

ATT-8S/22, CALIBRATION OF PRESSURE GAUGE**1.0 SCOPE**

This method describes the procedure for determining the pressure gauge reading required to achieve a known volume using the volu-tester (or volu-measure).

2.0 EQUIPMENT

volu-tester (or volu-measure) with pressure gauge and accessory equipment

calibrated proctor molds with base (101.6 mm or 152.4 mm diameter)

countertop (for a smooth horizontal surface)

Instead of trying to manually hold the volu-tester down with your hand on top of the proctor mold, you can build a jig to hold the volu-tester and proctor mold. Make a top and bottom plate out of wood ($\frac{3}{4}$ " thick and 1.5' square) which are held together by long lengths of threaded rod on each side of the wood plates. The threaded rod should be long enough so that the volu-tester, sitting on top of the proctor mold, will fit in between the top and bottom wood plates.

3.0 PROCEDURE

INITIAL VOLUME (of base plate hole):

1. Place the volu-tester base plate on a smooth level surface, and ensure that the hole on the base plate is flush with the horizontal surface.
2. Place the volu-tester on the recessed hole in the base plate. Put a mark on both the volu-tester base and the base plate so that the two can be realigned in the same position when taking subsequent readings. Hold the volu-tester down firmly in position, either by clamping the volu-tester to the base plate or by using hand pressure on the top cap to keep it in place. Some volu-testers may have surcharge weights which can be used to keep the volu-tester from lifting when pressure is applied to inflate the balloon.
3. Open the control valve, then insert the two-way pump (rubber bulb) into the pressure position and pump the balloon down until the gauge reads 3.0. Read the water level in the graduated cylinder and record it as the "Initial Cylinder Scale Reading".
4. Use the Cylinder Calibration Chart and the "Initial Cylinder Scale Reading" to determine the "Initial Corrected Actual Volume". An example of a cylinder calibration chart is shown in Figure 1.

FINAL VOLUME (of base plate hole & proctor mold):

5. Add the volume of a calibrated Proctor mold to this "Initial Corrected Actual Volume" to determine what pressure is needed to achieve the calibrated volume.

The proctor mold volume can be easily determined in the field using ATT-23, Supplement, Calibration of Proctor Mold.

VOLUTESTER CALIBRATION example

FIGURE 1

Cylinder No. 1

Water Temperature: 22 °C

Temperature Correction: 0.997724

Scale Reading	Actual Volume	Scale Reading	Actual Volume	Scale Reading	Actual Volume	Scale Reading	Actual Volume	Scale Reading	Actual Volume	Scale Reading	Actual Volume
10	9	510	493	1010	985	1510	1478	2010	1972	2510	2468
20	18	520	503	1020	995	1520	1488	2020	1982	2520	2478
30	28	530	513	1030	1005	1530	1498	2030	1992	2530	2488
40	37	540	522	1040	1015	1540	1509	2040	2002	2540	2498
50	46	550	532	1050	1025	1550	1519	2050	2012	2550	2508
60	55	560	542	1060	1035	1560	1529	2060	2022	2560	2518
70	64	570	551	1070	1045	1570	1539	2070	2032	2570	2528
80	74	580	561	1080	1055	1580	1549	2080	2042	2580	2538
90	83	590	571	1090	1065	1590	1559	2090	2053	2590	2548
100	92	600	581	1100	1075	1600	1569	2100	2063	2600	2559
110	102	610	591	1110	1084	1610	1579	2110	2072	2610	2568
120	111	620	601	1120	1094	1620	1589	2120	2082	2620	2578
130	121	630	611	1130	1104	1630	1598	2130	2092	2630	2588
140	130	640	621	1140	1114	1640	1608	2140	2102	2640	2598
150	140	650	631	1150	1124	1650	1618	2150	2111	2650	2608
160	149	660	641	1160	1133	1660	1628	2160	2121	2660	2618
170	159	670	651	1170	1143	1670	1637	2170	2131	2670	2628
180	169	680	661	1180	1153	1680	1647	2180	2140	2680	2638
190	178	690	671	1190	1163	1690	1657	2190	2150	2690	2648
200	188	700	681	1200	1172	1700	1667	2200	2160	2700	2658
210	198	710	690	1210	1182	1710	1677	2210	2170	2710	2668
220	207	720	700	1220	1192	1720	1687	2220	2180	2720	2678
230	217	730	710	1230	1203	1730	1697	2230	2190	2730	2688
240	227	740	719	1240	1213	1740	1707	2240	2200	2740	2698
250	237	750	729	1250	1223	1750	1717	2250	2210	2750	2708
260	247	760	739	1260	1233	1760	1727	2260	2220	2760	2718
270	257	770	749	1270	1243	1770	1737	2270	2230	2770	2728
280	267	780	758	1280	1253	1780	1747	2280	2240	2780	2738
290	276	790	768	1290	1263	1790	1757	2290	2250	2790	2747
300	286	800	778	1300	1273	1800	1767	2300	2260	2800	2757
310	296	810	788	1310	1283	1810	1777	2310	2269	2810	2767
320	306	820	798	1320	1292	1820	1787	2320	2279	2820	2777
330	315	830	808	1330	1302	1830	1797	2330	2289	2830	2787
340	325	840	819	1340	1312	1840	1807	2340	2299	2840	2797
350	334	850	829	1350	1321	1850	1817	2350	2309	2850	2807
360	344	860	839	1360	1331	1860	1826	2360	2319	2860	2817
370	354	870	849	1370	1341	1870	1836	2370	2329	2870	2826
380	363	880	860	1380	1350	1880	1846	2380	2339	2880	2836
390	373	890	870	1390	1360	1890	1856	2390	2349	2890	2846
400	382	900	880	1400	1370	1900	1866	2400	2359	2900	2856
410	393	910	890	1410	1379	1910	1875	2410	2369	2910	2866
420	403	920	899	1420	1389	1920	1885	2420	2379	2920	2876
430	413	930	909	1430	1399	1930	1894	2430	2389	2930	2886
440	423	940	918	1440	1409	1940	1904	2440	2398	2940	2896
450	433	950	928	1450	1419	1950	1914	2450	2408	2950	2906
460	443	960	937	1460	1429	1960	1923	2460	2418	2960	2916
470	453	970	947	1470	1439	1970	1933	2470	2428	2970	2927
480	463	980	956	1480	1448	1980	1942	2480	2438	2980	2937
490	473	990	966	1490	1458	1990	1952	2490	2448	2990	2947
500	483	1000	975	1500	1468	2000	1961	2500	2458	3000	2957

