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Small Volume Prover (SVP) Proving Reports

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This is the fifth and final article in the series of articles on SVPs. Previous articles covered all phases of small volume provers from definitions and terminology to the operating procedures for the use of SVPs when testing loading rack meters. However, knowing terminology or how to determine the mathematical meter error is not enough for the inspector to perform his job correctly. The professional weights and measures inspector must also understand the data contained in an SVP proving report. All five articles are located on the NIST WMD website at www.nist.gov/owm for reference and review. On the WMD website under "Publications," click on "Weights and Measures Newsletter Quarterly Archive," and then click on "Field Standards."

Data contained in SVP proving reports may affect the accuracy of the determination of meter error and two sample proving reports will be examined later. There are various software programs in use in industry, and thus SVP proving reports may vary depending on the software used. As noted in the fourth article of the series, in Section II of "Operating Procedures for the Use of SVPs when Testing Loading Rack Meter," the operator is responsible for the set-up of the SVP. This includes entering the data into the computer.

SVP Proving Reports

Information such as the prover operator, business name and the location of the meter under test is entered into the computer and recorded on the reports. The fluid type and density, type and manufacturer of the SVP, and meter information are also entered into the computer. If this information is incorrect, it can affect the accuracy of the results. As such, weights and measures inspectors should be familiar with the information in an SVP report and verify its accuracy. The information below provides an overview of data that may affect the accuracy of the results if it is incorrect. At the end of this article are two sample reports. For guidance in interpreting the data on these reports, sections of the reports are numbered to correspond to the descriptive paragraphs below.

Section 1. Fluid Data

The operator may select the fluid type from a master list which is included in the software and grouped according to the API tables for petroleum fluid types. The proving report will show the type of fluid tested along with other temperature and density information. The selection of the proper fluid type is important because fluid densities may vary and an error in the density may affect the calculations. If products other than petroleum products are being dispensed through the meter under test, the inspector should be sure to verify that appropriate tables/density information is used.

Section 2. Prover Data – Manufacturer Identification and SVP Specifications.

This section of the report includes information regarding the manufacturer of the SVP, the prover type, the upstream and downstream volume (sometimes referred to as the Base Prover Volume or BPV, which is the water draw volume), the pipe inner diameter, the

pipe wall thickness, water draw/calibration date and due date, prover material (when selected, the cubical expansion and elasticity of the prover material may be calculated automatically with some software), and switch bar material. The electrical switches/detectors, as described in Part 2 of this Series, are located on a switch bar. Detectors are used to start and stop the counters and determine the calibrated section of the prover. The effects of temperature on the switch bar can affect the accuracy of the device and must be taken into account. General prover data may be documented in the specifications section of the SVP operation/maintenance manual. Specific information, such as the base volume at the time of the last water draw, normally can be found on the certificate of calibration or associated worksheets and should be used to verify that the correct information is in the computer.

Section 3. Proving Data

Depending on the software used and set-up selections, the operator may be able to manually enter the switch bar temperature, prover pressure and temperature, and meter pressure and temperature, or this information may be recorded automatically from the pressure and temperature sensors in the system. This information, along with prover data from Section 2, is used to correct for the effects of temperature and pressure on the prover and meter volumes and, as noted above, to correct for the temperature effects on the switch bar. This information is located on the proving report under “Proving Data” in both sample reports.

Section 4. Density

Depending on the software, the density of the fluid is manually entered or automatically entered by the software using available data tables. In the examples provided, density is recorded under the “Fluid Data” on Sample Report 1 and under the “Proving Data” on Sample Report 2.

Section 5. Meter Data

This section includes the location, station name and number, the manufacturer, and/or the meter base K-factor. The meter base K-factor, as described in Part 3 of this Series, establishes a relationship between the pulses generated by the meter and the volume shown on the indicator; it is the number of pulses generated by a meter while a unit of volume is passing through it. The meter base K-factor is recorded on the proving report under “Meter Data” In both sample reports. Sample Report 2 contains a subheading for “Meter Data” under “Proving Data” where the meter base K-factor is recorded. Sample Report 1 uses the term nominal K-factor (NKF) for the meter base K-Factor.

