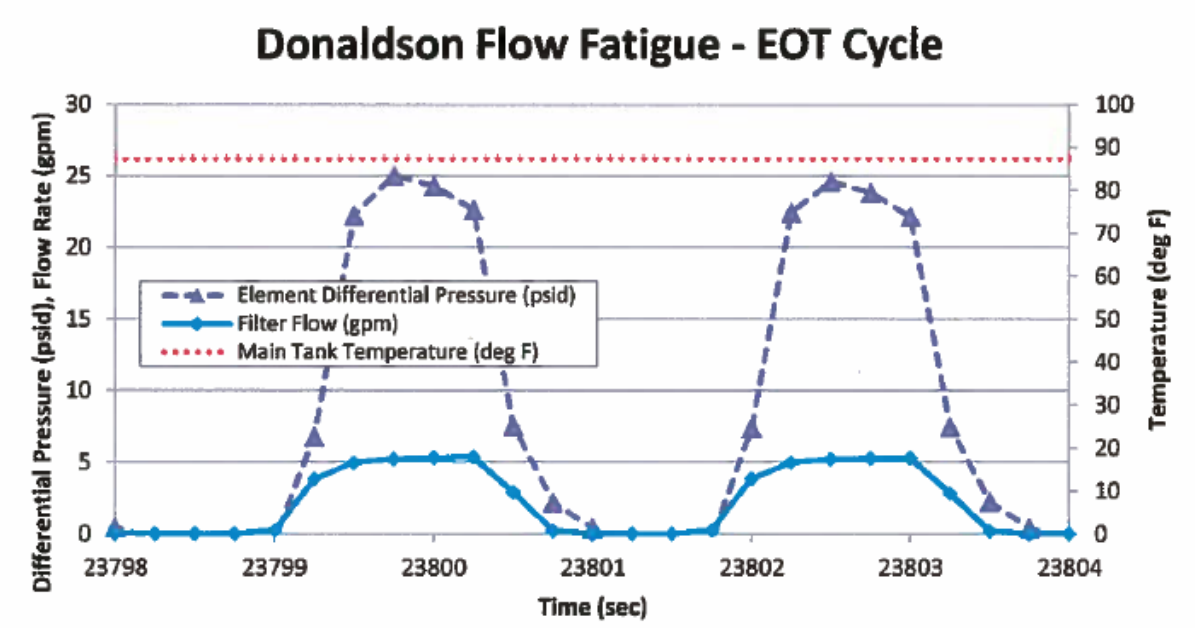


Figure 5. Flow Fatigue Filter Performance for Donaldson, 569380 at End of Test

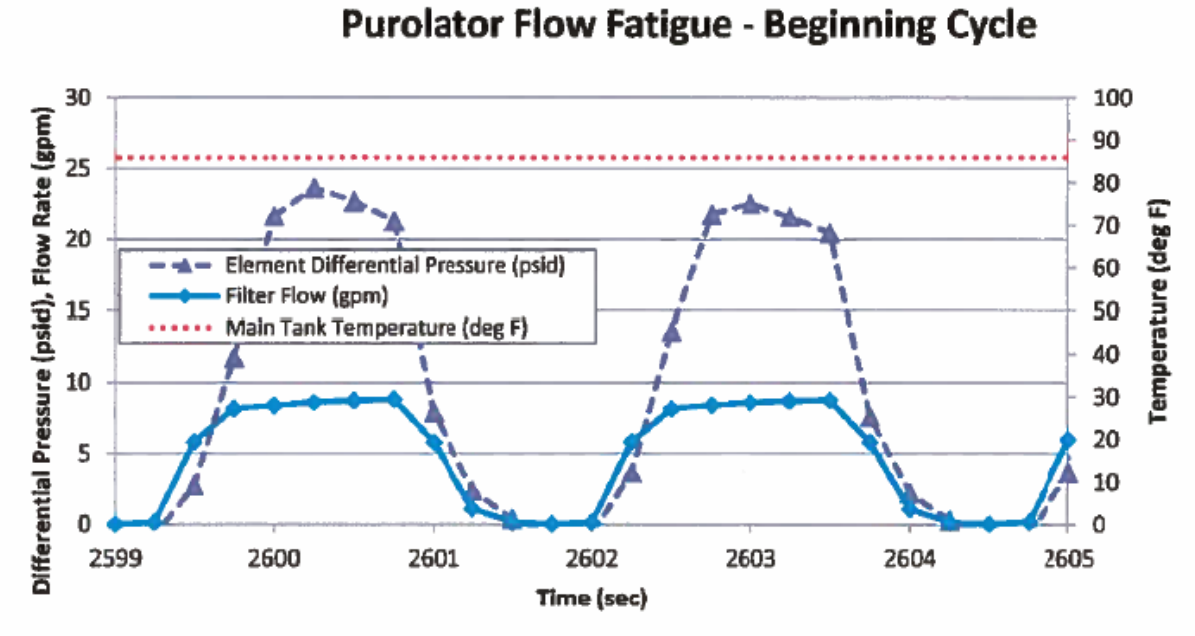


Figure 6. Flow Fatigue Filter Performance for Purolator, MFR90005 at Beginning of Test

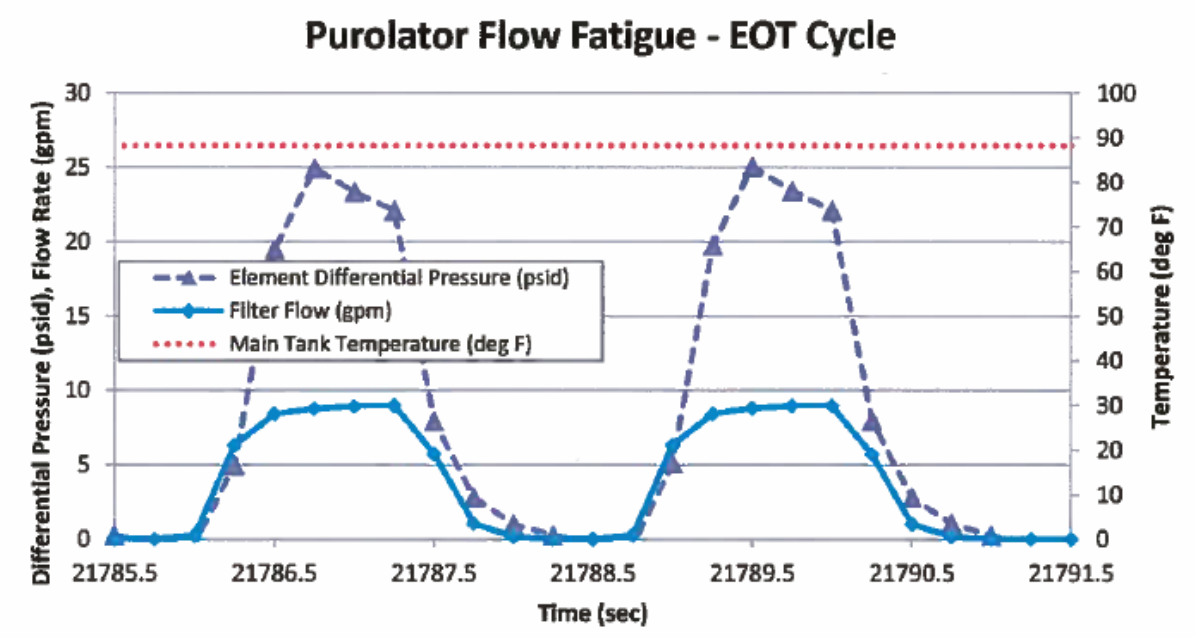


Figure 7. Flow Fatigue Filter Performance for Purolator, MFR90005 at End of Test

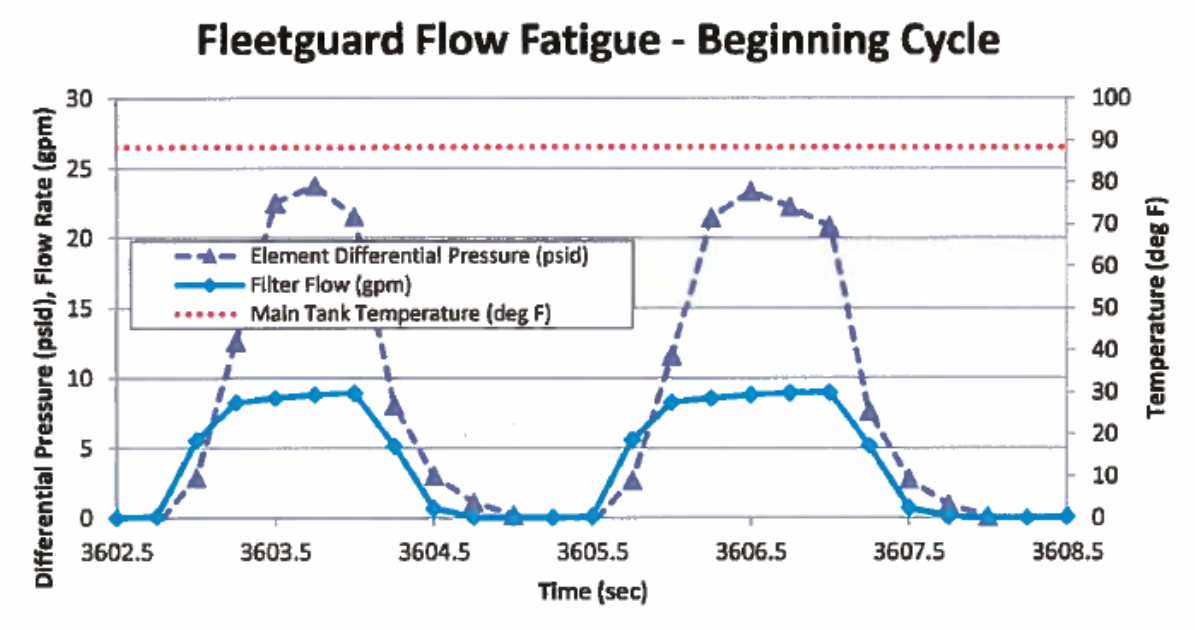


Figure 8. Flow Fatigue Filter Performance for Fleetguard, HF28202 at Beginning of Test

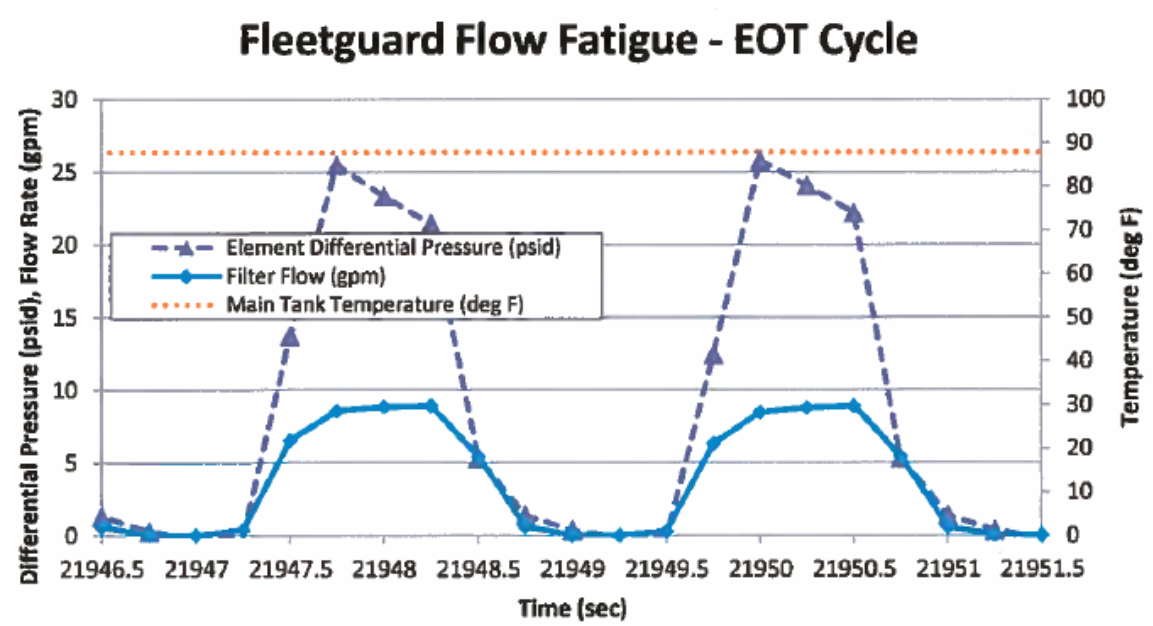


Figure 9. Flow Fatigue Filter Performance for Fleetguard, HF28202 at End of Test

2.5 PRESSURE DIFFERENTIAL TEST RESULTS

The pressure differential tests were performed using AeroShell Turbine Oil 560 (Classification HTS), conforming to MIL-PRF-23699, at 200 °F with a flow rate of 4000 pph. The resulting pressure loss met the maximum of 2 psid across the filter, shown as passed or failed in Table 9.

Table 9. Summary of Pressure Test Results

SwRI Filter ID	Filter Description	Pressure Differential
FL15-2345	Fleetguard, HF28202	Passed
FL15-2322	Donaldson, 569380	Passed

2.6 COLLAPSE PRESSURE TEST RESULTS

Collapse tests were completed using AeroShell Turbine Oil 560 (Classification HTS), conforming to MIL-PRF-23699, at a test temperature maintained within 5 °F a temperature between 61 °F and 100 °F using ISO 12103-1, A2 Fine test dust. The filters were loaded with test dust until the differential pressure no longer exhibited an increase, which signified the filter had collapsed. None of the filters met the 100 psid requirement called out in Specification 91547-E2128, measured at the rated flow of the filter.

Table 10. Summary of Collapse Pressure Test Results

SwRI Filter ID	Filter Description	Collapse Pressure (psid)	Collapse Pressure Requirements
FL15-2345	Fleetguard, HF28202	79	Not met
FL15-2318	Donaldson, 569380	71	Not met
FL16-2794	Purolator, MFR90005	78	Net met

2.7 MATERIAL COMPATIBILITY TEST RESULTS

Material compatibility testing was performed to ensure that filter materials and seals will not degrade when exposed to the test fluid over extended periods of time and a range of temperatures the filter may experience while in use. Filter elements were soaked in AeroShell Turbine Oil 560 (Classification HTS), conforming to MIL-PRF-23699, at 225 ± 5 °F for 100 hours. No damage was noted for the two (2) filters tested, as shown in Table 11.

Table 11. Summary of Material Compatibility Results

SwRI Filter ID	Filter Description	Fluid Temperature (°F)	Damage Noted
FL15-2345	Fleetguard, HF28202	225	None
FL15-2319	Donaldson, 569380	225	None

2.8 PHYSICAL CHARACTERISTICS TEST RESULTS

Donaldson Part Number 569380 and Cummins (Fleetguard) Part Number HF28202 oil filters were examined for compliance with Specification 91547-E2128, Figure 1, shown below in Figure 10, and Drawing 12286941 which is shown below in Figure 11. Results are documented in Table 12 through Table 16.

