Radiation Safety and Nuclear Gauge Field Technician Certification Class

(TDOT Employees Only)

2023 Version

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Instructor

Email: Rocky.Kelley@tn.gov

Cell: 615-924-6254

Office: 615-350-4412

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DOT Hazmat Training Requirements – 49 CFR Part 172, Subpart H Training

Training Defined
Training means a program that ensures a hazmat employee has general knowledge, is able to recognize and identify hazardous materials, has knowledge of specific requirement's, has knowledge of emergency response information, self-protection measures and accident prevention methods and procedures.

Who needs this training?
Anyone who handles hazardous materials.

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What is a hazardous material?
Hazardous material is a substance or material that the Secretary of Transportation has determined capable of posing an unreasonable risk to health, safety, and property.

What companies must follow DOT training?
Any company who has employees that perform work that is regulated by the US DOT Hazardous Materials Regulations (HMR).

What training is required?
General Awareness/Familiarization Training
Security Awareness Training
Safety Training

How often must training be updated or repeated?
The training requirements must be repeated every ***THREE*** years.

*TDOT will give a refresher test at the beginning of each calendar year.

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Why are you here?

1. Operators must be trained as required by Federal and State law.
2. TDOT Nuclear Gauge Policies .
3. SAFETY of operators, co-workers and the public.

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Radiation Safety Course

What we will cover:

1. Radioactivity Awareness
2. Nuclear Gauge Storage
3. Transportation Requirements
4. Nuclear Gauge Uses
5. Emergency Response Plan

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Testing Requirements

Test:

- **45** question test pertaining to Radiation Safety and Field Certification Course.
- **All** questions are multiple choice.
- Must score **70%** or better to pass.
- Be sure to answer all questions.
- You will receive an email from **TCAT** once your test has been graded.

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Radiation Safety Officers

TDOT Radiation Safety Officer (RSO):

Rocky Kelley
(615)-924-6254

Regional RSOs

Region 1: Billy Goins	(865) 806-1935
Region 2: Chris Gentry	(423) 322-0649
Region 3: John Asherbranner	(615) 806 9120
Region 4: Marc Turner	(731) 234-6048

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We have 3 types of gauges

HUMBOLDT
5001EZ2

TROXLER
3430

INSTROTEK
3500 Xplorer

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TDOT Nuclear Gauge Program

- In accordance with Federal Regulations, all gauges are monitored under TDOT's License with the Tennessee Department of Environment and Conservation, Division of Radiological Health (TDEC)
- This license lists all radioactive sources owned and maintained by TDOT and dictates how they will be transported, secured, and monitored.
- The license is maintained by HQ Materials & Test and maybe viewed upon request.

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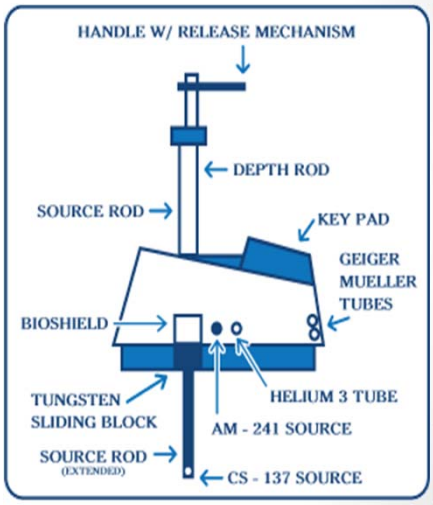
Radioactivity

- A small amount of radioactive material is embedded at the end of the source rod and in the base of these gauge which emits radiation.
- By detecting the amount of this controlled radiation that passes through a given material, a gauge can estimate the density of that material.
  - **Higher density material** → Allows less radiation to pass through
  - **Lower density material** → Allows more radiation to pass through