Section 6. Repeatability Tolerance

NIST Handbook (HB) 44 repeatability tolerance would be applied to multiple runs by comparing the meter factor from each run.

Section 7. Run Results and Temperature and Pressure Readings

The results of the individual runs are recorded on the proving report which will typically include the number of pulses for each run. Temperature and pressure readings are also recorded on the proving report, which are used to correct the prover and meter volumes.

Section 8. Corrected Prover Volume and Corrected Meter Volume
The prover volume and meter volume are corrected for temperature and pressure. The calculations for the corrected prover volume and corrected meter volume are included in both sample reports.

Section 9. Meter Factor
The meter factor as explained in Part 3 of this Series is the corrected prover volume divided by the corrected meter volume. This value is included under "Proving Data" for both sample reports and is used to calculate the percent meter error, which is also explained in Part 3. The weights and measures official should compare the percent meter error to the NIST HB 44 percent tolerances to determine compliance. Typically this information would be considered "as found" data, as it is common practice for service technicians to program the average meter factor from the runs into the register, thereby adjusting the meter error to approximately zero.

Section 10. Number of Passes Per Run
As noted in Part 4 of this Series, some documented procedures have established a maximum number of passes per run based on the size of the meter to prevent the possibility of averaging out repeatability problems in the system. See the fourth article, Section II (h) for additional guidance in verifying that the maximum number of runs has not been exceeded. The total number of passes is recorded on the proving report.

If you have any question concerning SVPs, you may contact G. Diane Lee of NIST WMD by e-mail at diane.lee@nist.gov, by fax at 301-926-0647 or by phone at 301-975-4405.

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Sample Report 1 (Note: Numbers in the top left corner of the sections below correspond to the above numbered paragraphs in this article. These paragraphs provide an explanation of the data in the report.)

Terminal: Meter:

Station: MAP Area: Company / Operator:

→ *5* **Meter Data**

22 - 1 - H

Factor Tracked	Meter Factor (MF)	
Temp Compensated	No	
NKF	95	P / gal
Manuf.		
Size	4	Inches
Serial No.		
Model No.		

→ *1, 4* **Fluid Data**

Name	HIRBob / 93 RFG	
Batch No.		
Obs. Gravity	70.7	API
Obs Temp	60.0	degF
API Table	B - General Products	
API @ 60 F	70.7	
R.D. @ 60 F	0.69980	
Viscosity	0	

→ *1, 3* **Proving Data**

	Previous	*Current*
Proving Name	1	2
ID	20040930130721	20050316142308
Date	9/30/2004	3/16/2005
Time	13:07	14:23
Fluid Type	B	B
Flowrate	348.7	402.6
Totalizer	0	0
Throughput	0	0
API @ 60 F	62.0	70.7
R.D. @ 60 F	0.73130	0.69980
Switch Bar Temp	67.5	46.8
Avg Prvr Temp	68.0	36.5
AvgPrvrPress	6.1	6.1
Repeatability	0.031%	0.027%
MF	0.9942	0.9933
MF Variation	0.0000	-0.0009

→ *2* **Prover Data**

BPV	19.996	gal
I.D.	13.998	in
W.T.	0.78100	in
Manufacturer	Calibron	
Type	Generic Small Volume	
Serial No.	ST0004101	
Elasticity	2.80E+7	per psig
Pipe Ga	1.92E-5	per degF
External Shaft Gl	6.20E-6	per degF
Certified	2/9/2005	

Tolerances

Tolerance Type: **Manual**
Max Run Rep Deviation: **0.05**
Enabled? Y *Passed?* Y
Criteria: **5** *out of* **7** *consecutive runs*

Max Prev X Factors Deviation: **0.05**
Enabled? **N** ***Passed?*** **N** *Prod Dep?* **N**
Prev X Factor Count Sought: **5**
Prev X Factor Count Used: **0**
Cut Off History? **N** *Cutoff Date:* **1/1/2000**

Max Prev Factor Deviation: **0.25**
Enabled? **Y** ***Passed?*** **Y** *Prod Dep?* **N**