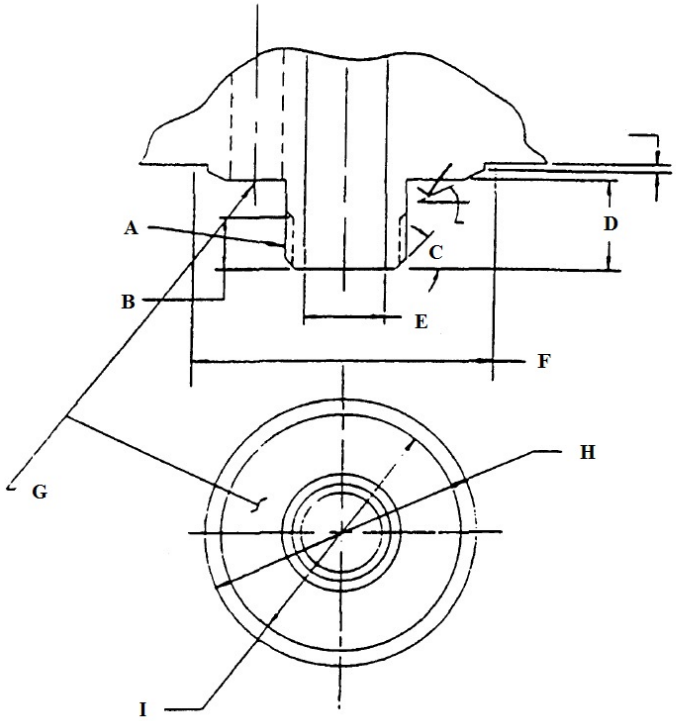


Figure 10. Specification Number 9157-E2128 (Figure 1)

Table 12. Physical Characteristics Measurements from Figure 10 for Fleetguard, HF28202 (FL15-2341)

Measurement Label	Measurement Description	Minimum Requirement	Measurement	Requirement Met (yes or no)
A	Thread (filter test head)	1 ½ - 16 UN-2A Thread	1 ½ - 16 UN-2A Thread	Yes

B	Thread length (filter test head)	0.62 inches	0.65 inches	Yes
C	Angle of mating surface (filter test head)	45 °	45 °	Yes
D	Length of nipple to contact surface (filter test head)	-	1.07 inches	-
E	Inside Diameter of nipple (test filter head)	1.00 inches	1.43 inches	Yes
F	Filter mating surface (Diameter of contact between filter and filter test head)	3.80 inches (clearance)	4.74 inches	Yes
G	Inlet flow (Inlet flow area)	0.63 inches flow area	0.82 inches	Yes
H	Outer Diameter (filter)	-	3.76 inches	-
I	Inner Diameter (filter)	-	2.89 inches	-

Table 13. Physical Characteristic Measurements from Figure 10 for Donaldson, 569380 (FL15-2327)

Measurement Label	Measurement Description	Minimum Requirement	Measurement	Requirement Met (yes or no)
A	Thread (filter test head)	1 ½ - 16 UN-2A Thread	1 ½ - 16 UN-2A Thread	Yes
B	Thread length (filter test head)	0.62 inches	0.65 inches	Yes
C	Angle of mating surface (filter test head)	45 °	45 °	Yes
D	Length of nipple to contact surface (filter test head)	-	1.07 inches	-
E	Inside Diameter of nipple (test filter head)	1.00 inches	1.43 inches	Yes
F	Filter mating surface (Diameter of contact between filter and filter test head)	3.80 inches (clearance)	4.74 inches	Yes
G	Inlet flow (Inlet flow area)	0.63 inches flow area	0.64 inches	Yes
H	Outer Diameter (filter)	-	3.68 inches	-
I	Inner Diameter (filter)	-	2.78 inches	-

Table 14. Summary of Weight Measurements

SwRI Filter ID	Filter Description	Weight (lbs)	Weight Requirement (lbs.)	Weight Requirement Met (yes or no)
FL15-2341	Fleetguard, HF28202	2.66	< 10	Yes
FL15-2327	Donaldson, 569380	1.83*	< 10	No

* Please note that the Donaldson, 569380 (FL15-2327) weight measurement did not include the required wrench cap that contains the square male drive opening. The weight obtained without this piece cannot be considered comparable.

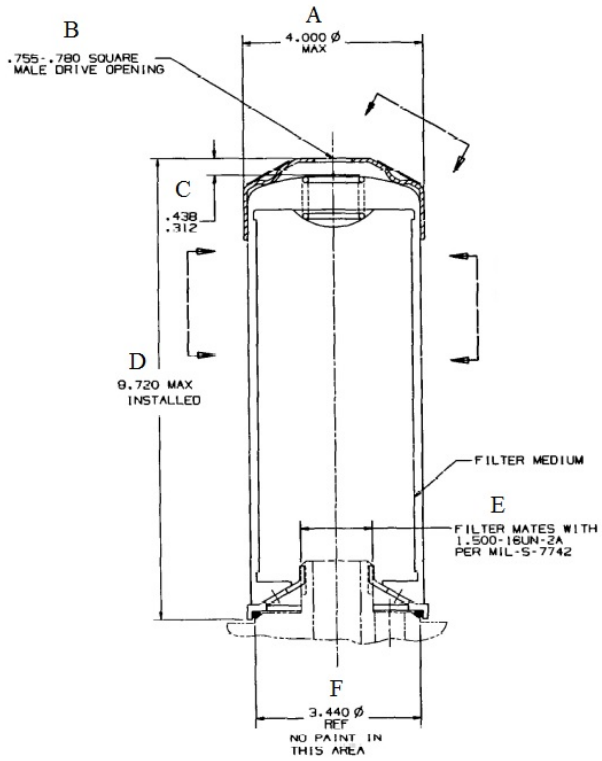


Figure 11. Drawing 12286941

Table 15. Physical Characteristic Measurements from Figure 11 (Drawing 12286941) for Fleetguard HF28202 (FL15-2341)

Measurement Label	Measurement Description	Minimum Requirement	Measurement	Maximum Requirement	Requirement Met (yes or no)
A	Width of filter	-	3.820 inches	4.000 inches	Yes
B	Square Male Drive Opening	0.755 inches	0.755 inches	0.780 inches	Yes
C	Length from Wrench Cap to the filter	0.312 inches	0.408 inches	0.438 inches	Yes
D	Length of filter (installed)	-	9.710 inches	9.720 inches	Yes
E	Filter mates with 1.500 - 16UN - 2A	-	-	-	Yes
F	Area requiring no paint	-	3.456 inches	3.440 inches	Yes

Table 16. Physical Characteristic Measurements from Figure 11 (Drawing 12286941) for Donaldson

Measurement Label	Measurement Description	Minimum Requirement	Measurement	Maximum Requirement	Requirement Met (yes or no)
A	Width of filter	-	3.673 inches	4.000 inches	Yes
B*	Square Male Drive Opening	0.755 inches	-	0.780 inches	No
C*	Length from Wrench Cap to the filter	0.312 inches	-	0.438 inches	No
D*	Length of filter (installed)	-	8.190 inches	9.720 inches	No
E	Filter mates with 1.500 - 16UN - 2A	-	-	-	Yes
F	Area requiring no paint	-	3.770 inches	3.440 inches	No

* Please note that the Donaldson, 569380 (FL15-2327) did not include the required wrench cap that contains the square male drive opening

2.9 DESIGN AND CONSTRUCTION RESULTS

Pending responses from Cummins Filtration and Donaldson Company, Inc.

2.10 SHOCK TEST RESULTS

Shock testing illustrates the ability of the filter to endure extreme rates of force with respect to short durations of time. Shock testing was performed with static shock levels of 20 G for 18 ms in both directions along three mutually perpendicular axes at an ambient temperature of 22 °C. A summary of shock test results are shown in Table 17, and test data sheets are presented in Appendix B.

Table 17. Summary of Shock Test Results

SwRI Filter ID	Filter Description	Shock Requirement Met (yes or no)	Temperature/Pressure Requirement Met (yes or no)
FL15-2332	Fleetguard, HF28202	Yes	Yes
FL15-2317	Donaldson, 569380	Yes	Yes

2.11 VIBRATION TEST RESULTS

Vibration tests were performed to simulate the vibration a filter experiences in the field, and whether those vibrations could cause the filter to underperform while in use. During vibration, the

filters were filled with AeroShell Turbine Oil 560 (Classification HTS), conforming to MIL-PRF-23699. Both filters met the visual and proof pressure requirements subsequent to vibration testing. The summary of vibration test results is shown in Table 18. Vibration input durations are shown in Table 19 and Table 20. Figure 12 and Figure 13 display the configuration of the filters while mounted to the shaker table. Figure 14 contains a sample of an actual controlled input vibration sweep.

Table 18. Summary of Vibration Test Results

SwRI Filter ID	Filter Description	Vibration Requirement Met (yes or no)	Visual/Proof Pressure Test Requirements Met (yes or no)
FL15-2338	Fleetguard, HF28202	Yes	Yes
FL15-2323	Donaldson, 569380	Yes	Yes

Table 19. Vibration Input Durations for Fleetguard, HF28202 (FL15-2332)

Frequency (Hz)	Acceleration	Time (min)
5 - 500 Sweep	91547-E2128 Table 1 Profile	0 - 20
56 Dwell	4 G	20 - 40
272 Dwell	4 G	40 - 60
302 Dwell	4 G	60 - 80
5 – 500 Sweep	91547-E2128 Table 1 Profile	80 - 100

Figure 12. Fleetguard, HF28202 (FL15-2332) Mounted to Shaker Table

Table 20. Vibration Input Durations for Donaldson, 569380 (FL15-2317)

Frequency	Acceleration	Time (min)
5 - 500 Sweep	91547-E2128 Table 1 Profile	0 - 20
5 - 500 Sweep	91547-E2128 Table 1 Profile	20 - 40
60 Dwell	4 G	40 - 60
399 Dwell	4 G	60 - 80
5 - 500 Sweep	91547-E2128 Table 1 Profile	80 - 100

Figure 13. Donaldson, 569380 (FL15-2317) Mounted to Shaker Table

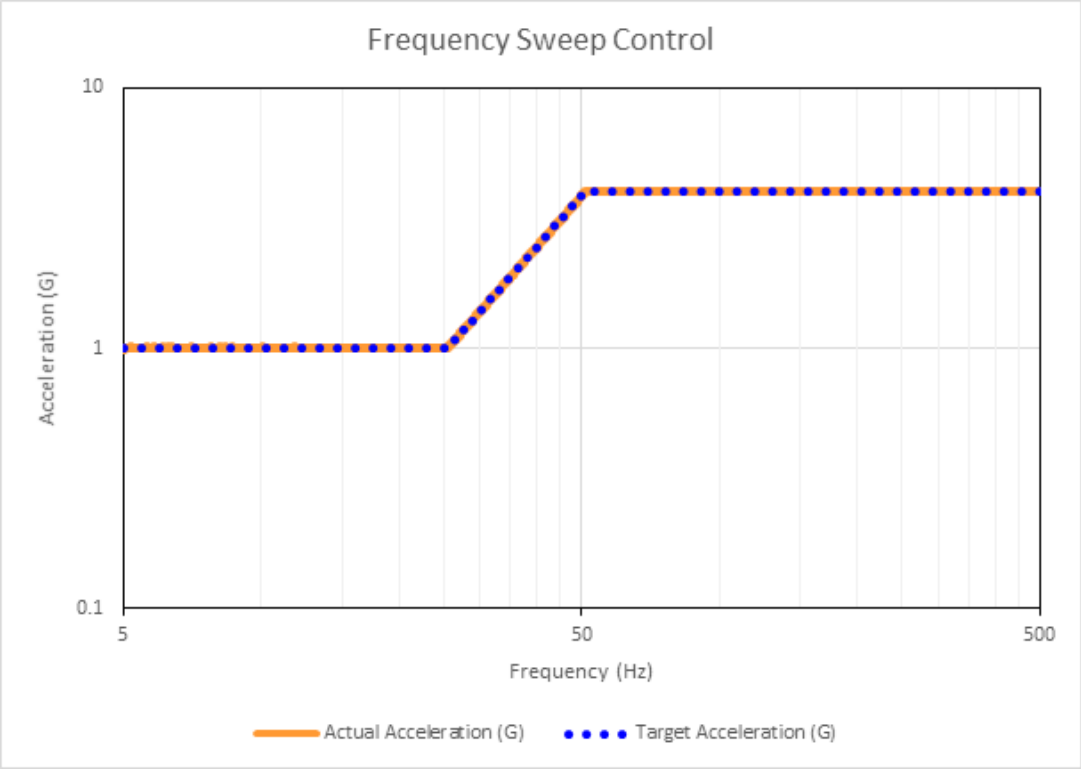


Figure 14. Sample of Actual Vibration Sweep Control

3.0 SUMMARY AND RECOMMENDATIONS

Specification 91547-E2128 states that the bubble point pressure should be higher than the manufacturer's minimum recommended rating for this in order to meet the requirements for fabrication integrity, as well as show no evidence of unsealed joints or defective medium. Both the Donaldson and Fleetguard filter results were higher than the baseline Purolator, and showed no obvious media flaws or manufacturing defects. The Donaldson and Fleetguard filters also passed the requirements of pressure (static, proof, and burst), flow fatigue, pressure differential, material compatibility, shock, and vibration testing.

Compared to the Purolator baseline multi-pass efficiency and capacity test results, the Donaldson filter exhibited very high efficiencies with a significantly shorter life. The capacity value was less than half of the Purolator filter, and would not be considered comparable. The Fleetguard filter showed slightly lower efficiency values at the lowest micron sizes, though otherwise performed similarly to the Purolator including a comparable life and capacity.

Both the Donaldson (71 psid) and the Fleetguard (79 psid) did not meet the 100 psid collapse requirement of Specification Number 9157-E2128. The Purolator baseline element (78 psid) also did not meet the collapse pressure requirement.

The Fleetguard element met all physical characteristic requirements of Specification Number 9157-E2128 (Figure 1), weight, and Drawing 12286941. The Donaldson filter met Specification Number 9157-E2128 (Figure 1) requirements; however, did not meet the weight requirement or Drawing 12286941, primarily because the filter did not have the required wrench cap that contains the square male drive opening. In addition, the Donaldson filter did not meet the maximum 3.440 inches of area requiring no paint.

Based on the above data, it is felt the Fleetguard element would be a sufficient alternative element for the M1 Abrams application.

APPENDIX A.

ISO 16889 (modified) Test Data Sheets

Test No.:	MUL00737
Test Date:	5/13/2016
Operator:	RVL

FILTER AND ELEMENT IDENTIFICATION

P/N:	HF28202	
Element ID:	FL15-2329	
Housing ID:	--	
Element Type:	Spin on	
Min. Element Bubble Point:	--	in. H2O
Bubble Point to ISO2942:	--	in. H2O
Wetting Fluid:	--	

TEST FLUID

Type:	Shell	
Ref.:	AeroFluid 4	
Batch No.:	65475	
Viscosity:	15.00	cSt
Temperature:	100	°F
Anti-Static Type Added:	Stadis 450	
Conductivity:	1368	pS/m

COUNTER CALIBRATION

Calibration Method:	ISO11943
Calibration Date:	10/12/2014

TEST CONTAMINANT

Type:	A-3
Batch No.:	11440M

TEST SYSTEM

Flow Rate:	8.2	GPM
Initial Volume:	30	L
Final Volume:	30	L

UPSTREAM CONCENTRATION

Base:	11.44	mg/L
80%:	17.60	mg/L

DIFFERENTIAL PRESSURE DATA

Terminal Element:	19.00	psid
Filter Housing:	0.43	psid
Clean Assembly:	1.34	psid
Clean Element:	0.92	psid
Net:	18.08	psid

INJECTION SYSTEM

	Initial	Final	Average
Flow (L/min)	0.32	0.25	0.28
Concen. (mg/L)	1266.2	1250	1258

RETENTION CAPACITY

Injected:	72.54	grams
Retained:	71.42	grams

Counting System	Counter and Sensor Ref.	Flow Rate (mL/min)	
Upstream	Pamas	25	--
Downstream	Pamas	25	--

DIFFERENTIAL PRESSURE VERSUS CONTAMINANT ADDED

% Net Pressure	Test Time (min)	Element DP (psid)	Injected Mass (grams)
5%	156.5	1.82	55.11
10%	172.8	2.73	60.88
15%	179.0	3.63	63.04
20%	183.1	4.54	64.48
40%	191.2	8.15	67.36
80%	200.4	15.38	70.60
100%	204.2	19.00	71.93

EFFICIENCY DATA

	4.0 µm(b)	5.0 µm(b)	6.0 µm(b)	7.0 µm(b)	10.0 µm(b)	12.0 µm(b)	14.0 µm(b)	20.0 µm(b)
Max Efficiency (%)	73.0%	85.6%	93.2%	96.2%	99.6%	99.9%	100.0%	100.0%
Min Efficiency (%)	56.9%	67.5%	77.9%	84.5%	97.0%	99.1%	99.7%	99.8%
Avg. Efficiency (%)	65.1%	78.7%	88.0%	92.5%	98.9%	99.7%	99.9%	100.0%