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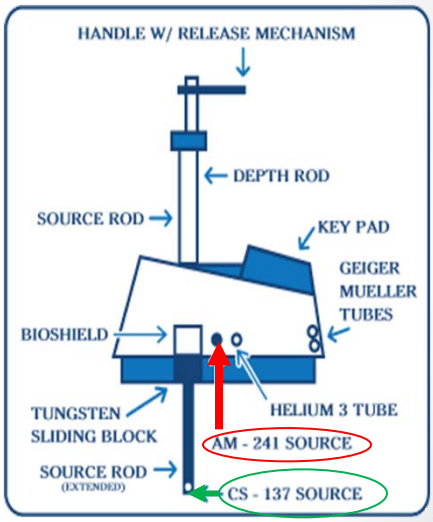
Radioactivity

Source location and type of source in our density gauges.

- Cesium-137 (Cs-137) is located at the end of a retractable source rod. **(GREEN)**
- **Cs-137 is a Gamma source.**
- Americium–241: Beryllium (Am-241) is located in the base of the gauge. **(RED)**
- **Am-241 is a Neutron source.**



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Direct Transmission

vs.

Backscatter Modes

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What are they used for?

Moisture Density Gauge

Direct Transmission

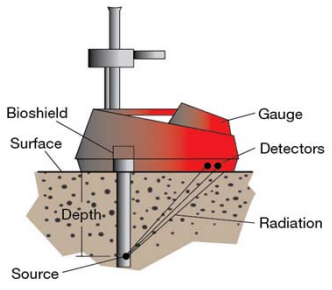

Photo courtesy: APNGA

A moisture density gauge indicates whether a foundation is suitable for constructing a building or roadway.

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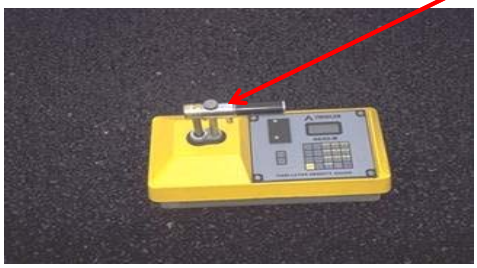
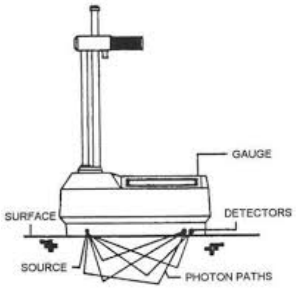
Backscatter

Asphalt Pavements



When testing dense-graded hot mix asphalt, gauges are operated in "backscatter" mode to avoid having to drive a hole through hard asphalt.



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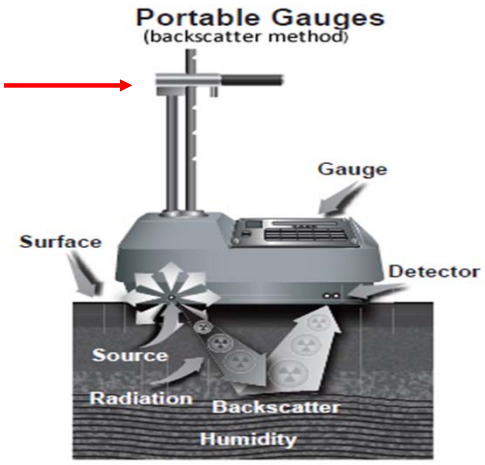
Backscatter Method

Backscatter is the first notch down



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Radioactivity

- A hazardous material is one that could possibly pose a risk to public health, safety or property. Because it contains small amounts of radioactive material, a nuclear gauge qualifies as a hazardous material under **Hazard Class 7.**