Proving Mode: **Volumetric**
Calc. Method: **Average Meter Factor**
Proving Method: **CIU**
Pass Per Run **2** → *10* *See Article 4 Section II (h)*

Liquid Properties at Metering Conditions for CMF

Normal Op. Pressure	0	psig
Eq. Vapor Pressure	0	psig
CPL	1.00000	

→ *7* *Run results with temperature and pressure readings.*

RUN	TEMPERATURE Tp	Tm	PRESSURE Pp	Pm	PULSES Ni	RUN	Accepted?	IMF
1	36.9	36.9	5.7	0.0	3823.269	1	Yes	0.99325
2	36.7	36.7	5.9	0.0	3822.959	2	Yes	0.99332
3	36.5	36.5	6.2	0.0	3823.558	3	Yes	0.99316
4	36.3	36.3	6.4	0.0	3822.530	4	Yes	0.99343
5	36.3	36.3	6.3	0.0	3822.943	5	Yes	0.99332
Average	36.5	36.5	6.1	0.0	3823.0518			0.99330

→ *8* *Corrected prover volume*

(1) GSVp: BPV • [CTSp • CPSp • CTLp • CPLp = CCFp]

BPV	*CTSp*	*CPSp*	*CTLp*	*CPLp*	*CCFp*	*GSVp*
39.9920	0.99947	1.00000	1.01740	1.00005	1.01691	40.6683

→ *8* *Corrected meter volume*

(2) ISVm: [N(avg) + NKF = IVm] • [CTLm • CPLm = CCFm]

N(avg)	*NKF*	*IVm*	*CTLm*	*CPLm*	*CCFm*	*ISVm*
3823.0518	95	40.24265	1.01740	1.00000	1.01740	40.9429

(3) Proving Factors:

→ *9* >>>>

(1)	GSVp ÷ ISVm	= 0.9933	MF
(2)	MF • CPL	= 0.9933	CMF
(3)	1 ÷ MF	= 1.0067	MA
(4)	NKF ÷ MF	= 95.641	KF
(5)	KF ÷ CPL	= 95.641	CKF

→ *6* *Repeatability:* **0.027%**

Security Seals

REMOVED	*INSTALLED*

X indicates seal different from prior proving

Notes

Technician Witness Company Date

Sample Report 2 Brooks Compact Proving Report 1988

Note: Numbers in the top left corner of the sections below correspond to the above numbered paragraphs in this article. These paragraphs provide an explanation of the data in the report.

There are 5 options for print outs. This is the "Typical Proving Summary"

METER PROVING REPORT

REPORT NO. _____ LOCATION _____ DATE _____

→ 2 **PROVER DATA**

WALL THICKNESS = 0.8750 INCHES — INSIDE DIAMETER = 12.250 INCHES
PROVER MATERIAL = 17-4 ST. STEEL — MODULUS OF ELASTICITY = 28500000 PSIG
DOWNSTREAM VOLUME @ 60.000 DGF AND 0.00000 PSIG = 15.0658 GAL.
FLOW TUBE SQ. COEFF. = 0.00001200 — INVAR LINEAR COEFF. = 0.00000080

PROVER NO. _____ DATE CALIB. _____ CERT NO. _____

→ 5 **METER DATA**

METER NO. _____ SERIAL NUMBER _____ MODEL _____

TOTALIZER _____ SEAL NO. OLD _____ NEW _____

LAST OVERHAULED: DATE _____ TOTALIZER _____

→ 1 **FLUID DATA**

TYPE _____ PRES-E = 0.00000 PSIG SAMPLE-TEMP = 69.000 DGF

→ 3, 4, 7 **PROVING DATA**

RUN NUMBER	#1	#2
** PROVER DATA **		
FLOWRATE GPM	747.30	747.30
TEMPERATURE	76.1	76.1
PRESSURE	115.6	115.7
CTL-P	0.99176	0.99176
CPL-P	1.00071	1.00071
CTS-P	1.00021	1.00020
CPS-P	1.00006	1.00006
NET PROVER VOLUME	14.9762	14.9760
→ 5 ** METER DATA **		
TEMPERATURE	71.6	71.6
PRESSURE	104.0	104.0
METER PULSES	1024.00	1024.00
BASE K-FACTOR	68.00000	
GROSS METER VOLUME	15.0588	15.0568
CTL-M	0.99407	0.99407
CPL-M	1.00063	1.00063
NET METER VOLUME	14.9789	14.9789
NET K-FACTOR	68.01281	68.01327
AVG NET K-FACTOR	68.01304	
METER-FACTOR	0.999820	0.999806
API GRAVITY @ 60°F	44.200	44.200