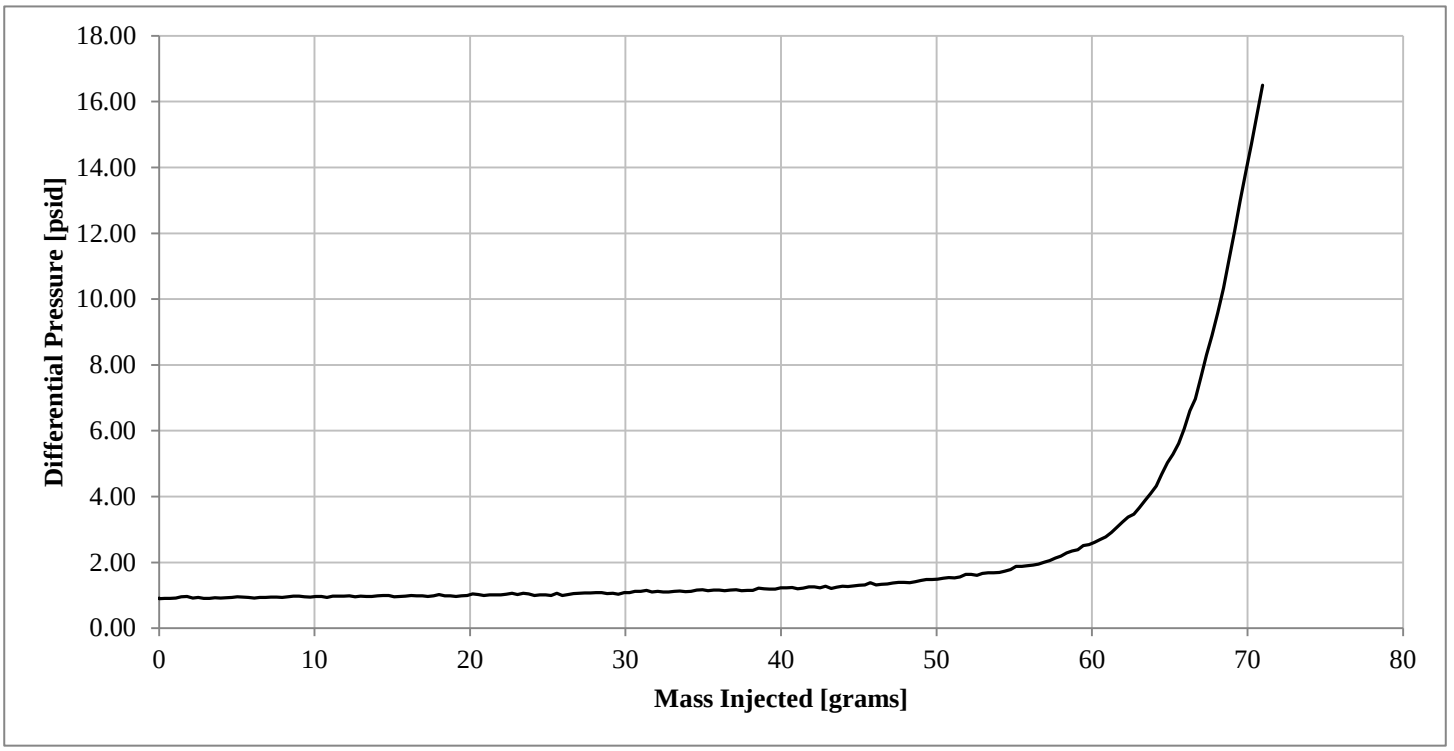
Efficiency (%)	50%	75%	90%	95%	99%
Particle Size µm(b)	--	5	6	8	10

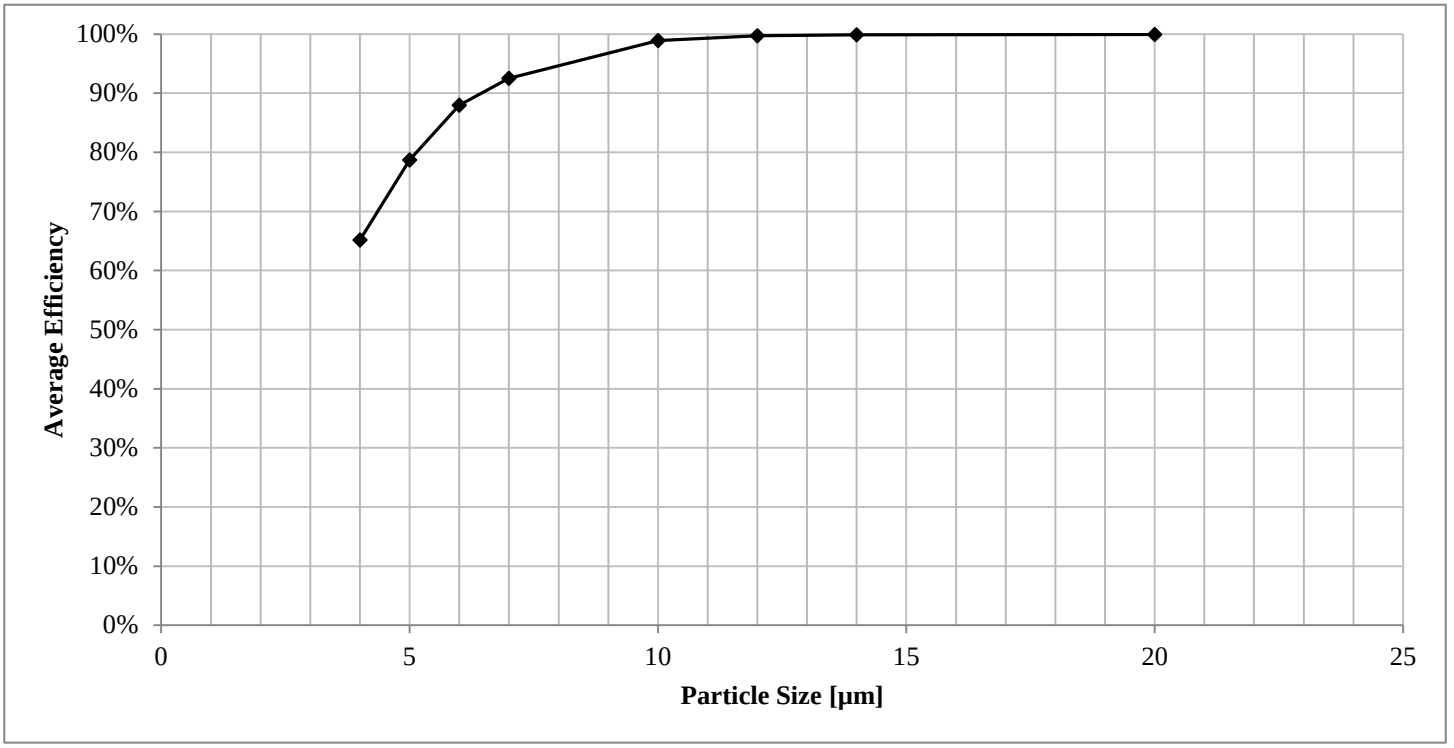
P/N:	HF28202	**Test No.:**	MUL00737
ID:	FL15-2329	**Test Date:**	5/13/2016

PARTICLE DISTRIBUTION ANALYSIS (particles/mL)

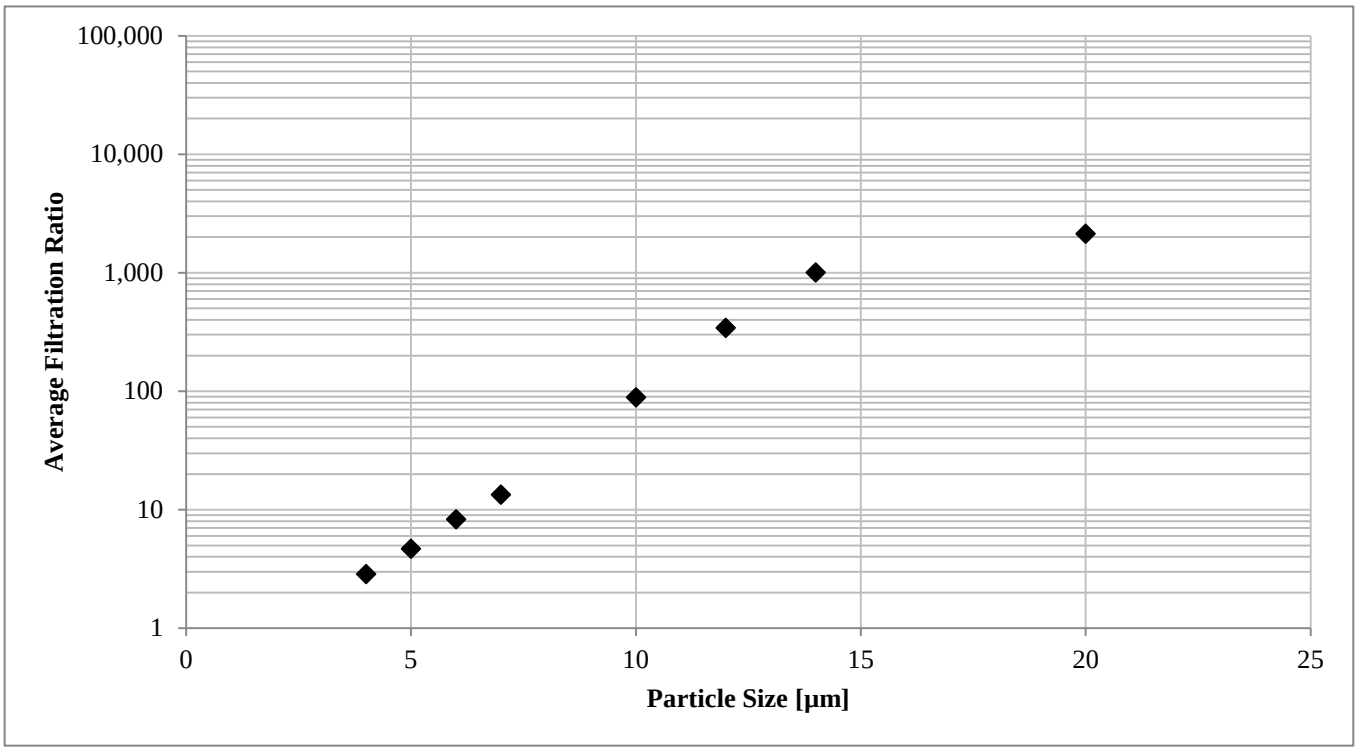
Sample Point		4.0 µm(b)	5.0 µm(b)	6.0 µm(b)	7.0 µm(b)	10.0 µm(b)	12.0 µm(b)	14.0 µm(b)	20.0 µm(b)
Initial	--	64.21	24.72	10.56	5.46	1.42	0.75	0.36	0.14
20.4 min	UP	30692.87	15941.73	8285.62	5028.94	1542.78	891.50	529.21	121.55
10% total time	DOWN	8300.29	2302.31	566.78	189.33	6.06	0.78	0.25	0.05
	EFF. (%)	72.96%	85.56%	93.16%	96.24%	99.61%	99.91%	99.95%	99.96%
40.9 min	UP	33784.65	16925.42	8684.64	5260.08	1617.16	936.12	560.62	128.51
20% total time	DOWN	11134.31	3003.47	753.82	255.25	8.20	1.05	0.28	0.04
	EFF. (%)	67.04%	82.25%	91.32%	95.15%	99.49%	99.89%	99.95%	99.97%
61.4 min	UP	34045.72	16942.52	8652.60	5231.41	1605.88	933.54	556.88	128.13
30% total time	DOWN	11749.07	3197.32	814.09	280.38	9.38	1.31	0.27	0.07
	EFF. (%)	65.49%	81.13%	90.59%	94.64%	99.42%	99.86%	99.95%	99.94%
80.8 min	UP	34311.53	17055.19	8691.21	5252.18	1608.82	931.51	556.89	129.08
40% total time	DOWN	12120.37	3371.18	872.06	303.18	10.73	1.49	0.32	0.05
	EFF. (%)	64.68%	80.23%	89.97%	94.23%	99.33%	99.84%	99.94%	99.96%
102.3 min	UP	34444.25	17168.23	8735.50	5260.88	1604.07	931.15	555.84	127.65
50% total time	DOWN	11918.67	3398.45	901.95	317.54	11.64	1.51	0.27	0.02
	EFF. (%)	65.40%	80.21%	89.67%	93.96%	99.27%	99.84%	99.95%	99.99%
121.7 min	UP	34645.72	17407.54	8860.21	5327.45	1625.15	944.02	565.44	131.07
60% total time	DOWN	11702.56	3442.56	940.30	336.53	13.24	1.77	0.28	0.02
	EFF. (%)	66.22%	80.22%	89.39%	93.68%	99.19%	99.81%	99.95%	99.99%
142.2 min	UP	34053.60	17294.16	8823.87	5301.18	1612.11	933.98	557.74	128.80
70% total time	DOWN	11322.27	3451.08	969.41	353.67	15.16	2.14	0.36	0.03
	EFF. (%)	66.75%	80.04%	89.01%	93.33%	99.06%	99.77%	99.93%	99.98%
162.6 min	UP	34204.25	17602.45	8983.00	5381.61	1629.66	940.69	561.59	131.43
80% total time	DOWN	11302.83	3678.70	1090.77	412.49	19.54	3.05	0.51	0.03
	EFF. (%)	66.95%	79.10%	87.86%	92.34%	98.80%	99.68%	99.91%	99.98%
183.1 min	UP	38007.25	19368.40	9611.57	5630.83	1647.24	946.76	564.65	130.61
90% total time	DOWN	15593.04	5691.04	1839.57	728.26	39.19	6.20	1.16	0.06
	EFF. (%)	58.97%	70.62%	80.86%	87.07%	97.62%	99.34%	99.79%	99.96%
203.5 min	UP	40106.04	20408.52	9971.82	5767.72	1636.23	938.91	561.24	130.20
100% total time	DOWN	17297.05	6630.05	2207.75	891.12	49.32	8.11	1.87	0.24
	EFF. (%)	56.87%	67.51%	77.86%	84.55%	96.99%	99.14%	99.67%	99.82%
	UP								
	DOWN								
	EFF. (%)								

P/N:	HF28202	**Test No.:**	MUL00737
ID:	FL15-2329	**Test Date:**	5/13/2016





P/N:	HF28202	**Test No.:**	MUL00737
ID:	FL15-2329	**Test Date:**	5/13/2016



Test No.:	MUL00736
Test Date:	5/12/2016
Operator:	T.P.