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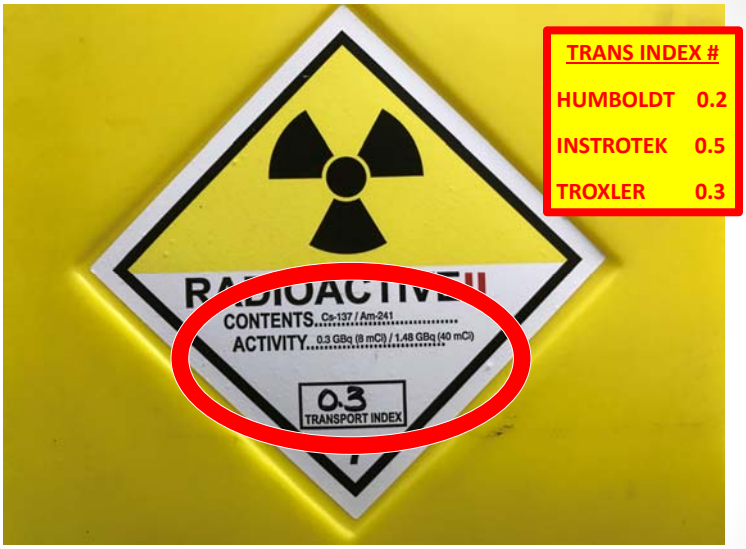

TRANS INDEX #	
HUMBOLDT	0.2
INSTROTEK	0.5
TROXLER	0.3

DO NOT TRANSPORT IF LABEL IS NOT FILL OUT

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Radioactivity

- There are four basic types of radiation that we are concerned with: alpha, beta, GAMMA, and NEUTRON.
- When radiation passes through living things, it gives up energy to the tissue and cells. The energy deposits may cause damage to or destroy the cell.
- If too many cells are damaged or destroyed, radiation sickness or death may occur. For this reason, radiation exposure of personnel handling radioactive materials must be held to safe limits.

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Personal Instadose Plus Badges

The Instadose+ dosimeter, with SmartMonitoring is a digital radiation monitoringdevice that will help safeguard from radiation over-exposure.

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Personal Instadose Plus Badges

We now have:

INSTANT…access to real-time, on-demand dose reads and measurement data. Featuring Bluetooth Technology to quickly, easily, remotely transmit radiation dose data via smart devices, PCs, and hotspot stations.

PRECISE…measurements based upon Direct Ion Storage (DIS) technology, enabling high sensitivity and accuracy.

SMARTER…eliminating the need to collect, return, and redistribute dosimeters for processing.

SMARTER…reporting and tracking allows users to pinpoint high dose exposures and anomalies faster.

On-demand and scheduled calendar reads with real-time access to both historical and current dose measurements and reports.

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Radioactivity

- Exposure records for TDOT are measured in rems.
- A radiation dose of **400** to **450** rems in a short period would probably be fatal.
- Humans are exposed every year to **0.1** to **0.3** rems. This comes from several natural sources.
- Following safe testing protocol Nuclear Gauge operator will be exposed to **0.025** to **0.050** rems annually.

Source	Description	Annual Dose
Cosmic	From the sun and other space sources.	0.039-0.092rem
Earth	From the natural radioactive materials in the ground	0.007rem
Living	Television (2 hours/day) Plane (3000 mile flight)	.0003rem 0.002rem
Housing	From the materials we use to build our homes and work places	0.048rem
Man	Medical X-rays	0.009-0.21rem

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Radioactivity

All gauge operators must wear a dosimeter badge.

NRC Regulations (10 CFR) > § 20.1201 Occupational dose limits for adults:

1. The annual total whole body dose should not exceed **5 rems**. This includes head, trunk, arm above the elbow, and legs above the knee.
2. The specified annual dose limit to the skin or any extremity is **50 rems** limits
3. The specified annual dose limit to the eye is **15 rems**.
4. If you are a Declared Pregnant worker. Then the limit shall be limited to **0.5** rems of exposure during the pregnancy.
5. Declared pregnant workers will be asked to fill out an "Declaration of Pregnancy" form. This will be provided by your RSO.

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DO NOT SHARE BADGES

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The A L A R A Philosophy

As Low As Reasonably Achievable (ALARA) –

Before you use or transport a gauge, remember to take all the steps reasonable to limit your exposure and the public's exposure to radiation.