#PASSES/RUN REPEAT%	AVG. METER FACTOR @ 60.000°F & 0.0 PSIG		CPL CORR. FOR METERING COND.		COMPOSITE FACTOR @ CONSTANT PRES.
→ 10 5	→ 6 0.001	0.999813	* _____	=	_____

PREVIOUS PROVINGS	DATE	METER FACTOR	RATE	GRAVITY	TEMP.	PRES.

Sample Report 2 (Cont.) Brooks Compact Proving Report 1988 Page 2 of 2

(Note: Numbers in the top left corner of the sections below correspond to the above numbered paragraphs in this article. These paragraphs provide an explanation of the data in the report.)

PROVING RUN: 1 OF 2 **(This shows the correction factors and calculations of run # 1 from page 1 of 2 of this proving report. There are 5 options for print out This is the "Typical Run Results")**

PASS NUMBER	FREQ	GROSS F RATE	GROSS K	TDVOL	TEMP	INTERPOLATED METER PULSES
1	845.44	747.31	67.87840	1.21121	1.21121	1024.00
2	845.43	747.30	67.87840	1.21122	1.21122	1024.00
3	845.43	747.30	67.87840	1.21122	1.21122	1024.00
4	845.44	747.30	67.87896	1.21122	1.21121	1024.01
5	845.44	747.31	67.87840	1.21121	1.21121	1024.00
AVERAGE	845.44	747.30	67.87851	1.21122	1.21121	1024.00

→ 7 **COMPENSATION DATA:**

	METHOD	MIN VALUE	MAX VALUE	AVERAGE VALUE	
PROVER FLUID TEMPERATURE	AUTOMATIC	76.0	76.1	76.1	DGF
PROVER FLUID PRESSURE	AUTOMATIC	115.4	115.7	115.6	PSIG
METER FLUID TEMPERATURE	AUTOMATIC	71.6	71.7	71.6	DGF
METER FLUID PRESSURE	AUTOMATIC	103.8	104.0	104.0	PSIG
API GRAVITY AT 60° F	CALCULATED	44.200	44.200	44.200	
API GRAVITY AT OBSERVED T	MANUAL	45.000	45.000	45.000	
TEMPERATURE OF SAMPLE	MANUAL	69.000	69.000	69.000	DGF

TEMP-INVAR = 75.000 DGF
REFERENCE TEMPERATURE = 60.000 DGF
EQUILIBRIUM VAPOR PRESSURE = 0.00000 PSIG

→ 7

	METHOD	PROVER	METER
CPL	LINEAR EQUATION	1.00071	1.00063
CTL	API TABLES (6B)	0.99176	0.99407
CTS	CALCULATED	1.00021	
CPS	CALCULATED	1.00006	
F-FACTOR	TABLE 11.2.1	0.000006140	0.000006030

NET K-FACTOR = 68.01281 PUL/GAL

→ 8 PROVER VOLUME • CTS-P • CPS-P • CTL-P • CPL-P = CORRECTED PROVER VOLUME
15.0858 • 1.00021 • 1.00006 • 0.99176 • 1.00071 = 14.9762

AVERAGE PULSES / BASE-K = GROSS METER VOLUME
1024.00 / 68.00000 = 15.0588

→ 8 GROSS METER VOLUME • CTL-M • CPL-M = CORRECTED METER VOLUME
15.0588 • 0.99407 • 1.00063 = 14.9789

→ 9 CORRECTED PROVER VOLUME/CORRECTED METER VOLUME = METER FACTOR
14.9762 / 14.9789 = 0.999820

(Excerpt from Measurement Canada's training manual.)