INSTRUCTIONS

WACEL is allowing the P.E. of an office (or an approved WACEL Practical Examiner) to perform the practical component of WACEL's Soils I Field Technician Certification. **The tests must be witnessed by a registered professional engineer or an approved WACEL Practical Examiner.** No other individual, regardless of his/her position in the organization, may substitute. All of the tests included in this set of worksheets, with only two exceptions, must be performed by the technician and witnessed by the examiner. The only optional tests are one of the moisture content tests - only one of the two included must be performed, but both may be performed; and one of the 1-point Proctor tests - only one of the two included must be performed, but both may be performed. Not all of the tests need to be witnessed on the same date. If tests are spread out over several days, include the range of dates on page 2 on the date line. The examiner (P.E. or approved WACEL Practical Examiner) must sign the signature box for each test method and the P.E. must sign the final page. Additional instructions (some repeat for emphasis) are on the following page.

WACEL Soils I Field Technician Practical

Name (Technician): _____ Date(s): _____

Office / Location: _____ Final Rating (P or F): _____

Name of Examiner:_____

Instructions: A P.E. or approved WACEL Practical Examiner shall observe the testing technician perform the following tests. Rate the performance appropriately and score the overall performance as either pass or fail. A failure of any individual test will result as a failure of the practical exam. The examiner shall sign as witnessing each individual test method and the P.E. shall sign the final page. Completed forms must be returned to WACEL.

ASTM D4959-07 Water (Moisture) Content of Soil by Direct Heating	**Pass**	**Fail**	**N/A**
1. Sample protected from moisture loss (sealed container, shielded from direct sunlight).			
2. Determine and record the mass of a clean, dry container to 0.1 g.			
3. Representative portion of the sample placed into the container and the mass immediately recorded.			
4. Sample size conforms to the following: Nom./Max. Size (Largest sieve retaining >10%) — Minimum Mass of Moist Specimen No. 10 — 200-300 g No. 4 — 300-500 g 3/4" — 500-1000 g			
5. Heat applied to container, stirring frequently to minimize localized overheating.			
6. Continue heating until sample appears dry.			
7. Container removed from heat and allowed to cool until it can be handled.			
8. Determine and record the mass of the container and sample.			
9. Container and sample returned to heat source and stirred.			
10. Care taken when stirring, and in general when handling the container, not to lose any material.			
11. Container removed from heat and allowed to cool until it can be handled.			
12. Determine and record the mass of the container and sample.			
13. Heating and weighing process repeated until constant mass (0.1% or less change) achieved.			
14. Moisture content calculated. $MC\% = (MASS_{water} / MASS_{dry\ solids}) \times 100$			
Signature of examiner observing — OVERALL			

OPTIONAL – If D4959 is not performed, D4944 must be performed. This (D4959) is the more common method and is suggested to be included.

ASTM D4944-04 Moisture Content by Calcium Carbide Gas Pressure Tester	Pass	Fail	N/A
1. Technician using a **CALIBRATED** Calcium Carbide Pressure Tester Set.			
• Calibration curve available.			
2. Soil sample to be used contains only particles smaller than No. 4.			
3. Required amount of calcium carbide placed into chamber, along with the 2 steel balls. (amount recommended by manufacturer – usually 22 grams of reagent, or 2 scoops full)			
4. Using the balance provided in the set, obtain a soil specimen (minus No. 4) meeting the recommended mass, as provided by the manufacturer.			
• One-half specimen sizes are permitted if the moisture content is expected to exceed the limits of the gauge or if the limit of the gauge is exceeded on any test.			
5. Soil specimen placed in chamber cap.			
6. With the apparatus held horizontally, cap inserted into the chamber and clamped to seal.			
7. Care taken so that the soil and calcium carbide to not come in contact until the chamber is sealed.			
• The soil and calcium carbide may be added in reverse if desired (soil in chamber, cc in cap).			
8. Apparatus turned upright so that the contents of the cap fall into the chamber.			
9. Side of apparatus struck with open hand to ensure all material has fallen out of the cap.			
10. Apparatus shaken vigorously with rotating motion, periodically checking the gauge for stabilization.			
• Shaken at least 1 minute for sandy soils, increasing time for silts, and up to 3 minutes for clays. *Note: Some highly plastic clay soils may require more than 3 minutes.*			
11. When pressure gauge dial stops moving, dial read while holding the apparatus horizontally.			
• If gauge capacity is exceeded, test redone using ½ sample size. (gauge reading multiplied by 2 for use with the calibration curve)			
12. Pressure read from gauge dial and moisture content determined using the calibration curve.			
13. Gas pressure released from chamber with cap pointed away from technician (and others).			
14. Chamber emptied and specimen examined for lumps.			
• If specimen is not completely pulverized, test repeated with new sample.			
Signature of examiner observing OVERALL			

OPTIONAL – If D4944 is not performed, D4959 must be performed. It is recommended that D4944 be included if working in Virginia (VDOT).

