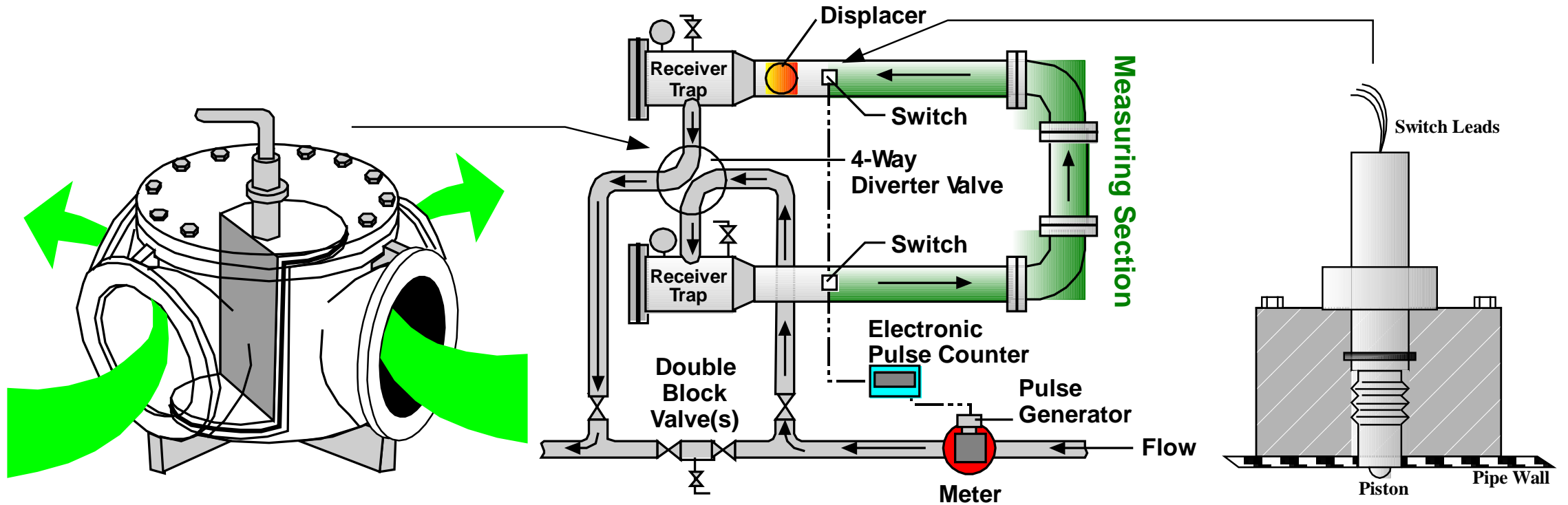
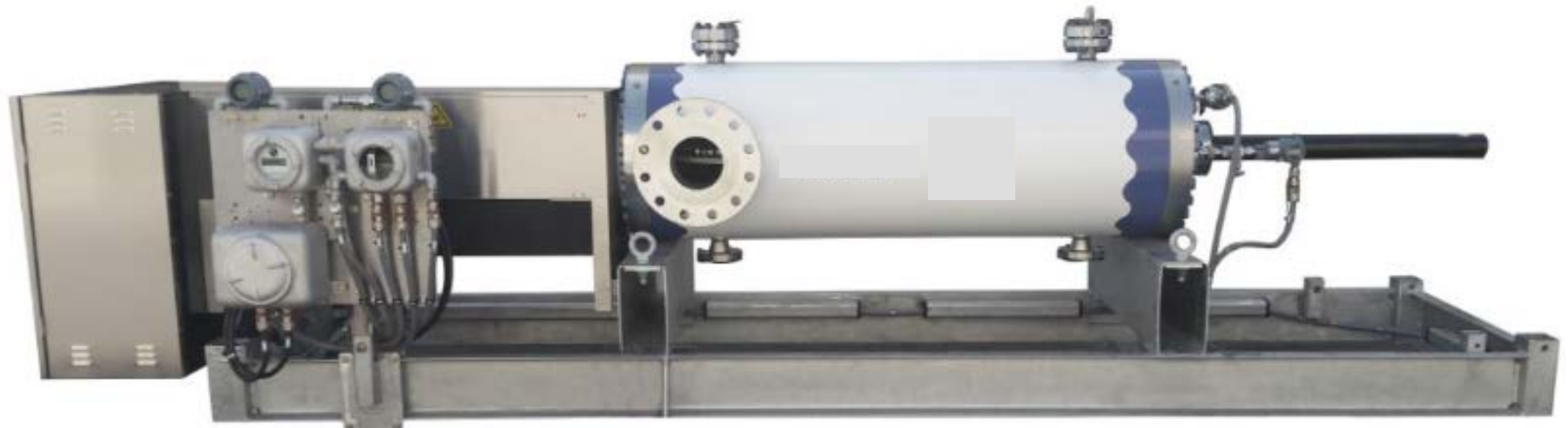