TEST CONTAMINANT

Type:	A-3
Batch No.:	11440M

FILTER AND ELEMENT IDENTIFICATION

P/N:	99193SOCN3-300-474-05	
Element ID:	FL15-2390	
Housing ID:	--	
Element Type:	Spin on	
Min. Element Bubble Point:	--	in. H2O
Bubble Point to ISO2942:	--	in. H2O
Wetting Fluid:	--	

TEST SYSTEM

Flow Rate:	8.2	GPM
Initial Volume:	30	L
Final Volume:	30	L

UPSTREAM CONCENTRATION

Base:	12.96	mg/L
80%:	9.80	mg/L

TEST FLUID

Type:	Shell	
Ref.:	AeroFluid 4	
Batch No.:	65475	
Viscosity:	15.00	cSt
Temperature:	100	°F
Anti-Static Type Added:	Stadis 450	
Conductivity:	1347	pS/m

DIFFERENTIAL PRESSURE DATA

Terminal Element:	19.00	psid
Filter Housing:	0.37	psid
Clean Assembly:	1.39	psid
Clean Element:	1.03	psid
Net:	17.97	psid

COUNTER CALIBRATION

Calibration Method:	ISO11943
Calibration Date:	10/12/2014

INJECTION SYSTEM

	Initial	Final	Average
Flow (L/min)	0.29	0.37	0.33
Concen. (mg/L)	1241	1218.78	1230

RETENTION CAPACITY

Injected:	81.28	grams
Retained:	80.71	grams

Counting System	Counter and Sensor Ref.	Flow Rate (mL/min)	
Upstream	Pamas	25	--
Downstream	Pamas	25	--

DIFFERENTIAL PRESSURE VERSUS CONTAMINANT ADDED

% Net Pressure	Test Time (min)	Element DP (psid)	Injected Mass (grams)
5%	104.3	1.92	42.34
10%	120.7	2.82	48.98
15%	129.9	3.72	52.72
20%	136.0	4.62	55.21
40%	154.4	8.22	62.68
80%	185.1	15.41	75.13
100%	202.1	19.00	82.02

EFFICIENCY DATA

	4.0 µm(b)	5.0 µm(b)	6.0 µm(b)	7.0 µm(b)	10.0 µm(b)	12.0 µm(b)	14.0 µm(b)	20.0 µm(b)
Max Efficiency (%)	99.3%	99.7%	99.9%	99.9%	100.0%	100.0%	100.0%	100.0%
Min Efficiency (%)	97.4%	99.2%	99.7%	99.8%	99.9%	99.9%	99.9%	99.9%
Avg. Efficiency (%)	98.4%	99.5%	99.8%	99.9%	99.9%	99.9%	99.9%	99.9%

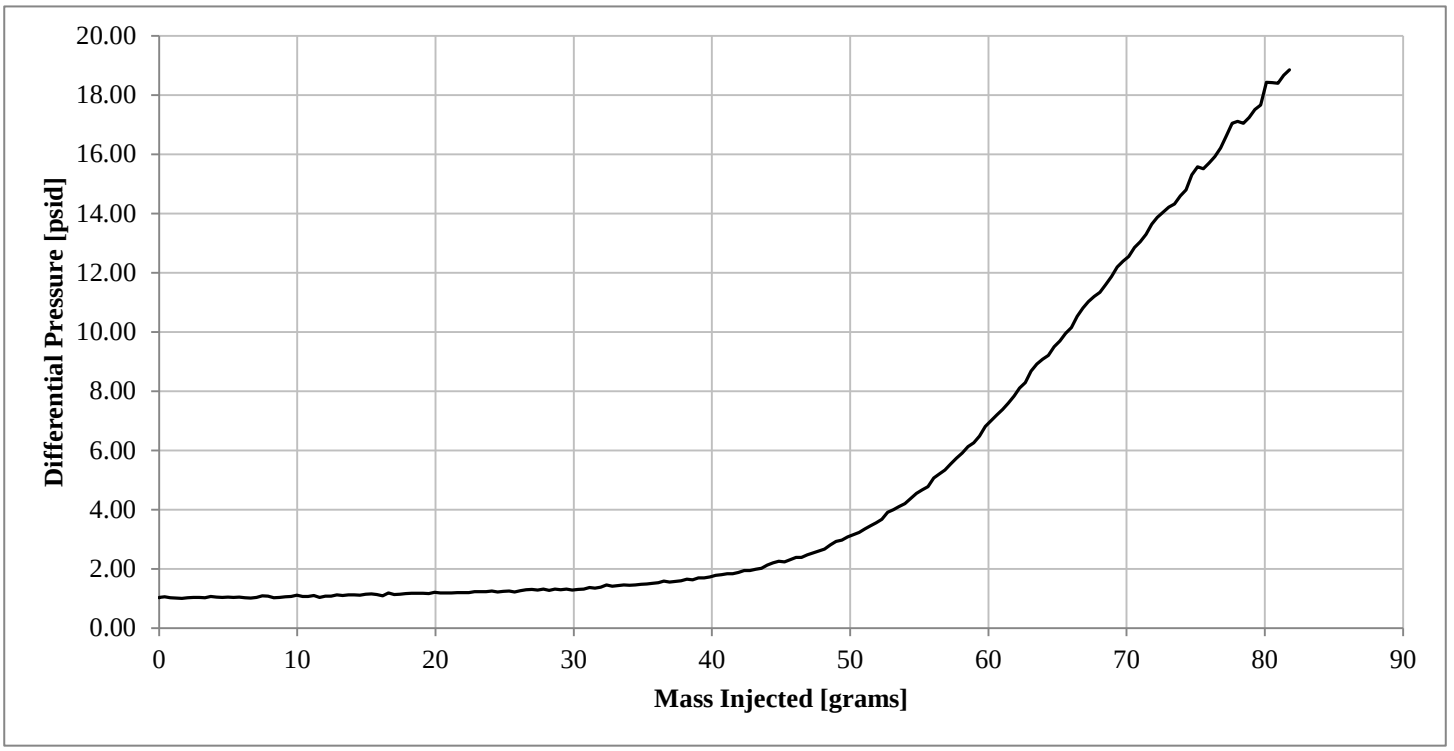
Efficiency (%)	50%	75%	90%	95%	99%
Particle Size µm(b)	--	--	--	--	5

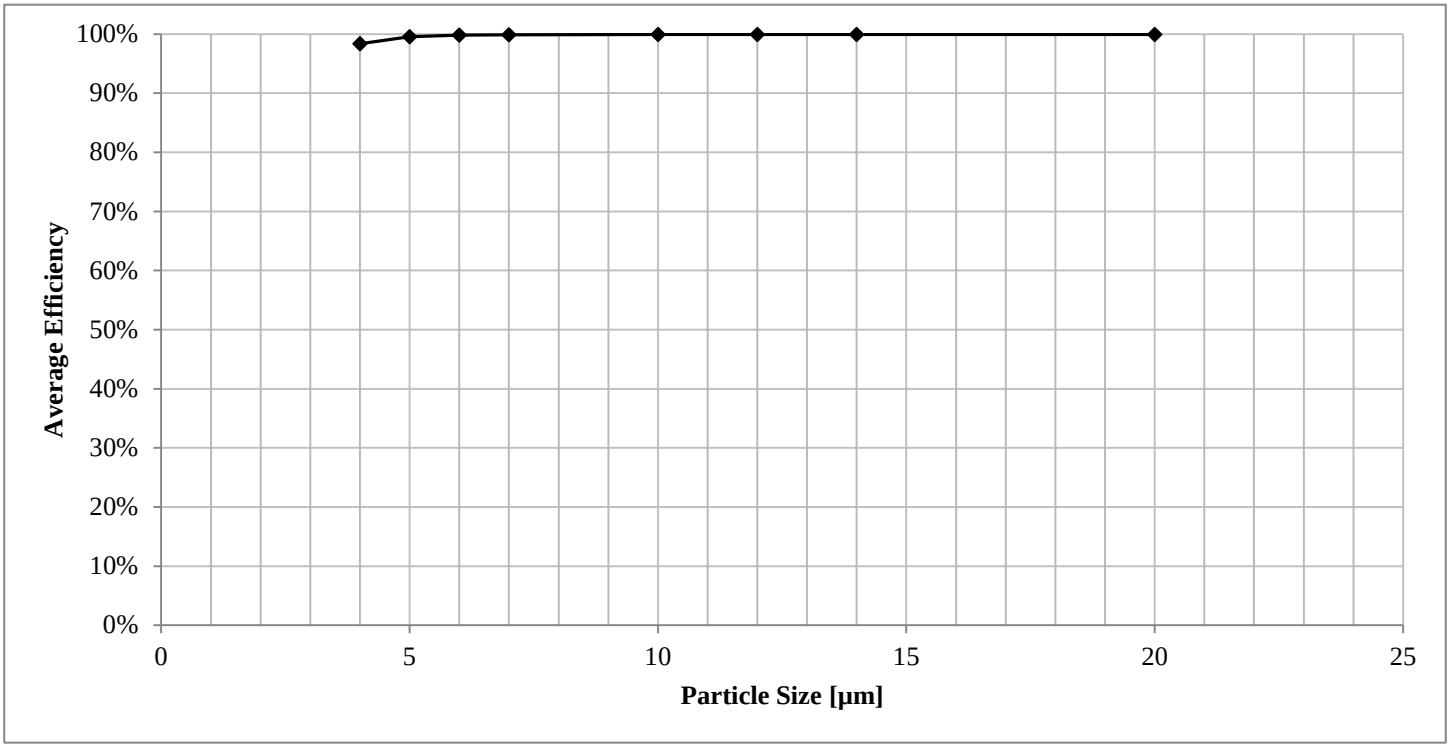
P/N:	99193SOCN3-300-474-05	**Test No.:**	MUL00736
ID:	FL15-2390	**Test Date:**	5/12/2016

PARTICLE DISTRIBUTION ANALYSIS (particles/mL)

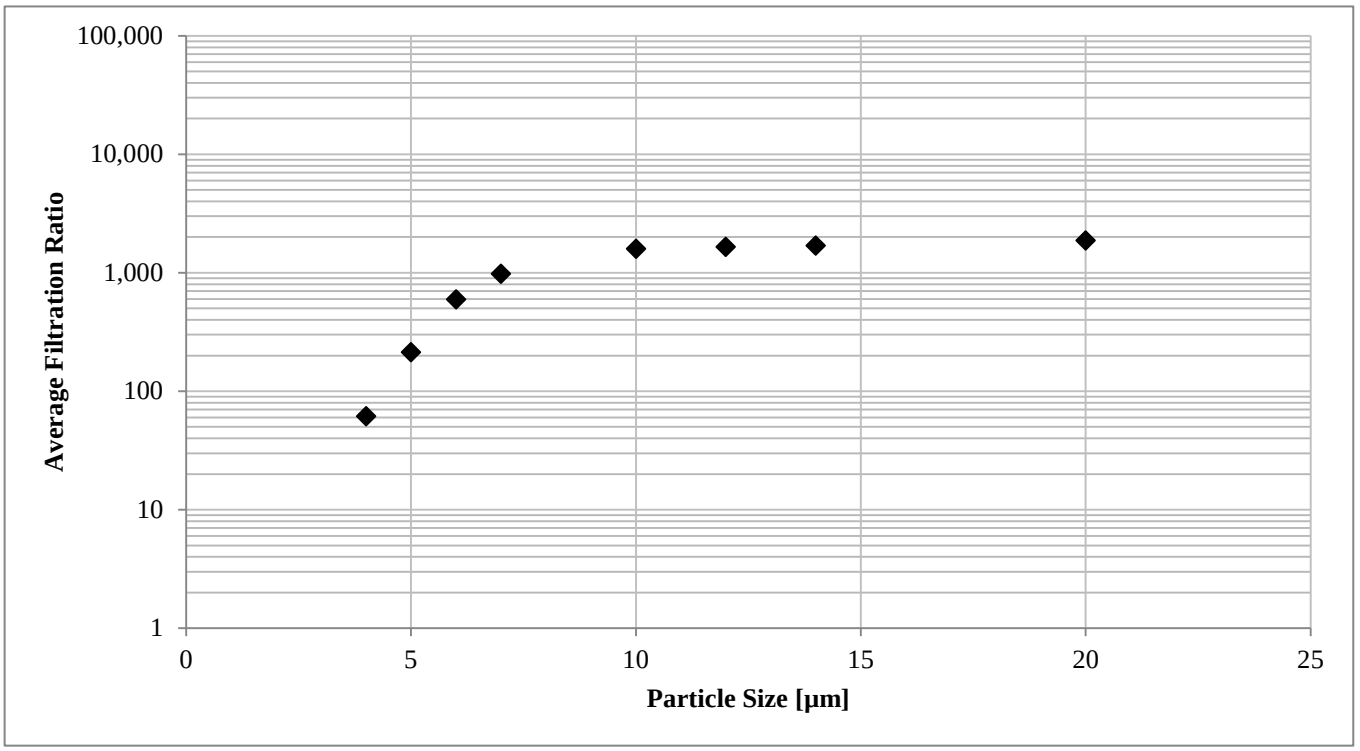
Sample Point		4.0 µm(b)	5.0 µm(b)	6.0 µm(b)	7.0 µm(b)	10.0 µm(b)	12.0 µm(b)	14.0 µm(b)	20.0 µm(b)
Initial	--	141.12	69.22	36.93	22.21	6.94	4.18	2.75	0.77
20.4 min	UP	20614.79	12400.71	7030.37	4434.95	1407.47	814.35	486.56	110.82
10% total time	DOWN	258.71	41.82	11.44	6.06	1.88	1.03	0.60	0.15
	EFF. (%)	98.75%	99.66%	99.84%	99.86%	99.87%	99.87%	99.88%	99.87%
39.9 min	UP	21219.95	12712.14	7207.18	4538.67	1439.25	835.47	498.67	113.16
20% total time	DOWN	316.52	42.96	8.04	3.05	0.65	0.34	0.20	0.02
	EFF. (%)	98.51%	99.66%	99.89%	99.93%	99.95%	99.96%	99.96%	99.98%
60.3 min	UP	21198.25	12662.57	7165.40	4517.84	1436.48	831.20	498.98	113.69
30% total time	DOWN	333.92	46.06	8.09	2.95	0.67	0.36	0.21	0.04
	EFF. (%)	98.42%	99.64%	99.89%	99.93%	99.95%	99.96%	99.96%	99.96%
80.8 min	UP	21569.02	12907.03	7310.21	4601.85	1457.69	849.61	509.42	117.31
40% total time	DOWN	337.31	46.18	7.50	2.69	0.58	0.32	0.22	0.01
	EFF. (%)	98.44%	99.64%	99.90%	99.94%	99.96%	99.96%	99.96%	99.99%
101.2 min	UP	21510.50	12867.08	7280.44	4584.21	1450.15	842.95	503.52	115.16
50% total time	DOWN	359.79	54.48	9.32	2.99	0.49	0.29	0.14	0.03
	EFF. (%)	98.33%	99.58%	99.87%	99.93%	99.97%	99.97%	99.97%	99.97%
120.7 min	UP	21774.83	12990.50	7333.79	4606.63	1462.39	850.00	508.61	116.51
60% total time	DOWN	498.87	86.20	15.51	5.18	0.59	0.36	0.22	0.05
	EFF. (%)	97.71%	99.34%	99.79%	99.89%	99.96%	99.96%	99.96%	99.95%
141.1 min	UP	22047.11	13094.47	7382.89	4647.19	1477.75	860.94	516.25	118.76
70% total time	DOWN	579.95	109.72	20.41	6.66	0.86	0.51	0.29	0.07
	EFF. (%)	97.37%	99.16%	99.72%	99.86%	99.94%	99.94%	99.94%	99.94%
160.6 min	UP	22128.79	13234.26	7470.50	4698.98	1491.88	869.81	522.94	120.47
80% total time	DOWN	433.61	88.20	19.57	7.34	1.24	0.61	0.33	0.08
	EFF. (%)	98.04%	99.33%	99.74%	99.84%	99.92%	99.93%	99.94%	99.93%
181 min	UP	22361.39	13428.94	7581.89	4773.45	1514.30	880.74	527.43	121.48
90% total time	DOWN	253.65	55.08	13.37	5.42	1.03	0.58	0.40	0.08
	EFF. (%)	98.87%	99.59%	99.82%	99.89%	99.93%	99.93%	99.92%	99.93%
201.5 min	UP	22539.54	13559.62	7665.08	4825.17	1536.23	892.94	537.84	124.79
100% total time	DOWN	160.73	37.84	10.54	4.96	1.17	0.73	0.41	0.09
	EFF. (%)	99.29%	99.72%	99.86%	99.90%	99.92%	99.92%	99.92%	99.93%
	UP								
	DOWN								
	EFF. (%)								

P/N:	99193SOCN3-300-474-05	**Test No.:**	MUL00736
ID:	FL15-2390	**Test Date:**	5/12/2016





P/N:	99193SOCN3-300-474-05	**Test No.:**	MUL00736
ID:	FL15-2390	**Test Date:**	5/12/2016



Test No.:	MUL00792
Test Date:	8/29/2016
Operator:	Tyler

FILTER AND ELEMENT IDENTIFICATION

P/N:	P569380	
Element ID:	FL15-2326	
Housing ID:	--	
Element Type:	Spin on	
Min. Element Bubble Point:	--	in. H2O
Bubble Point to ISO2942:	--	in. H2O
Wetting Fluid:	--	