One Point Proctor	Pass	Fail	N/A
1. Sample collected and weighed.			
2. Material sieved over #4 sieve.			
3. The +#4 material collected from sieve and weighed.			
4. Use -#4 material as is or dry to 4% less than assumed OMC.			
5. Compact -#4 material in 4" mold in 3 equal lifts and using 25 blows/lift.			
6. Excess material should be observed. (not shy, not excessively overfilled)			
7. Excess screeded off using a straight edge.			
8. Mold cleaned, weighed, and wet density determined. D_w = net weight of soil / volume of mold (0.0333 ft^3)			
9. Soil removed from mold and split vertically through the center.			
10. 300-500 g of material removed from cut face(s).			
11. Moisture content of this sample determined in accordance with either D4959 or D4944.			
12. Dry density calculated. $D_d = D_w / 1 + .MC\%$			
13. Plot the 1-point data for the -#4 material on the family of curves. (Family of curves and nomograph attached.)			
14. Closest curve (or higher curve) selected and the likely MDD and OMC looked up in table.			
IF THERE IS > 5% OVERSIZE MATERIAL (+#4), CONTINUE TO GET CORRECTED VALUE. OTHERWISE STOP HERE. (Only continue with #15-21 if an oversize correction is necessary.)			
15. Using nomograph, line drawn from D_d to 2.65 (or actual SG if known) on Specific Gravity axis.			
16. Dry weight of +#4 material calculated. Dry Weight of +#4 = *Line 3* / 1.02			
17. Dry weight of all -#4 material calculated. Dry Weight of -#4 = (*Line 1 – Line 3*) / (1+ *Line 11*) note: write MC% from *Line 11* as decimal			
18. Calculate % of +#4 material. % +#4 = *Line 16* / (*Line 16* + *Line 17*)			
19. % +#4 material marked at top of nomograph and line drawn down to intersection of previous line.			
20. At the point of intersection, line drawn horizontally back to the density axis and the corrected density determined.			
21. Corrected OMC calculated. $OMC_{corrected}$ = (% -#4 x MC of -#4) + (% +#4 x 2%) Where %+#4 and %-#4 are written as decimals and the MCs% are written as whole numbers.			
Signature of examiner observing OVERALL			

One-Point Proctor – Only one method is required to be performed. If seeking reciprocity with MARTCP, the preferred method is the MSMT 351 method.

If performing MSMT 351, a unique family of curves related to the specific soil used for demonstration during this practical examination must be available.

One Point Proctor (MSMT Designation 351)	Pass	Fail	N/A
1. Obtain a representative 12 lb sample of material from the site.			
2. Take a representative moisture sample and determine moisture content.			
3. Weigh sample and sieve through 2 in., ¾ in., and No. 4 sieves into pan, discarding all material retained on the 2 in. sieve.			
4. Weigh and discard all material retained on the ¾ in. sieve.			
5. Weigh the material retained on the No. 4 sieve.			
• If more than 35% of material is retained on the No. 4 sieve – skip to line 12.			
6. Replace the material retained on the ¾ in. sieve with an equal weight of material retained on the No. 4 sieve (minus ¾ in. and plus No. 4) and thoroughly mix the sample.			
7. Compact material in 4 in. diameter mold with the modified rammer (10 lb with 18 in. drop).			
• Compacted in 5 approximately equal layers to get a specimen height of approximately 5 in.			
• Compacted using 25 uniformly distributed blows per layer.			
• Mold rests on a dense, uniform, rigid, and stable foundation during compaction.			
8. After compaction, collar removed and excess soil trimmed flush with top of mold using straightedge.			
9. Mold and soil weight determined to nearest 0.01 lb.			
10. Wet density calculated. D_w = (Weight of mold and soil – Weight of mold) / Volume of mold			
11. Wet density and moisture content plotted onto typical family of curves.			
• If point falls directly on one of the curves, determine max dry density from that curve.			
• If point falls between two curves - interpolate the max dry density by projecting a line, mirroring between the two curves until the projection intersects the max dry density-optimum moisture content line on the chart. This intersection is the max dry density.			
• If point falls above or to the right of the max dry density-optimum moisture line, the material should be dried to a lower moisture content and the procedure repeated.			
• If point falls outside of range covered by the family of curves (above highest curve or below the lowest curve), a completely new curve should be developed.			
END. ONLY CONTINUE MORE THAN 35% OF MATERIAL WAS RETAINED ON No. 4 SIEVE			
12. Thoroughly mix the material passing through the ¾ in. sieve.			
13. Compact material in 6 in. diameter mold with the modified rammer (10 lb with 18 in. drop).			
• Compacted in 5 approximately equal layers to get a specimen height of approximately 5 in.			
• Compacted using 56 uniformly distributed blows per layer.			
• Mold rests on a dense, uniform, rigid, and stable foundation during compaction.			
14. After compaction, collar removed and excess soil trimmed flush with top of mold using straightedge.			
15. Mold and soil weight determined to nearest 0.01 lb.			
16. Wet density calculated. D_w = (Weight of mold and soil – Weight of mold) / Volume of mold			
17. Wet density and moisture content plotted onto typical family of curves.			
• If point falls directly on one of the curves, determine max dry density from that curve.			
• If point falls between two curves - interpolate the max dry density by projecting a line, mirroring between the two curves until the projection intersects the max dry density-optimum moisture content line on the chart. This intersection is the max dry density.			
• If point falls outside of range covered by the family of curves (above highest curve or below the lowest curve), a completely new curve should be developed.			
Signature of examiner observing OVERALL			