Captive Displacers

SWMA – October 2021

Prover: Bi-Directional

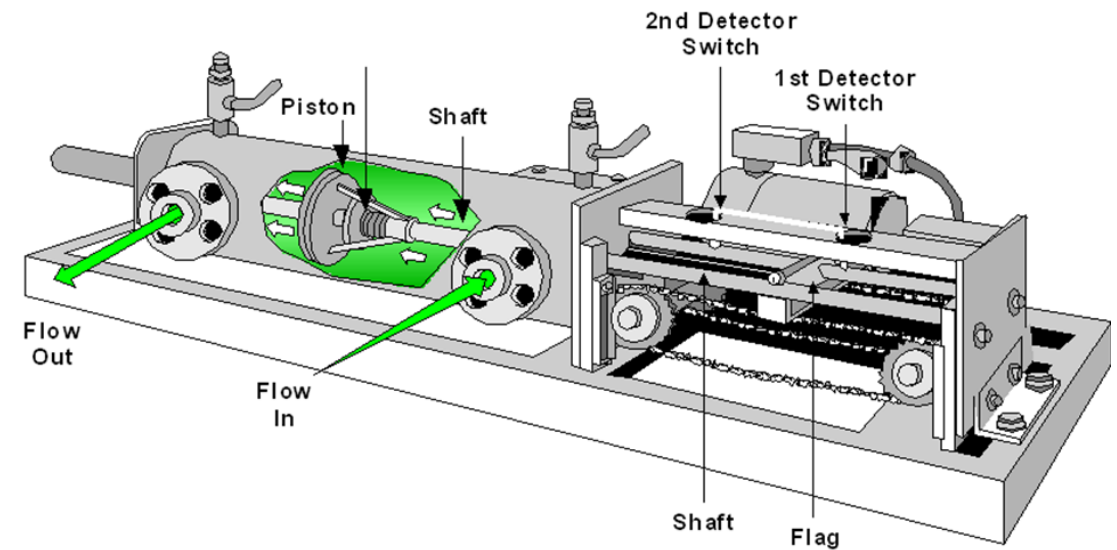
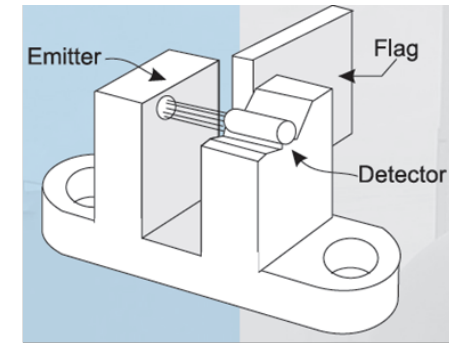


Prover: Captive Displacer



Prover: Captive Displacer

- Uses a piston attached to a rod rather than a sphere as a displacer
- Small in size
- Mechanically actuated drive
- Optical switches