6. Use the calculated final actual volume needed and cylinder calibration chart to determine the "Calculated Final Scale Reading".
7. Center the volu-tester base plate over top of the proctor mold. Align the marks previously put on the base plate and volu-tester base.
8. Place the volu-tester on the base plate. Ensure the pump is in the pressure position.
9. Open the air release valve and allow the balloon to fall into the mold. Wait until the water level is stationary.
10. Begin pumping air pressure into the cylinder. The apparatus must not break contact with the mold.
11. Lower your eye parallel to the surface of the water and take volume indicator readings until the calculated final scale reading (from step 6) is reached.

Volume indicator readings are taken when the water is stationary. Always read the bottom of the meniscus.
12. Close the air release valve and record the pressure gauge reading. **This pressure is the minimum pressure dial reading required to obtain an accurate volume during the field tests.**

The volu-tester (or volu-measure) apparatus must be capable of maintaining the required pressure at which volume indicator readings are taken.
13. Open the air release valve and begin pumping.
14. If the water level remains constant, the calibration is complete.

Close the air release valve and **record the dial reading as the maximum pressure reading required to obtain an accurate volume.**
15. If the water level decreased, that is, the calculated final scale reading increased with an increase in pressure, either the cylinder calibration chart or the volume of the proctor mold is in error. If this occurs, verify the chart and proctor mold volume.
16. Reverse the pump, open the valve and pump the balloon back up into the graduated cylinder.
17. Loosen the clamping devices and remove the apparatus from the proctor mold.
18. Replace the volu-tester (or volu-measure), density plate, pump and chart in the equipment box.

3.1 Calibration Example

Using the example cylinder calibration chart in Figure 1.

Initial scale reading	= 65 cm ³
Initial actual volume (from cylinder calibration chart)	= 60 cm ³
Volume of a calibrated Proctor mold	= 941 cm ³
Final actual volume should read	= 941 + 60 = 1 001 cm ³ (now go to calib.chart)
Final scale reading (from cylinder calibration chart)	= 1 026 cm ³

The Volu-tester is then pumped up till the volume reading of 1026 is attained.

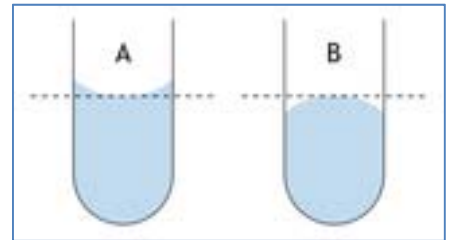
Minimum pressure dial reading to attain a volume reading of 1 026 = 2.5 psi

Maximum pressure dial reading to attain a volume reading of 1 026 = 3.0 psi

4.0 HINTS AND PRECAUTIONS

1. **Ensure the cylinder number matches the number on the calibration chart.**

2. **Always read the volume indicator scale in a position parallel to the water level.** When you read a scale on the side of a container with a meniscus, such as a graduated cylinder or volumetric flask, it's important that the measurement accounts for the meniscus. Measure so that the line you are reading is at eye level even with the center of the meniscus. For water and most liquids, this is the bottom of the meniscus (see example A at right).



Mercury has a higher surface tension than the walls of the graduated cylinder which produces a convex meniscus (see example B at right).

3. Never take a scale reading when the water is moving up and down. Wait until the water level is stationary, and always read the bottom of the meniscus.

4. **Mark the density plate and volu-tester base so that the two can be realigned in the same position whenever initial and final readings are taken.**

5. The volu-tester or volu-measure apparatus must remain stationary and centered on the Proctor mold throughout the calibration.

6. **Recalibrate the pressure gauge whenever the balloon is changed.** A new balloon may have a different resistance and may require a different pressure to achieve the correct volume.

After a new balloon is installed, it is necessary to flex the balloon, in and out of the cylinder several times, before the calibration check is performed.

7. **A couple drops of food coloring can be put into the water to increase the readability of the water level in the volu-tester.**