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ASTM D1556-07 Density and Unit Weight of Soil in Place by Sand Cone	Pass	Fail	N/A
1. The technician understands that the sand must be calibrated (bulk density) and that the volume of funnel and base plate (or mass of sand required to fill the funnel) must be known/determined.			
2. Apparatus in working condition and is a set.			
3. Level testing surface prepared.			
4. Outline of base plate marked (or secured, if necessary) to prevent movement.			
5. Depth of hole approximately the same depth as the lift being tested.			
6. Hole dug ensuring that:			
• Sides of hole slope slightly inward.			
• Bottom is reasonably flat or concave.			
• The hole is free of pockets, overhangs, and protrusions.			
• Care is taken to avoid the loss of material.			
• Material is protected to prevent loss of moisture until MC% sample is taken.			
7. Any material cleaned from flange of base plate.			
8. Mass of apparatus (sand, jar, & funnel) determined.			
9. Sand Cone inverted and funnel placed in base plate, in same position as calibration (marks matched).			
10. Vibration from personnel and equipment avoided (or minimized).			
11. Valve opened until sand ceases to flow.			
12. Valve closed and mass of apparatus (remaining sand, jar, & funnel) determined.			
13. If oversized material is encountered, mass of oversized material determined and corrected for.			
14. Determine mass of moist material removed from hole.			
15. Material thoroughly mixed and representative MC% specimen taken (if not entire sample).			
16. Moisture content determined (preferably by D4959).			
17. Proper calculations:			
V = (M1 – M2) / BD V – Volume M1 – Mass of sand to fill test hole, funnel, & plate M2 – Mass of sand to fill funnel & plate BD – Bulk density of sand	**Wd = M3 / V** Wd – Wet density M3 – Mass of moist material from hole		
Dd = Wd / (1 + .MC%) Dd – Dry density .MC% - Moisture content as decimal			
Signature of examiner observing OVERALL			