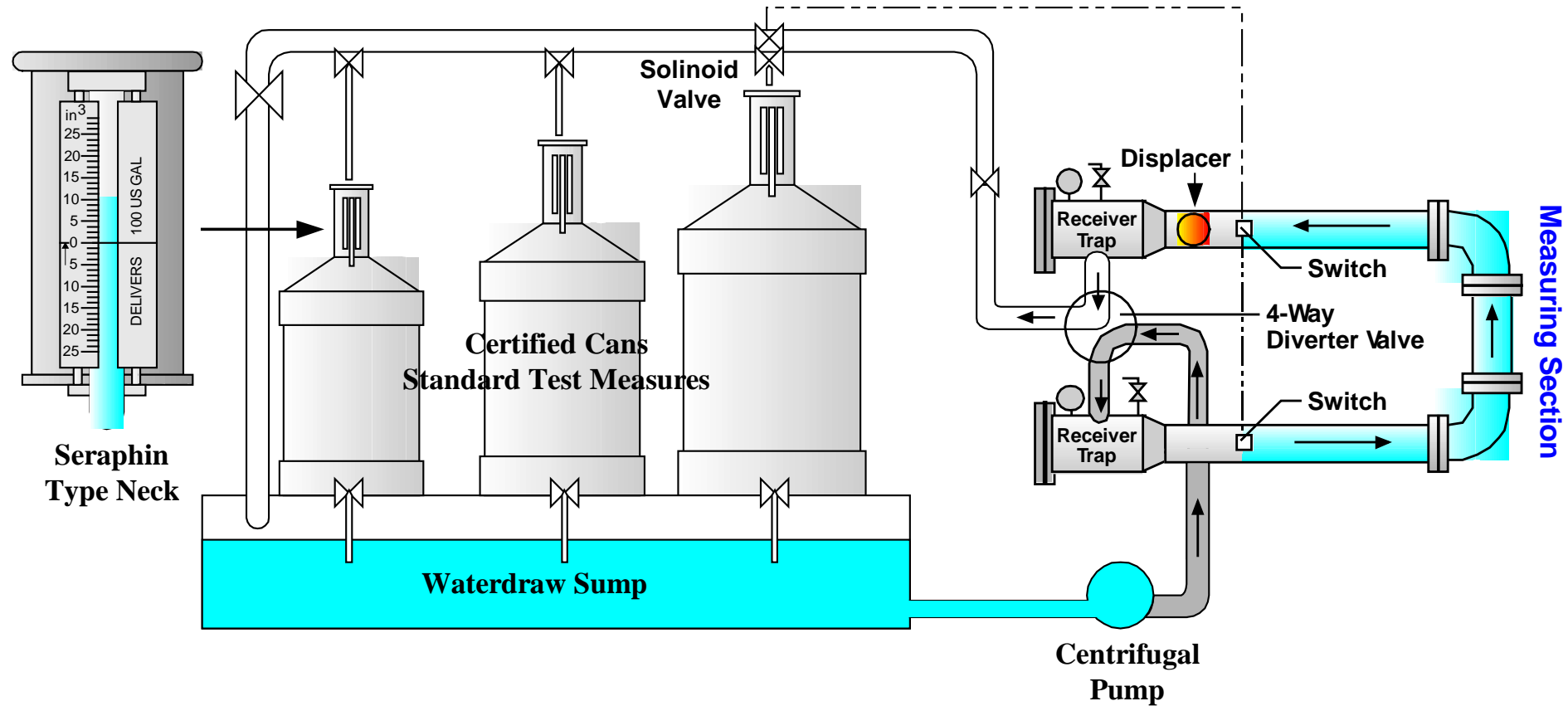
Prover: Calibration

Existing provers require re-calibration:

- Every 5 years for stationary provers
- Every 3 years for portable provers



Prover: Calibration via Water Draw



Prover: Calibration Certificate

- Issued by 3rd party calibration company
- Internally verified to industry standard calculations
- Shows tractability to NIST
- Provides the final base prover volume