This is achieved by:

TIME: Always strive to limit your time around a gauge.

SHIELDING: Always keep the gauge source rod shielding and in a stored position when not using the gauge.

DISTANCE: Always maintain your distance when the gauge is taking a test.

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Summary

- The source of radiation within a nuclear gauge is very small.
- Responsible operation of a well-maintained gauge will ensure no technician is exposed to excessive radiation.
- To further ensure safe operations, technicians must wear "**personal dosimetry badge**" which help monitor whether technicians are absorbing radiation.

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GAUGE STORAGE SITES

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Storing the Gauge

The handle trigger will only be **LOCKED** with

Master Lock **P-581** or **P-812** for Troxler or InstoTek gauges and

American Lock **15G351** for Humboldt gauges and the gauge stored in its transport case.

The transport case shall be locked with a **LSDA Lock only.**

Keys to the transportation case and gauge **WILL NOT** be stored with the gauge or in the storage building.

The gauge and transport case shall be stored at least **15ft** (5 m) from work areas, in a locked closet/storage area in a dry location (indoors).

The storage area shall be marked with a radiation sign that reads **"CAUTION RADIOACTIVE MATERIALS".**

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Storage Site continued

- Gauges are not allowed to be permanently stored in a vehicle. The gauge must be returned and signed back to its permanent storage building once the project(s) testing it was signed out for is completed.
- In the event the gauge will be used for multiple projects in a given day/week, it must be returned to its permanent storage building and signed in when the last test is completed for the work week.
- At no time will any gauge be stored inside an employee/operator home of residence.
- **Ref to SOP 7-2**

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Storage Site continued

- All **storage sites** will maintain a SIGN IN/OUT LOG with name of operator, date signed out/in, location/project# and time signed out/in. This log will be maintained by the storage site manager and will be readily available for inspection.
- Sign in/out log sheets will be provided by your RSO as needed.
- Only nuclear gauges are allowed to be stored inside the storage site. No tools/equipment/debris of any kind is allowed to be place inside the storage site. **(Unless cleared by your RSO)**
- **Ref. SOP 7-2**

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Transporting the Gauge

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WHEN YOU LOAD THE NUCLEAR DENSITY GAUGE IN YOUR TRUCK YOU ARE HAULING

HAZARDOUS MATERIAL.

Let's make sure we are hauling it correctly.

If not, YOU can be fined for ALL VIOLATIONS of state and federal regulations dealing with transporting RADIOACTIVE MATERIAL.

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Gauge Inspection

- Push the source rod down into the backscatter position, and then raise it back to the SAFE (shielded) position. The source rod opening in the bottom of the gauge is equipped with a spring loaded tungsten sliding block that shuts when the source rod is in the SAFE position. **Turn the gauge over and verify that the sliding block is completely closed.** **If any portion of the opening is uncovered, notify your Regional RSO or HQ RSO immediately.**
- **I would encourage you to check the slide block after you have completed your tests each day.**
- **DO NOT TRANSPORT** the gauge unless the sliding block is completely closed. Increased radiation levels ***will violate*** transportation regulations and cause excessive personal radiation exposure.
- **Ref to SOP 7-2 or get with your RSO.**