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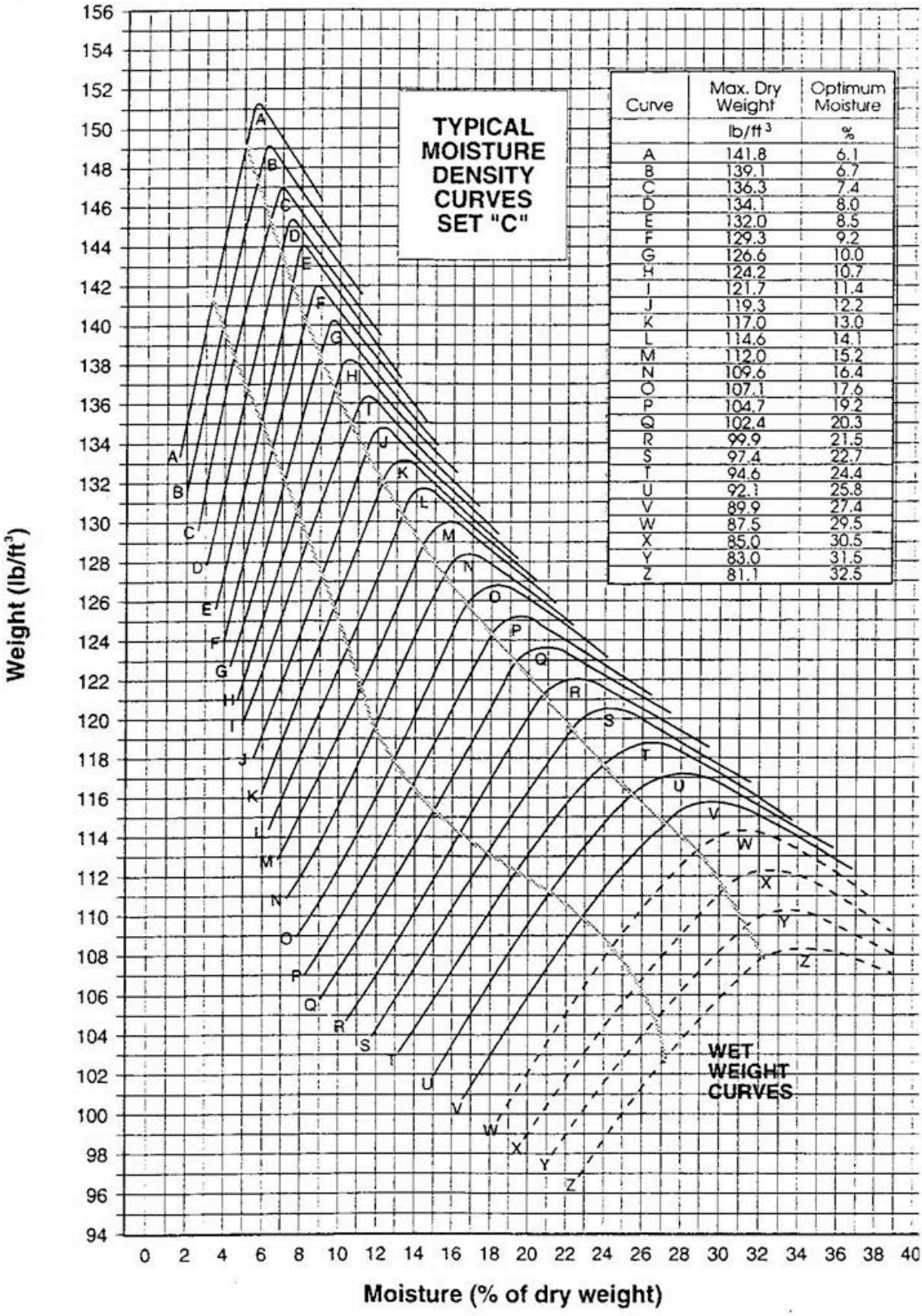
ASTM D6938-07b Nuclear Density Gauge	Pass	Fail	N/A
1. Gauge standardized at start of day's use.			
2. Testing location selected and surface prepared.			
3. Surface allows total contact with bottom of gauge, voids filled as necessary (no void > 1/8").			
4. Hole-forming device driven through guide to a depth at least 2" deeper than the testing depth.			
5. Hole-forming device removed and corners of guide marked.			
6. Any necessary repairs made to surface.			
7. Gauge carefully aligned on surface, placing the source rod over the hole (aligned from scoring marks).			
8. Source rod inserted into the hole to the testing depth.			
9. Gauge seated firmly by rotating back and forth.			
10. Gauge gently pulled such that the source rod is in contact with the side of the hole nearest detectors.			
11. Perform and record at least one reading for the normal measurement period.			
12. If oversized material is present, oversized correction performed.			
13. If sample must be obtained, taken from directly under the center of the gauge.			
Signature of examiner observing OVERALL			

I attest that the tests results reported above are accurate and testing was conducted and proctored in accordance with WACEL requirements.

_____
PRINTED NAME OF P.E.

_____
P.E. LICENSE NUMBER & STATE
(ONLY 1 NECESSARY, STATE OF OFFICE LOCATION)

_____
STAMP/SEAL W/ SIGNATURE



Curve	Max. Dry Weight	Optimum Moisture
	lb/ft³	%
A	141.8	6.1
B	139.1	6.7
C	136.3	7.4
D	134.1	8.0
E	132.0	8.5
F	129.3	9.2
G	126.6	10.0
H	124.2	10.7
I	121.7	11.4
J	119.3	12.2
K	117.0	13.0
L	114.6	14.1
M	112.0	15.2
N	109.6	16.4
O	107.1	17.6
P	104.7	19.2
Q	102.4	20.3
R	99.9	21.5
S	97.4	22.7
T	94.6	24.4
U	92.1	25.8
V	89.9	27.4
W	87.5	29.5
X	85.0	30.5
Y	83.0	31.5
Z	81.1	32.5