Waterdraw Calibration Report

Date: APRIL 12, [REDACTED] Location: [REDACTED]
Owner: [REDACTED] Certificate No: [REDACTED]
Prover Type: 20.000" Bi-Dir. Wall .375 Manufacturer: [REDACTED]
Service Location: [REDACTED] Prover Serial No: [REDACTED]
Pipeline Re: [REDACTED] Service I.D. [REDACTED]

This is to certify that using water as the calibration medium, the above subject prover was calibrated by the waterdraw method, in accordance with the procedures outlined in API Chapters 4.2, 4.3, 4.4, 11.23, and 12.2. The calibrated volume at standard conditions has been determined to be:

490,393.2656 Cubic Inches @ 60 degrees F & O PSIG
2,122.91 U.S. Gallons @ 60 degrees F & O PSIG

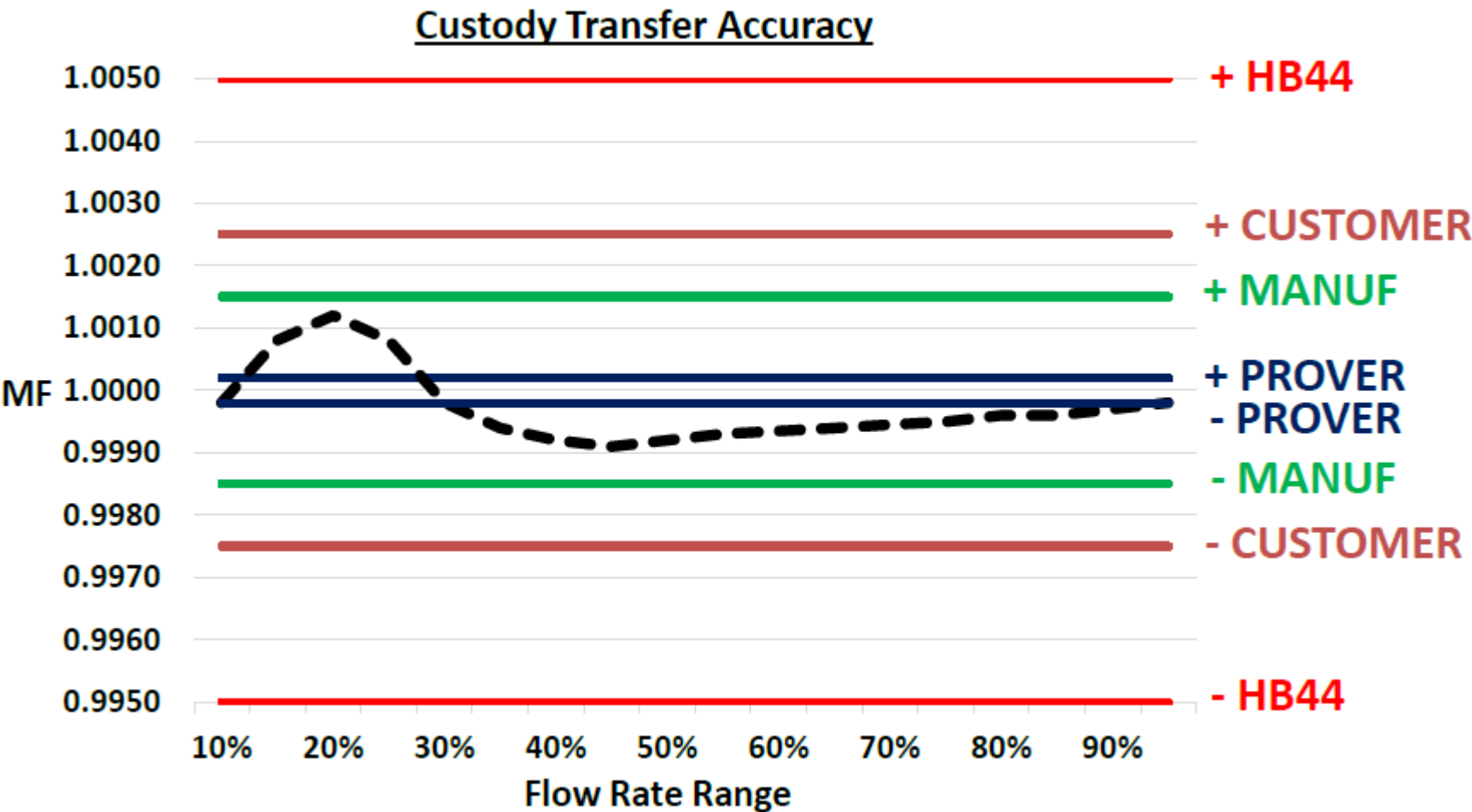
50.5456 Barrels @ 60 degrees F & O PSIG

The test measures used to obtain the above volumes were calibrated by the National Institute of Standards and Technology (NIST) and are listed as follows:

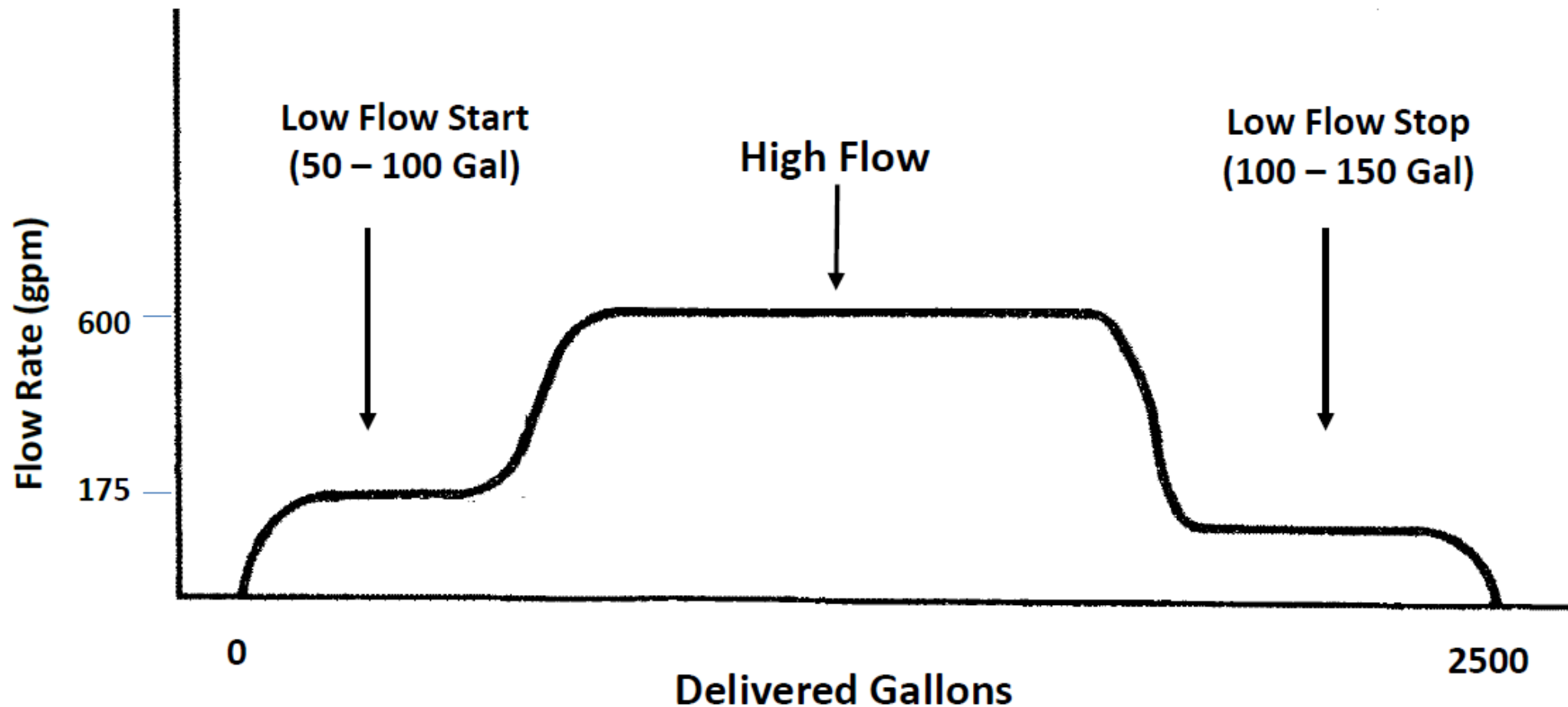
NIST NO. 7285	NIST NO. 7280	NIST NO. 7275
[REDACTED]	NIST NO.	NIST NO.
		Certified Thermometer: 4Y1408/4Y1412
		Certified Guage No. 140512011-041-001