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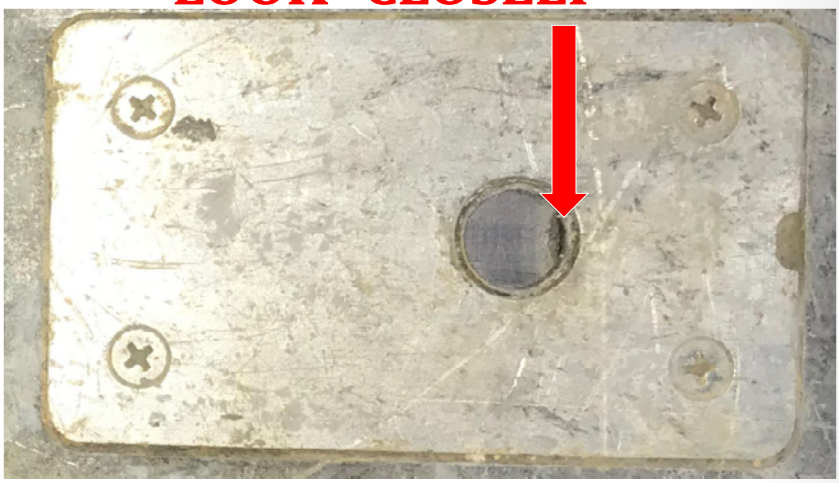
LOOK CLOSELY



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Content of Gauge Case

Ensure **ALL** tools are in the case.

1. Scrapper Plate
2. Gauge
3. Standard Block
4. Drill Rod
5. A/C Charger
6. Standard Count logbook
7. Extraction Tool
8. Red Folder

Report any missing items to your RSO.

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LABEL PLACEMENT

TRANS INDEX #	
HUMBOLDT	0.2
INSTROTEK	0.5
TROXLER	0.3

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Transporting Gauge

While in transit, the following paperwork must be in the vehicle and readily accessible by the driver:

- Nuclear gauge shipping paper (Red & White BOL)
- Proof of Operator's Hazmat Certification (Accessible electronic copy is acceptable)

The following will be maintained in the red folder assigned to the gauge and updated as required:

- TDOT Radiation Safety Plan (SOP 7-2 dated January 1, 2023)
- IAEA Certificate
- Current Leak Test (No more than 6 months old)
- Manufacturers Closure Report

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Transporting Gauge

1. Under a locked bed cover with the device secured in place with heavy chain to prevent the case from being easily removed and to prevent the case from moving more than ½ inch in any direct. Chain will be secured to the bed of the truck through both side handles and top handle, if present, to prevent the case from being opened and gauge being removed while secured.

OR

2. A mounted transportation box, specifically designed for the nuclear gauge case or one that has been approved by your RSO with two forms of locks. In either case, ensure the gauge will not move more than a ½ inch in any direction while being transported.

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Transporting Gauge continued

- The bed cover and/or mounted transportation box shall be LOCKED at all times while the gauge is being transported.
- TDOT is required to have a minimum of **2 forms of security** barriers while transporting a gauge in our trucks.
- The transportation case lock ***IS NOT*** a form of security barrier.
- Transporting the gauge any other way will violate our transportation license agreement.
- **Do not transport a gauge in an open bed truck.**
- REF to SOP 7-2 for more information.

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Transporting Gauge to Project

- The handle for the gauge shall be locked with a Master Lock **P-581** or **P-812** for Troxler and InstroTek gauges and an American lock **15G351** for Humboldt gauges.
- The nuclear gauge shall be placed inside the transportation case and the transportation case shall be locked with a **LSDA LOCK only.**
- All gauge tools (drill rod, scraper plate, extraction tool and standard block) shall be stored in the transportation case as designed.

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Transporting Gauge continued

- Ensure the "**Red Folder**" is with & for the gauge.
- Inspect transportation case to ensure all **labels** are in place and are **readable**. (Check case itself for any damage)
- **DO NOT transport gauge with missing or damaged labels.**
- **DO NOT transport gauge with a damaged case or missing/ broken latches.**
- If you find any damages to the case notify your Regional RSO.
- Replace missing/damaged labels before transporting.
- **Ref to SOP 7-2 (January 1, 2023)**

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Transporting Gauge continued

DO NOT drill holes or modify the Transportation case.
If something is wrong with the case notify your RSO immediately.