TEST FLUID

Type:	Shell	
Ref.:	AeroFluid 4	
Batch No.:	65475	
Viscosity:	15.00	cSt
Temperature:	100	°F
Anti-Static Type Added:	Stadis 450	
Conductivity:	1470	pS/m

COUNTER CALIBRATION

Calibration Method:	ISO11943
Calibration Date:	8/1/2016

TEST CONTAMINANT

Type:	A-3
Batch No.:	11440M

TEST SYSTEM

Flow Rate:	8.2	GPM
Initial Volume:	30	L
Final Volume:	30	L

UPSTREAM CONCENTRATION

Base:	11.07	mg/L
80%:	15.00	mg/L

DIFFERENTIAL PRESSURE DATA

Terminal Element:	19.00	psid
Filter Housing:	1.28	psid
Clean Assembly:	4.58	psid
Clean Element:	3.31	psid
Net:	15.69	psid

INJECTION SYSTEM

	Initial	Final	Average
Flow (L/min)	0.33	0.25	0.29
Concen. (mg/L)	1140	1218.2	1179

RETENTION CAPACITY

Injected:	27.74	grams
Retained:	27.20	grams

Counting System	Counter and Sensor Ref.	Flow Rate (mL/min)
Upstream	Pamas	25
Downstream	Pamas	25

DIFFERENTIAL PRESSURE VERSUS CONTAMINANT ADDED

% Net Pressure	Test Time (min)	Element DP (psid)	Injected Mass (grams)
5%	27.6	4.09	9.44
10%	38.9	4.88	13.29
15%	47.1	5.66	16.09
20%	52.2	6.45	17.83
40%	66.5	9.58	22.73
80%	77.9	15.86	26.64
100%	80.7	19.00	27.60

EFFICIENCY DATA

	4.0 µm(b)	5.0 µm(b)	6.0 µm(b)	7.0 µm(b)	10.0 µm(b)	12.0 µm(b)	14.0 µm(b)	20.0 µm(b)
Max Efficiency (%)	98.8%	99.5%	99.7%	99.8%	99.9%	99.9%	99.9%	99.9%
Min Efficiency (%)	97.3%	98.6%	99.1%	99.2%	99.2%	99.0%	98.9%	98.7%
Avg. Efficiency (%)	98.3%	99.3%	99.6%	99.7%	99.8%	99.8%	99.8%	99.8%

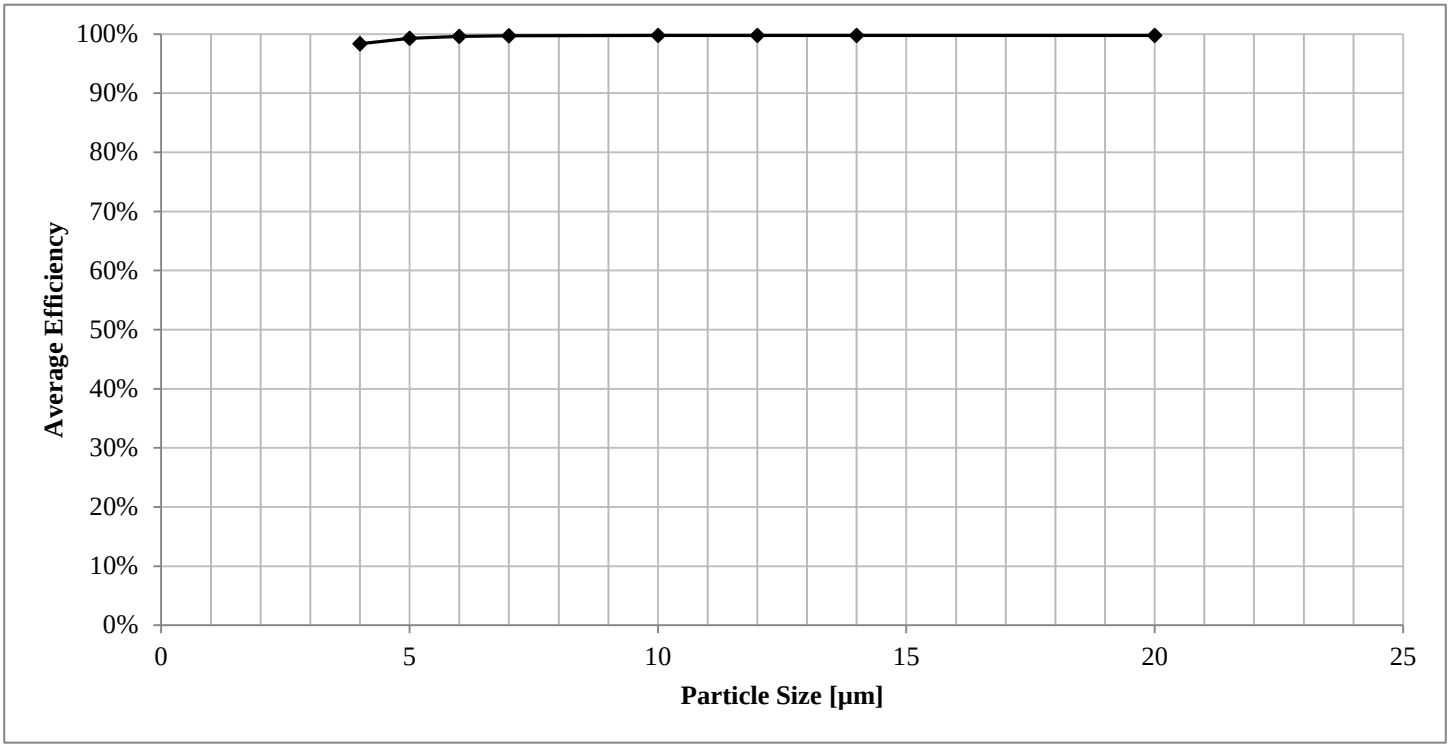
Efficiency (%)	50%	75%	90%	95%	99%
Particle Size µm(b)	--	--	--	--	5

P/N:	P569380	**Test No.:**	MUL00792
ID:	FL15-2326	**Test Date:**	8/29/2016

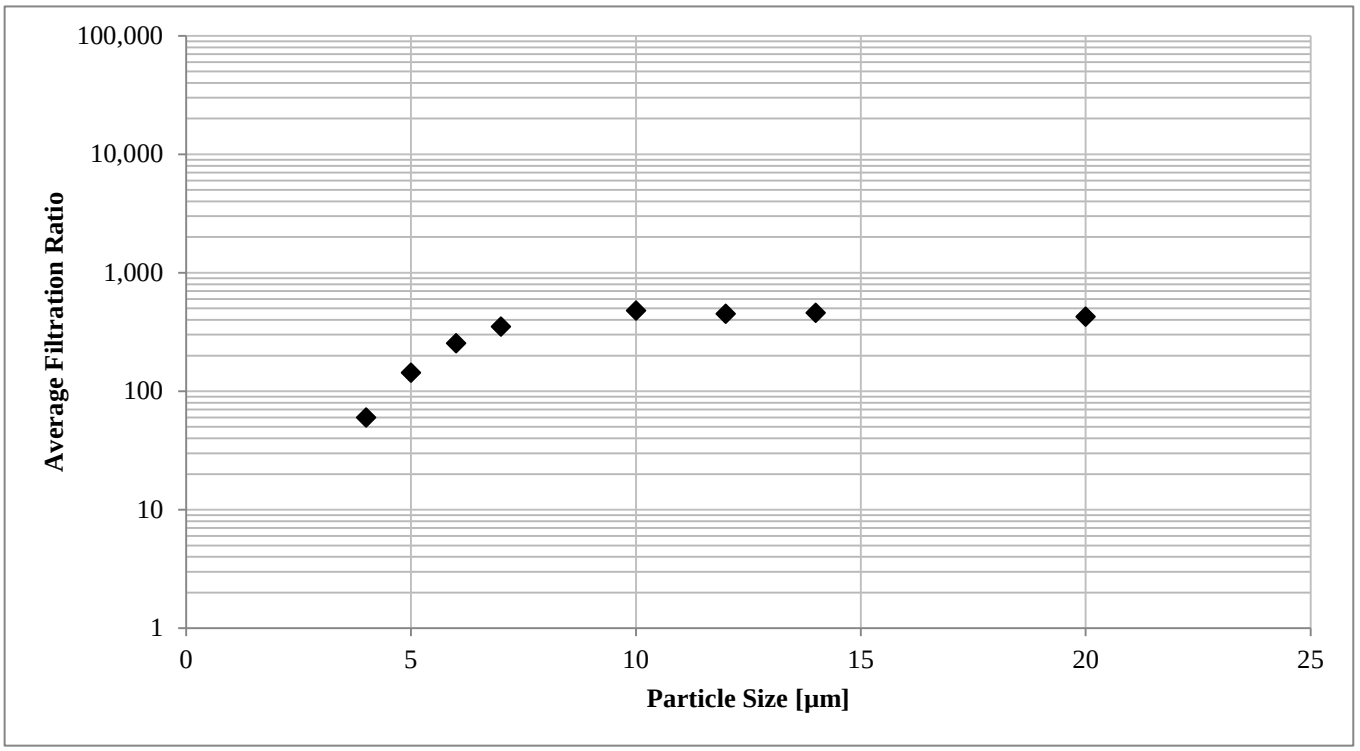
PARTICLE DISTRIBUTION ANALYSIS (particles/mL)

Sample Point		4.0 µm(b)	5.0 µm(b)	6.0 µm(b)	7.0 µm(b)	10.0 µm(b)	12.0 µm(b)	14.0 µm(b)	20.0 µm(b)
Initial	--	76.69	61.20	47.94	38.40	20.53	13.56	9.59	4.30
8.2 min	UP	13677.94	8793.97	5439.19	3684.21	1506.63	933.19	618.45	248.30
10% total time	DOWN	162.73	39.79	15.13	8.46	2.87	1.78	0.99	0.31
	EFF. (%)	98.81%	99.55%	99.72%	99.77%	99.81%	99.81%	99.84%	99.88%
16.4 min	UP	14300.55	9133.57	5594.47	3744.01	1472.30	884.20	569.28	208.16
20% total time	DOWN	201.54	46.80	15.92	7.73	2.13	1.22	0.65	0.16
	EFF. (%)	98.59%	99.49%	99.72%	99.79%	99.86%	99.86%	99.89%	99.92%
23.5 min	UP	14755.06	9443.68	5805.03	3898.76	1543.61	929.11	597.43	218.23
30% total time	DOWN	215.60	50.31	16.69	7.76	2.19	1.29	0.79	0.26
	EFF. (%)	98.54%	99.47%	99.71%	99.80%	99.86%	99.86%	99.87%	99.88%
31.7 min	UP	14320.91	9154.95	5616.95	3765.22	1486.96	895.69	576.87	209.46
40% total time	DOWN	215.74	51.28	15.96	7.42	1.94	1.12	0.65	0.20
	EFF. (%)	98.49%	99.44%	99.72%	99.80%	99.87%	99.88%	99.89%	99.91%
39.9 min	UP	14455.38	9249.01	5676.61	3807.72	1505.83	905.05	583.63	213.58
50% total time	DOWN	222.28	54.50	16.85	7.50	1.88	1.13	0.63	0.23
	EFF. (%)	98.46%	99.41%	99.70%	99.80%	99.87%	99.88%	99.89%	99.89%
48.1 min	UP	14389.17	9189.32	5628.06	3772.22	1490.47	898.42	576.72	210.27
60% total time	DOWN	232.39	58.91	18.76	7.84	1.63	0.89	0.47	0.16
	EFF. (%)	98.38%	99.36%	99.67%	99.79%	99.89%	99.90%	99.92%	99.92%
56.2 min	UP	14452.24	9247.48	5675.10	3810.04	1509.78	911.76	585.93	214.63
70% total time	DOWN	232.96	61.40	19.69	8.81	1.92	1.08	0.61	0.20
	EFF. (%)	98.39%	99.34%	99.65%	99.77%	99.87%	99.88%	99.90%	99.91%
64.4 min	UP	14452.56	9249.26	5673.34	3805.98	1507.97	908.98	582.50	212.35
80% total time	DOWN	246.21	67.86	22.13	9.63	2.02	1.14	0.62	0.23
	EFF. (%)	98.30%	99.27%	99.61%	99.75%	99.87%	99.87%	99.89%	99.89%
71.6 min	UP	14722.15	9406.66	5753.95	3849.27	1518.23	914.91	588.97	216.56
90% total time	DOWN	290.90	84.46	28.77	13.36	3.08	1.96	1.20	0.50
	EFF. (%)	98.02%	99.10%	99.50%	99.65%	99.80%	99.79%	99.80%	99.77%
80 min	UP	13972.69	8901.53	5442.66	3647.95	1445.29	870.07	559.42	205.45
100% total time	DOWN	371.22	121.99	50.35	28.11	11.22	8.29	5.91	2.70
	EFF. (%)	97.34%	98.63%	99.07%	99.23%	99.22%	99.05%	98.94%	98.69%
	UP								
	DOWN								
	EFF. (%)								

P/N:	P569380	**Test No.:**	MUL00792
ID:	FL15-2326	**Test Date:**	8/29/2016



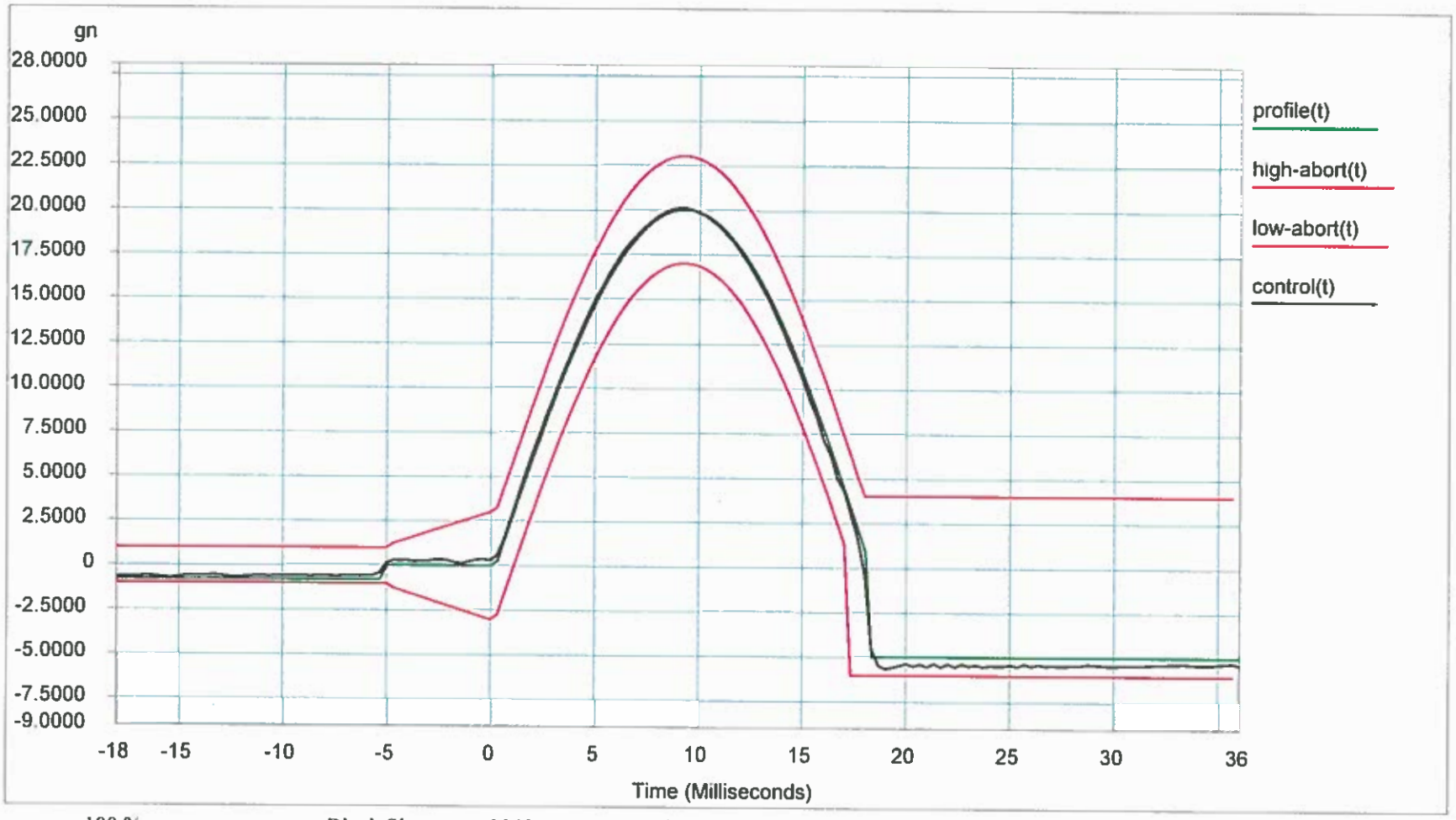
P/N:	P569380	**Test No.:**	MUL00792
ID:	FL15-2326	**Test Date:**	8/29/2016



APPENDIX B.