Certified by: [REDACTED]

Flow Meter Performance Curve



Typical Truck Filling Delivery Sequence

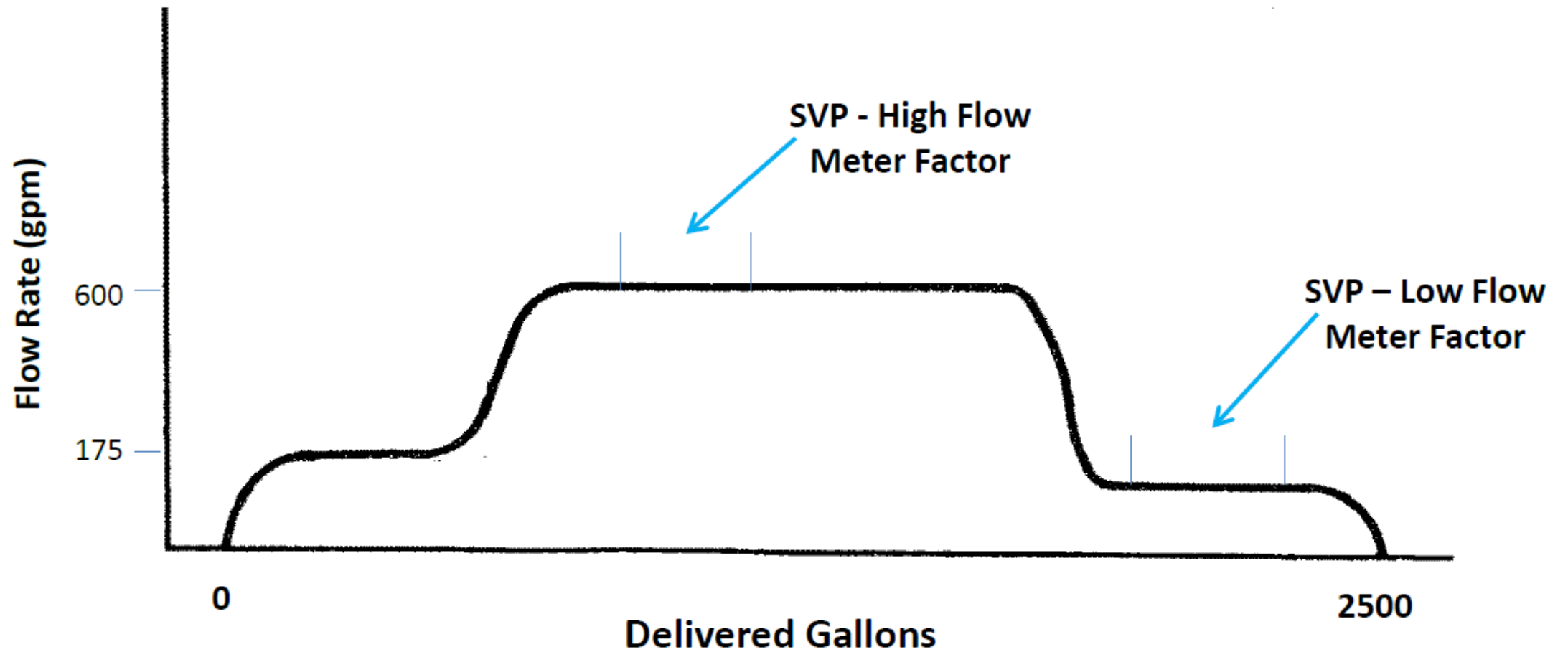


Meter Factor from Tank Prover

1200 Gallons Tank Prover		
	Fill Stage Volume	Percent of Prover Capacity
Low Flow Start	50	4.16%
High Flow	1100	91.66%
Low Flow Stop	50	4.16%
Meter Factor	1.0004	