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USING THE GAUGE

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While Using the Gauge

- Follow SOP 7-1 for use.
- Remove Gauge only while in use.
- **Anytime the Gauge is out of the case, it shall be in the possession of the operator**

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While Using the Gauge

- Don't run gauge within ***30'*** of another gauge.
- Don't run the gauge within ***10'*** of a large object.
- Non- dosimeter badged personnel shall be ***30'*** from gauge while in use.

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While Using the Gauge

- Once operator has set the gauge to read, step away. 3ft (1m)
- You can use your truck to move the gauge on site, but the gauge **must** be placed back into its transportation case. However, you do not have to install the trigger lock or case lock.

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Do Not transport gauge like this on job site!

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EMERGENCY RESPONSE PLAN

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- An Accident Happened.
- What now?
- Look in….
- SOP 7-2

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Gauge was damaged

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EMERGENCY RESPONSE PLAN

First Priority:

If someone is critically injured

Help them:

If something is on fire

Put it out/control if possible:

Nuclear Gauge is a minimum radiation hazard in a transportation accident

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EMERGENCY RESPONSE PLAN

If no immediate threat to life or property:

1. Visually inspect gauge for damage.
2. Locate source rod if missing.
3. Secure Area, if gauge is damaged or source rod is unshielded. Evacuate everyone to min 15' radius.
4. If can't find source, evacuate larger area.

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EMERGENCY RESPONSE PLAN

- If vehicle/construction equipment is involved in incident, detain it until it can be inspected for contamination.
- **IMMEDIATELY** after the above actions contact your **Regional RSO/HQ RSO.**

NOTE: Copy of these instructions are in **SOP 7-2** in the Transportation Booklet.

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SOP 7-2

(Make sure you have the current SOP 7-2)

Make sure you have read it before transporting or using the gauge.

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If you have any questions, concerns or ideas concerning what we covered today.

Please contact me

Rocky Kelley TDOT RSO

615-924-6254 (call or text)

Or email

rocky.kelley@tn.gov

Thank You

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Nuclear Gauge Field Technician Certification

2023 version

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Why are you here?

Proper testing practices

- How to verify gauge is working
- How to determine correction factors for asphalt testing
- How to test

Where to test

- Determine Lots
- Determine random testing locations

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Contact Information

Derek Gaw

615-879-0098

Derek.Gaw@tn.gov

Rocky Kelley, State RSO

615-924-6254

Rocky.Kelley@tn.gov

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Setting Up the Gauge to Test

Before we test we need to make sure that:

- The gauge is working accurately
- Determine Correction Factors if testing on asphalt.

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Standard Count

- Keep a log of your standard counts!
- Standard counts provide a quick reference check to ensure that the gauge is operating correctly.
- A standard count must to be taken **daily** on the reference standard block.

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Standard Count

Keep a daily log of all Standard Counts.

Max Variation day to day:

- 1% for density
- 2% for moisture.

Place the reference standard block on the surface you are about to test.

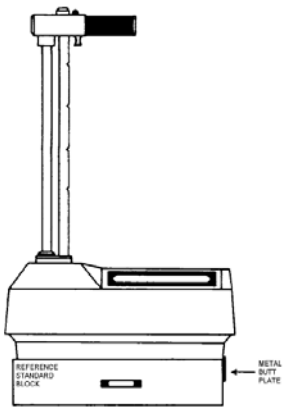

Figure 3-3. Standard Count Position

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Standard Count

Moisture Count	
Yesterday	1251
Today	1271

$\%\ VAR = \frac{Old - New}{Old} \times 100$

$= \frac{1251 - 1271}{1251} \times 100$

$= 1.5\% < 2\%$ OK

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Standard Count

If a standard count log has **NOT** been kept or if your **FIRST** standard count fails, do the following:

1. Take five new counts
2. Average the first four
3. Compared with the 5th reading
4. Check if the reading is within the required limits.

If the standard count still fails, call your Regional RSO.