Shock Test Data Sheets

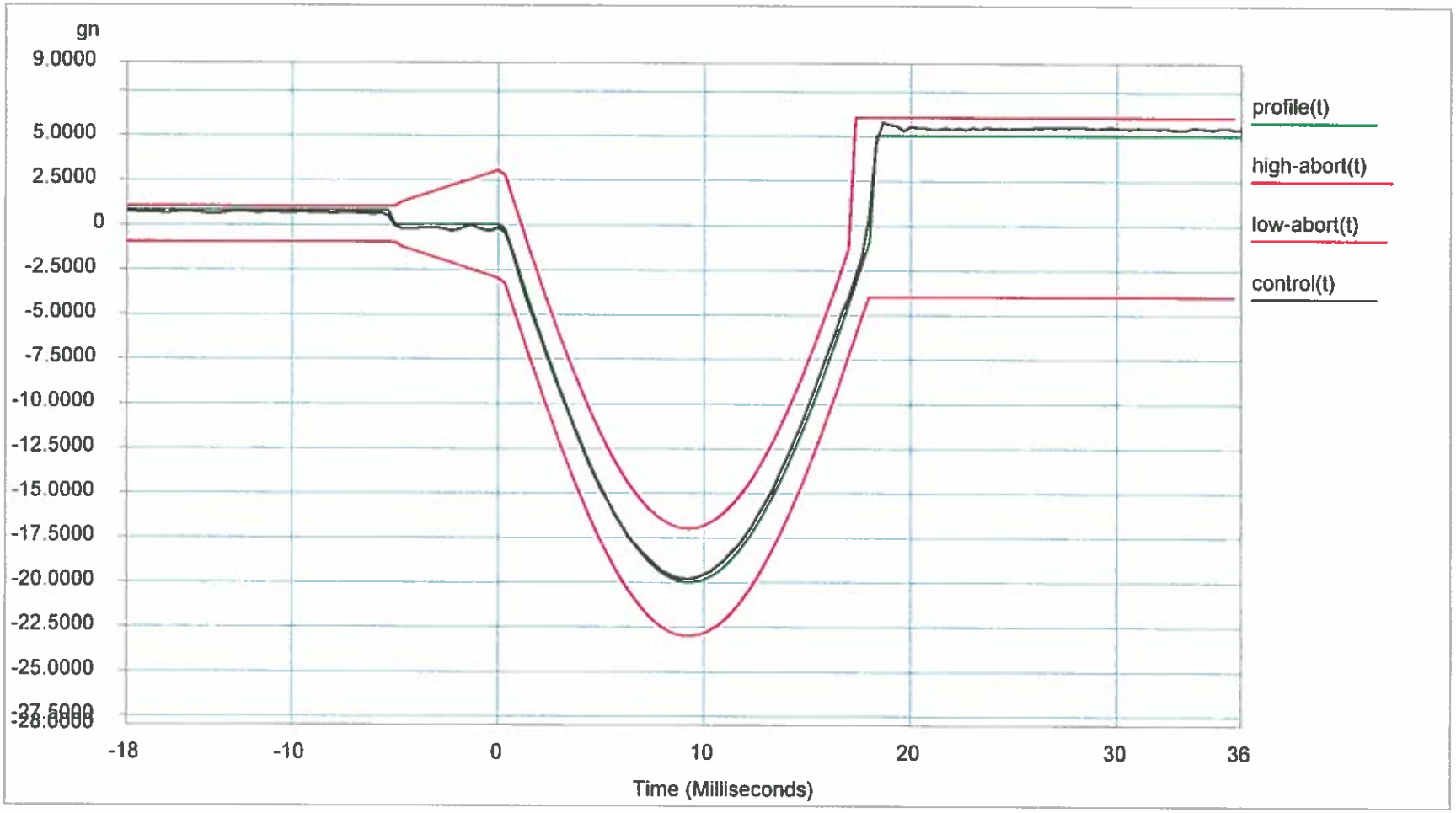
DUT: Donaldson 569380
Axis: Z (axial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 14-26-28



Level:	100 %	Block Size:	2048	Elapsed Pulses:	18	
Frame Time:	0.682667 Seconds	Control Peak:	20.084103	Control RMS:	2.858875	Full Level Elapsed Pulses: 3
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses: 10
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms	

Data saved at 02:27:09 PM, Thursday, September 22, 2016 Report created at 02:27:10 PM, Thursday, September 22, 2016

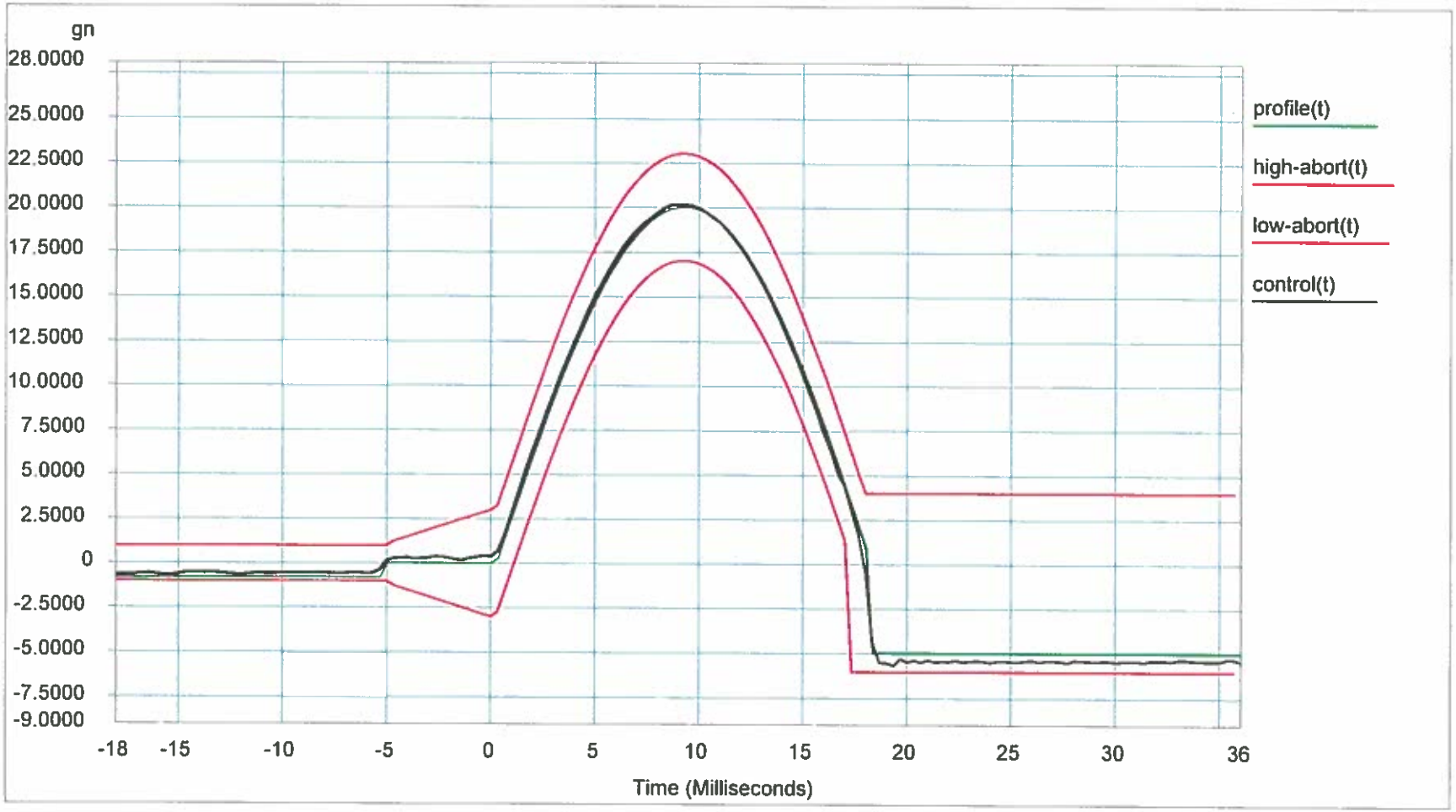
DUT: Donaldson 569380
Axis: Z (axial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 14-26-28



Level:	100 %	Block Size:	2048	Elapsed Pulses:	28		
Frame Time:	0.682667 Seconds	Control Peak:	19.830194	Control RMS:	2.845844	Full Level Elapsed Pulses:	6
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms		

Data saved at 02:27:29 PM, Thursday, September 22, 2016 Report created at 02:27:30 PM, Thursday, September 22, 2016

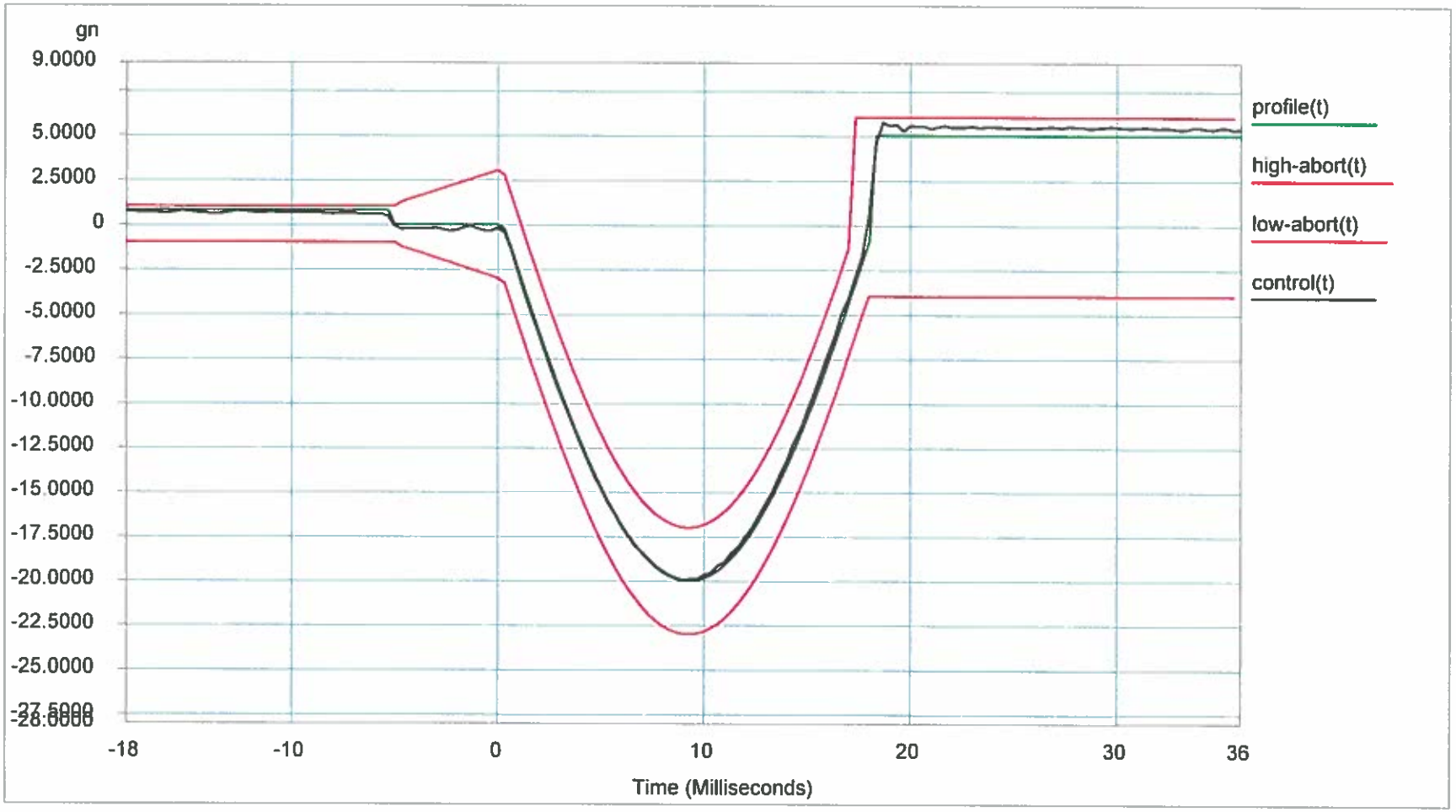
DUT: Donaldson 569380
Axis: X (radial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 14-53-52



Level:	100 %	Block Size:	2048	Elapsed Pulses:	19		
Frame Time:	0.682667 Seconds	Control Peak:	20.107185	Control RMS:	2.870490	Full Level Elapsed Pulses:	3
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses:	10
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms		

Data saved at 02:54:34 PM, Thursday, September 22, 2016 Report created at 02:54:34 PM, Thursday, September 22, 2016

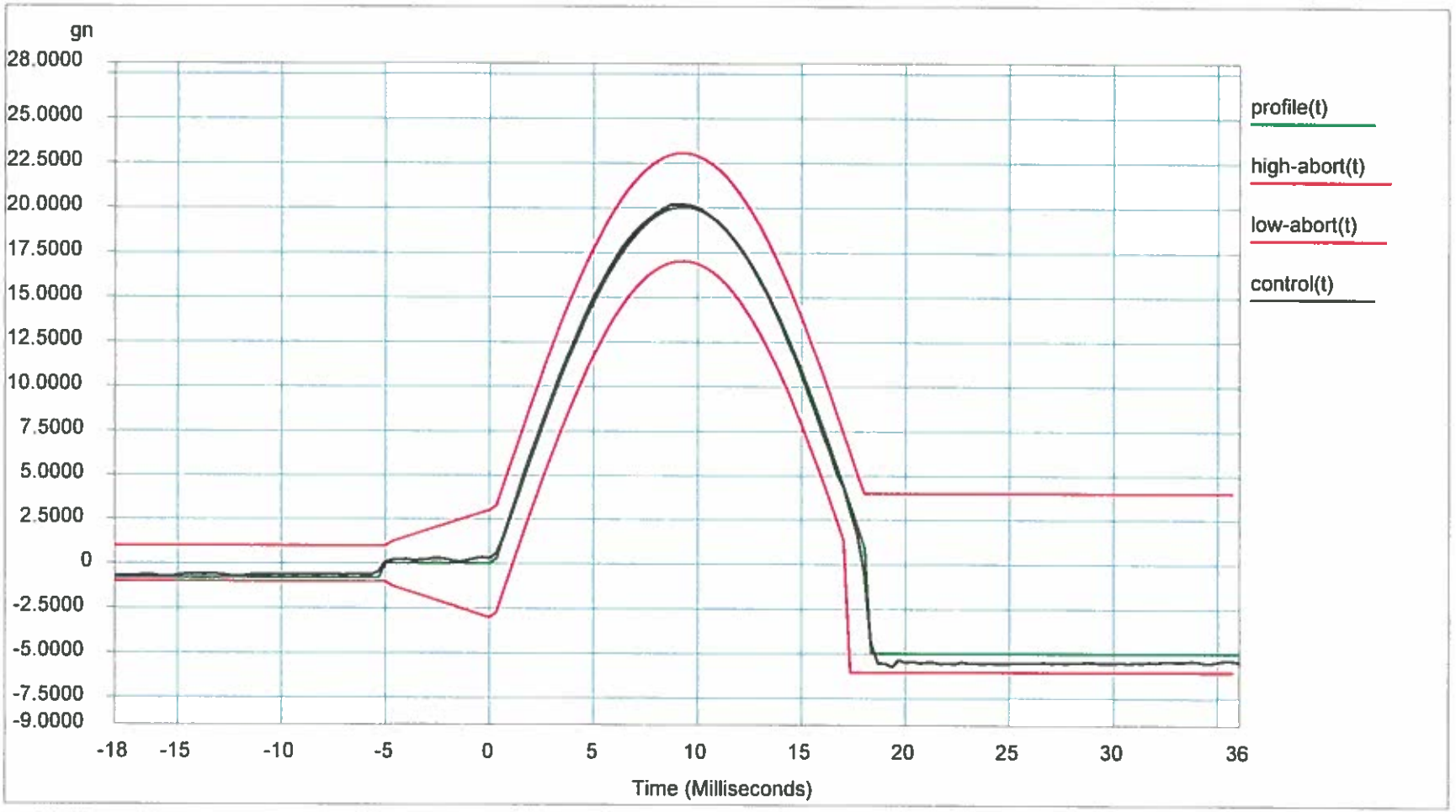
DUT: Donaldson 569380
Axis: X (radial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 14-53-52