2500 Gallons Truck Compartment		
	Fill Stage Volume	Percent of Truck Capacity
Low Flow Start	50	2.00%
High Flow	2400	96.00%
Low Flow Stop	50	2.00%
Meter Factor	1.0004?	

Prove High and Low Flow



Proving Report Examples

Proving

Meter: STO_14_REG_HI - 14 Regular High
Field Location:
Reason:
Date Performed: 5/24/2017 7:36:57AM

Identification

Customer: Operator: Federal ID:

Meter

Characteristics

Brand: Nominal K-Factor: 50.0000 N/gal
Model: Nominal Size: 4.00 in
Serial: Passes Per Run: 1
Proving Mode: Volumetric Temp. Compensated: No
MF Calc. Method: Avg. Data Factor Interface: PIU
Track Factor: Composite MF Density Mode: Manual

Proving Acceptance Criteria

Repeatability: 0.050 % - Historical Deviation -
Consistency Req.: 5 out of 6 Perform Check: Yes
- Prior Deviation - No, Prev. Factors: 5
Perform Check: Yes Max Deviation: 0.25 %
Max Deviation: 0.25 % Historical Cutoff: 09/08/2010
Prior Cutoff: No Product Dependent: Yes
Product Dependent: Yes Use Failed Proving: No
Use Failed Proving: No

Prover/Proving

Prover

Prover Class: Displacement Area Coeff. (Ga): 1.92E-51/F
Displacer: Piston Elasticity: 2.8E7psi
Brand: Linear Coeff. (G): 9.6E-61/F
Serial: Upstream BPV: 20.0065gal
Pipe ID: 14.000 in Cert. Date: 05/02/2017
Pipe Thickness: 1.450 in

Product Data

Product: Regular
Product Table: Table B - Refined Products (1980)
Hydro. Correction: Yes
Density: 59.6 °API
@ Temperature: 60.0 °F
@ Pressure: 0.0 psi
Equil. Vapor Pres.: 0.0 psig
Base Density: 59.6 °API

Proving

		Run Data							
Run No.	Accepted	Tp (°F)	Tm (°F)	Pp (psig)	Pm (psig)	Td (°F)	Ni	FlowRate	IMF
1	Yes	73.7	74.8	27.5	44.9	65.8	1001.221	524.991	1.00004
2	Yes	74.7	75.5	27.6	44.8	65.8	1001.122	524.060	0.99996
3	Yes	75.0	75.7	27.6	44.9	65.8	1001.108	524.152	0.99990
4	Yes	75.3	75.9	27.6	44.8	65.8	1001.098	523.845	0.99985
5	Yes	75.5	76.0	27.6	44.8	65.8	1001.100	523.871	0.99979
Average		74.9	75.6	27.6	44.8	65.8	1001.1298	524.184	0.99991

Results

- Meter - - Prover - - Factors -
Nm: 1001.1298 CTSp: 1.00034 MF: 0.9999 Repeatability: 0.012%
Ivm: 20.0226 CPSP: 1.00001 CMF: 1.0003 Uncertainty: 0.013%
CTLm: 0.98934 CTLp: 0.98982 MA: 1.0001 Passed: Yes
CPLm: 1.00036 CPLp: 1.00022 KF: 50.005 Status:
CCFm: 0.98970 CCFp: 0.99038 CKF: 49.985
ISVm: 19.8164 GSVp: 19.8140 CPLo: 1.0004