Level:	100 %	Block Size:	2048	Elapsed Pulses:	29		
Frame Time:	0.682667 Seconds	Control Peak:	19.967964	Control RMS:	2.863493	Full Level Elapsed Pulses:	6
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms		

Data saved at 02:54:54 PM, Thursday, September 22, 2016 Report created at 02:54:54 PM, Thursday, September 22, 2016

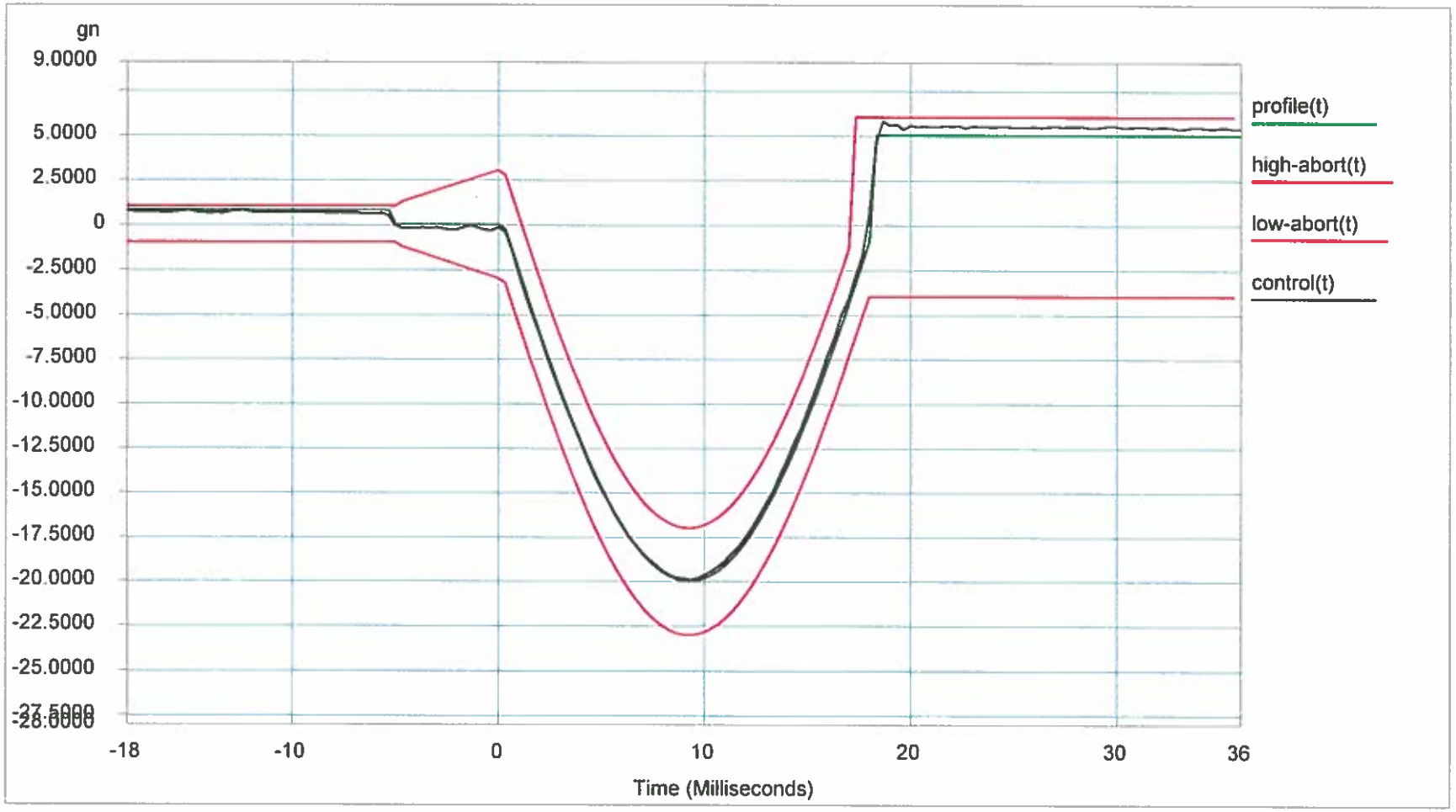
DUT: Donaldson 569380
Axis: Y (radial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 14-59-15



Level:	100 %	Block Size:	2048	Elapsed Pulses:	19		
Frame Time:	0.682667 Seconds	Control Peak:	20.123434	Control RMS:	2.875806	Full Level Elapsed Pulses:	3
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses:	10
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms		

Data saved at 02:59:57 PM, Thursday, September 22, 2016 Report created at 02:59:58 PM, Thursday, September 22, 2016

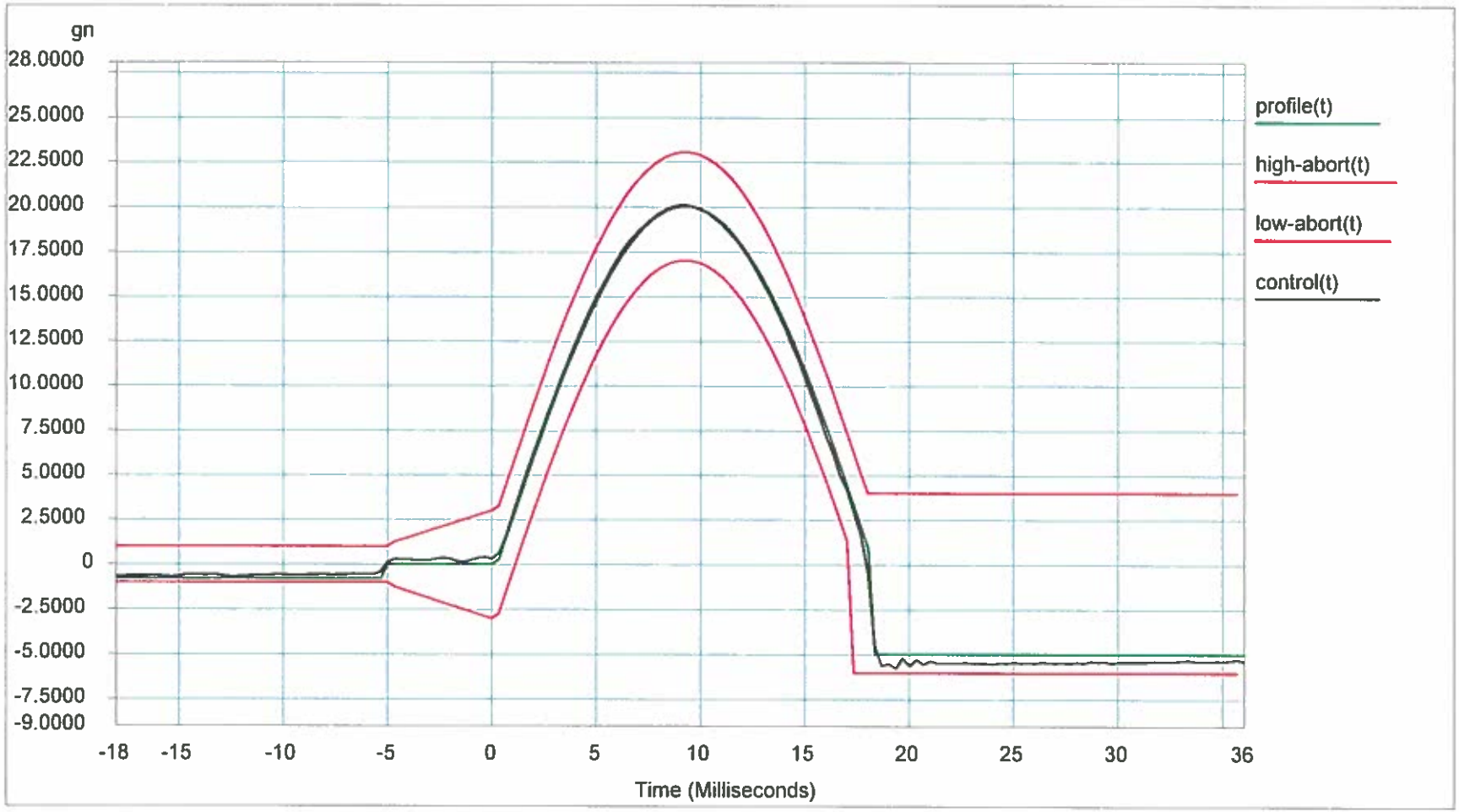
DUT: Donaldson 569380
Axis: Y (radial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 14-59-15



Level:	100 %	Block Size:	2048	Elapsed Pulses:	29		
Frame Time:	0.682667 Seconds	Control Peak:	19.940605	Control RMS:	2.862298	Full Level Elapsed Pulses:	6
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms		

Data saved at 03:00:17 PM, Thursday, September 22, 2016 Report created at 03:00:18 PM, Thursday, September 22, 2016

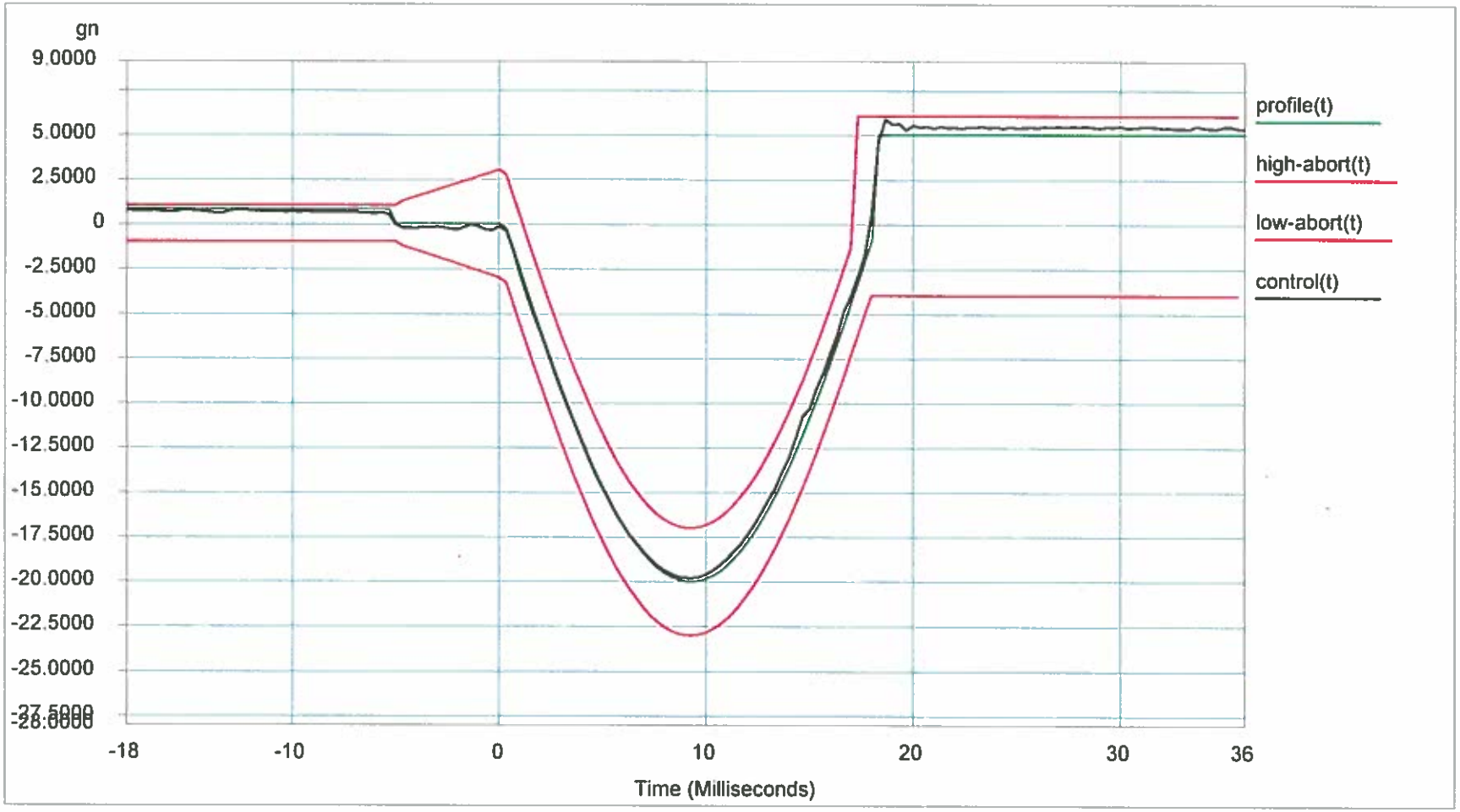
DUT: Fleetguard HF28202
Axis: Z (axial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 13-57-38



Level:	100 %	Block Size:	2048	Elapsed Pulses:	18		
Frame Time:	0.682667 Seconds	Control Peak:	20.045460	Control RMS:	2.857537	Full Level Elapsed Pulses:	3
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses:	10
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms		

Data saved at 01:58:18 PM, Thursday, September 22, 2016 Report created at 01:58:19 PM, Thursday, September 22, 2016

DUT: Fleetguard HF28202
Axis: Z (axial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 13-57-38



Level:	100 %	Block Size:	2048	Elapsed Pulses:	28		
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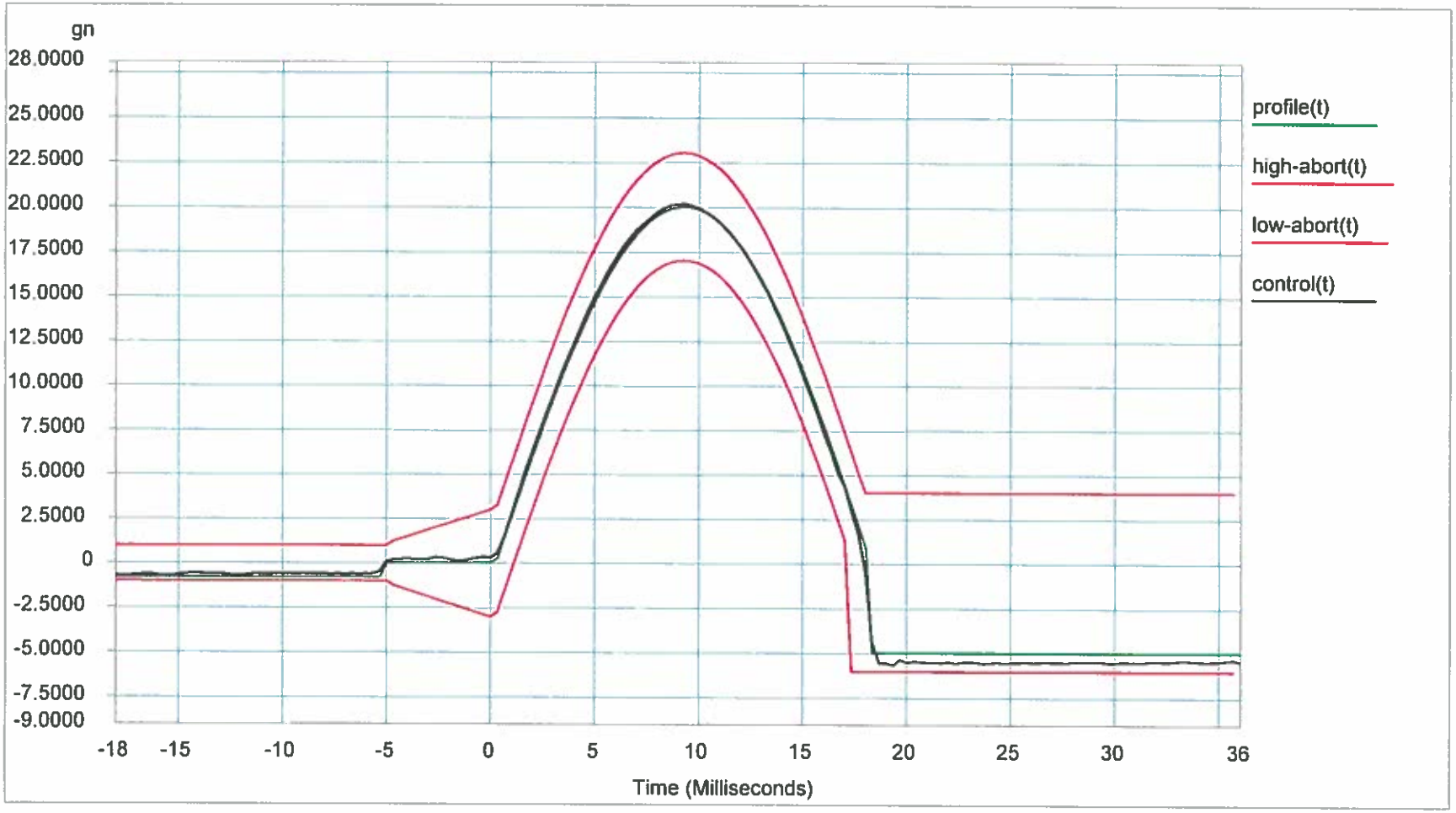
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms		

Data saved at 01:58:38 PM, Thursday, September 22, 2016 Report created at 01:58:38 PM, Thursday, September 22, 2016

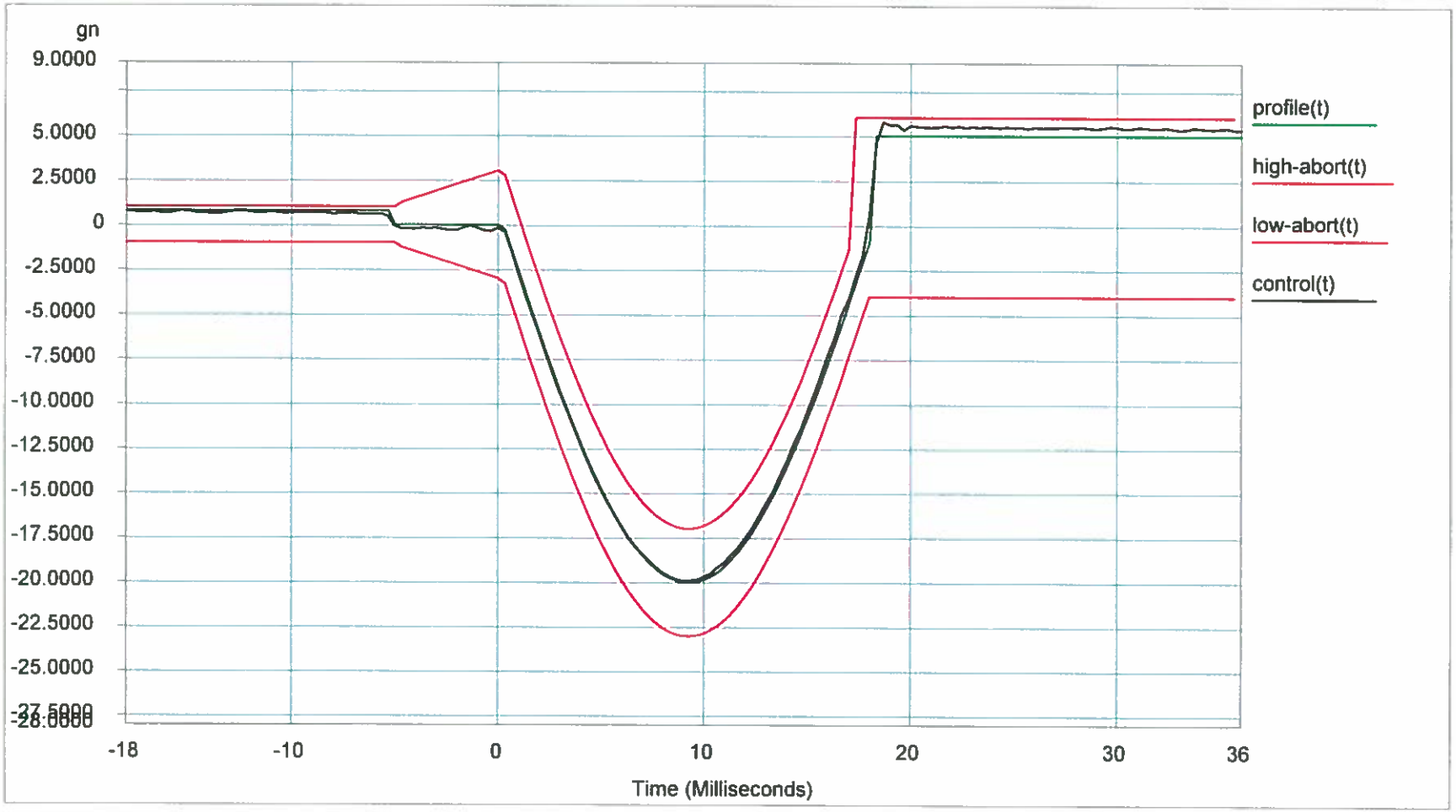
DUT: Fleetguard 569380
Axis: X (radial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 15-11-14



Level:	100 %	Block Size:	2048	Elapsed Pulses:	19		
Frame Time:	0.682667 Seconds	Control Peak:	20.155060	Control RMS:	2.875046	Full Level Elapsed Pulses:	3
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses:	10
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms		

Data saved at 03:11:56 PM, Thursday, September 22, 2016 Report created at 03:11:58 PM, Thursday, September 22, 2016

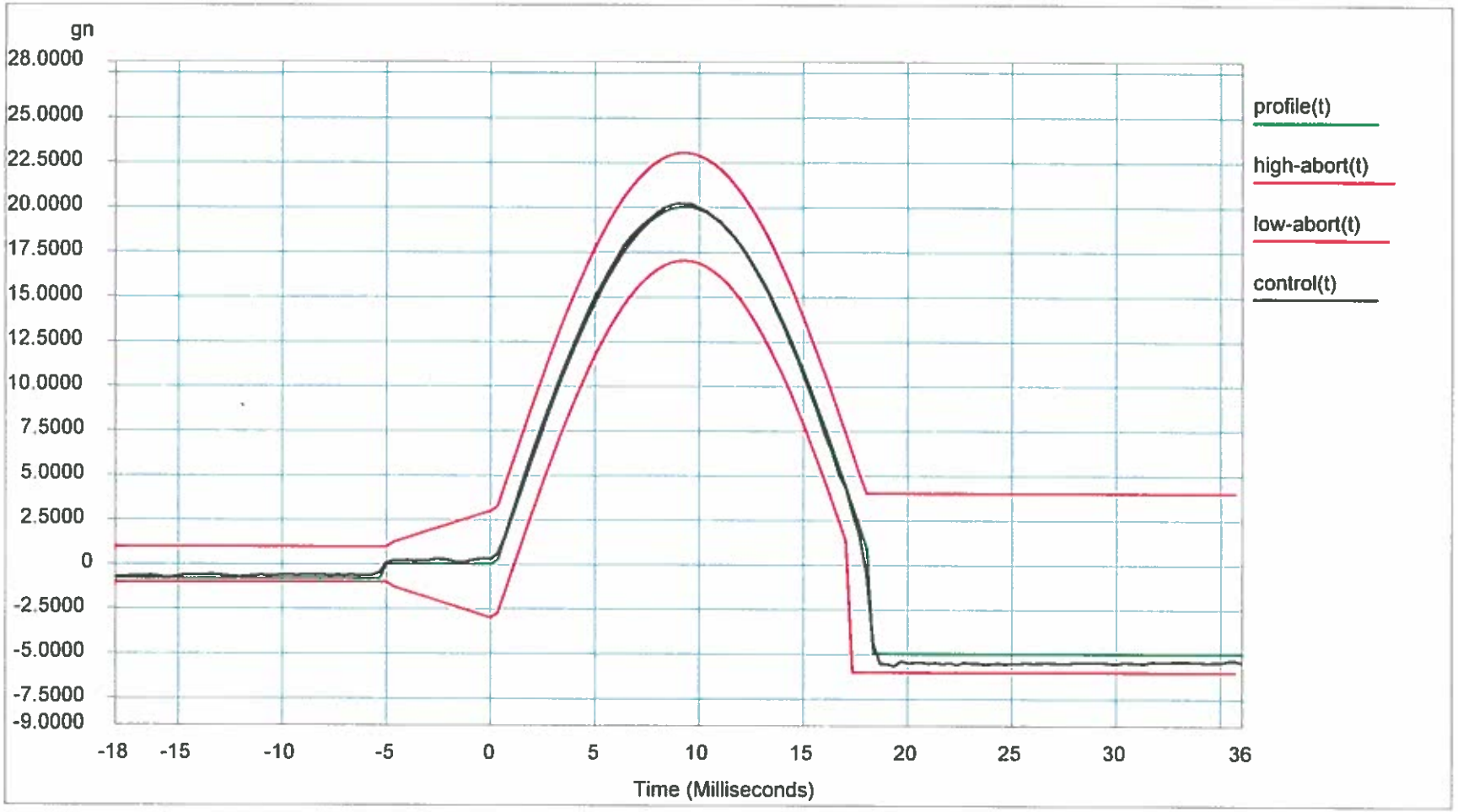
DUT: Fleetguard 569380
Axis: X (radial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 15-11-14



Level:	100 %	Block Size:	2048	Elapsed Pulses:	29		
Frame Time:	0.682667 Seconds	Control Peak:	19.921360	Control RMS:	2.862304	Full Level Elapsed Pulses:	6
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms		

Data saved at 03:12:16 PM, Thursday, September 22, 2016 Report created at 03:12:17 PM, Thursday, September 22, 2016

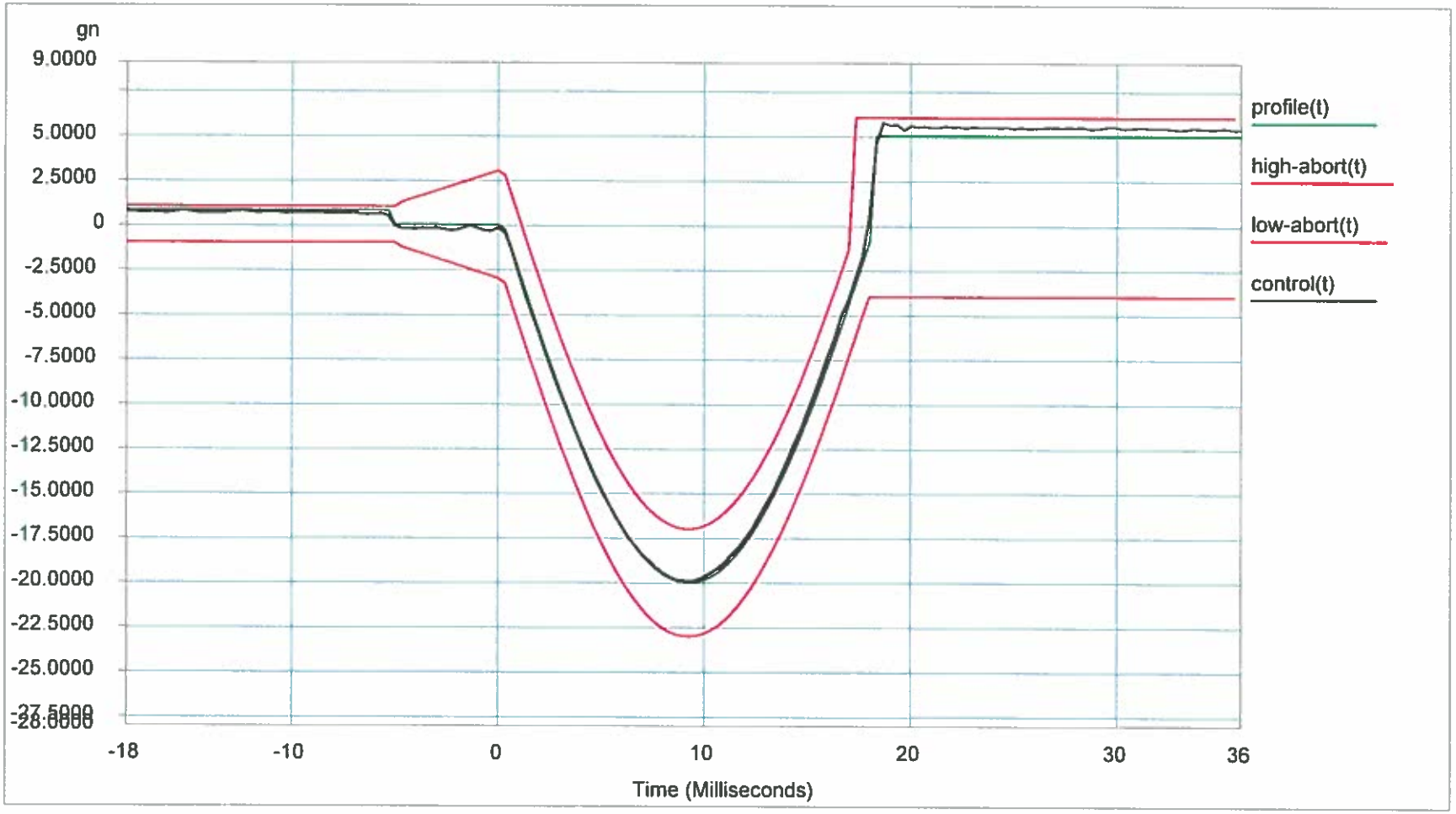
DUT: Fleetguard 569380
Axis: Y (radial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 15-16-11



Level:	100 %	Block Size:	2048	Elapsed Pulses:	19	
Frame Time:	0.682667 Seconds	Control Peak:	20.161377	Control RMS:	2.875444	Full Level Elapsed Pulses: 3
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses: 10
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms	

Data saved at 03:16:52 PM, Thursday, September 22, 2016 Report created at 03:16:53 PM, Thursday, September 22, 2016

DUT: Fleetguard 569380
Axis: Y (radial)
Project File Name: Untitled
Profile Name: 5gn 11mSec Test Type: Classical Shock Run Folder: .\RunDefault Sep 22, 2016 15-16-11



Level:	100 %	Block Size:	2048	Elapsed Pulses:	29		
Frame Time:	0.682667 Seconds	Control Peak:	19.939596	Control RMS:	2.862139	Full Level Elapsed Pulses:	6
dT:	0.000333 Seconds	Demand Peak:	20.000000	Demand RMS:	2.829574	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	20.000000	Pulse Width:	18.000000 ms		

Data saved at 03:17:12 PM, Thursday, September 22, 2016 Report created at 03:17:13 PM, Thursday, September 22, 2016