Historical Data

	Task ID	Date	Product	Flow Rate	Totalizer	Throughput	Base Dens	Repeatability	CMF	CMF Dev
Previous	1486525576	02/07/2017 13:46	Regular	596 gal/min	34.69442	4086974	64.1 °API	0.010 %	1.0000	-0.0008
Current	1495658217	05/24/2017 07:36	Regular	524 gal/min	37343093	3173651	59.6 °API	0.012 %	1.0003	0.0003

Notes

Proving

Meter: STO_12_ULSD_HI - 12 Diesel High
Field Location:
Reason:
Date Performed: 5/23/2017 7:30:39AM

Identification

Customer: Operator: Federal ID:

Meter

Characteristics

Brand: Nominal K-Factor: 50.0000 N/gal
Model: Nominal Size: 4.00 in
Serial: Passes Per Run: 1
Proving Mode: Volumetric Temp. Compensated: No
MF Calc. Method: Avg. Data Factor Interface: PIU
Track Factor: Composite MF Density Mode: Manual

Proving Acceptance Criteria

Repeatability: 0.050 % - Historical Deviation -
Consistency Req.: 5 out of 6 Perform Check: Yes
- Prior Deviation - No, Prev. Factors: 5
Perform Check: Yes Max Deviation: 0.25 %
Max Deviation: 0.25 % Historical Cutoff: 09/08/2010
Prior Cutoff: No Product Dependent: Yes
Product Dependent: Yes Use Failed Proving: No
Use Failed Proving: No

Prover/Proving

Prover

Prover Class: Displacement Area Coeff. (Ga): 1.92E-51/F
Displacer: Piston Elasticity: 2.8E7psi
Brand: Linear Coeff. (G): 9.6E-61/F
Serial: Upstream BPV: 20.0065gal
Pipe ID: 14.000 in Cert. Date: 05/02/2017
Pipe Thickness: 1.450 in

Product Data

Product: Diesel
Product Table: Table B - Refined Products (1980)
Hydro. Correction: Yes
Density: 39.3 °API
@ Temperature: 60.0 °F
@ Pressure: 0.0 psi
Equil. Vapor Pres.: 0.0 psig
Base Density: 39.3 °API

Proving

		Run Data							
Run No.	Accepted	Tp (°F)	Tm (°F)	Pp (psig)	Pm (psig)	Td (°F)	Ni	FlowRate	IMF
1	Yes	76.6	76.8	20.6	69.0	69.7	1003.425	534.048	0.99716
2	Yes	76.7	76.8	20.5	68.7	69.7	1003.414	533.669	0.99712
3	Yes	76.8	76.7	20.6	68.7	69.7	1003.251	533.135	0.99720
4	Yes	76.8	76.7	20.5	68.8	69.7	1003.390	532.723	0.99706
5	Yes	76.8	76.7	20.7	68.9	69.7	1003.361	532.720	0.99709
Average		76.7	76.8	20.6	68.8	69.7	1003.3682	533.259	0.99713

Results

- Meter - - Prover - - Factors -
Nm: 1003.3682 CTSp: 1.00041 MF: 0.9972 Repeatability: 0.017%
Ivm: 20.0674 CPSP: 1.00001 CMF: 0.9975 Uncertainty: 0.007%
CTLm: 0.99188 CTLp: 0.99193 MA: 1.0028 Passed: Yes
CPLm: 1.00039 CPLp: 1.00012 KF: 50.140 Status:
CCFm: 0.99227 CCFp: 0.99247 CKF: 50.123
ISVm: 19.9123 GSVp: 19.8559 CPLo: 1.0003

Historical Data

	Task ID	Date	Product	Flow Rate	Totalizer	Throughput	Base Dens	Repeatability	CMF	CMF Dev
Previous	1486503116	02/07/2017 07:31	Diesel	561 gal/min	15366682	665492	39.5 °API	0.013 %	0.9969	0.0002
Current	1495571439	05/23/2017 07:30	Diesel	533 gal/min	17419568	2052886	39.3 °API	0.017 %	0.9975	0.0006

Notes