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Standard Count

Example:

- Count 1: Density – 1650 Moisture – 632
- Count 2: Density – 1640 Moisture – 630
- Count 3: Density – 1630 Moisture – 628
- Count 4: Density – 1625 Moisture – 632
- Count 5: Density – 1624 Moisture – 630

Average 1636.25

Average 630.5

$Density = \frac{1636.25 - 1624}{1636.25} \times 100\% = 0.75\%$

$Moisture = \frac{630.5 - 630}{630.5} \times 100\% = 0.079\%$

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Asphalt Test Strips

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Test Strip Calibration (Asphalt)

TDOT Standard specifications 407.15.

- Nuclear Gauge readings are not valid on Asphalt until the gauge is correlated to the mix and project location. A new test strip shall be required for each project and each mix design used on the project (for mix types that require density testing as noted above). Uncorrelated gauges shall not be used for acceptance or assurance testing.

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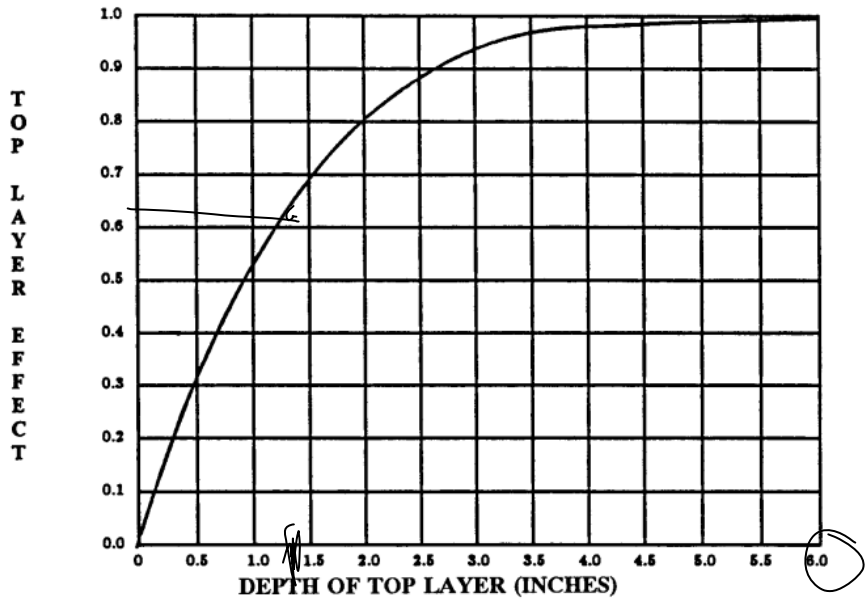

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Test Strip Calibration (Asphalt)

- Required for all mixtures that require density testing.
- Each test section shall be 1 paver width/lane width wide and a minimum of 400 SY
  - 9’ wide= 400’ long
  - 10’ wide= 360’ long
  - 11’ wide= 330’ long
  - 12’ wide= 300’ long

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Test Strip Calibration (Asphalt)

- Step 1: Compact test strip area

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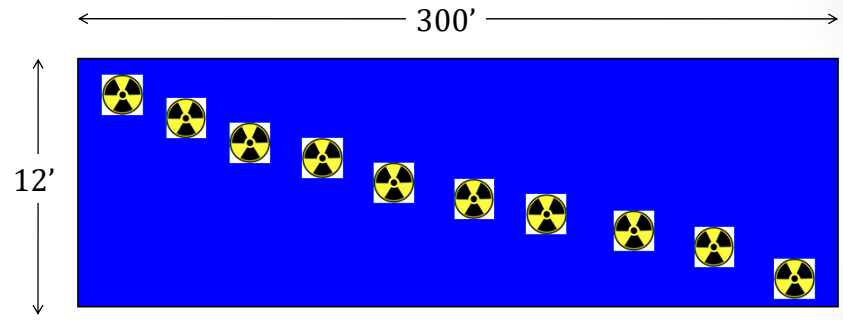
Test Strip Calibration (Asphalt)



Step 2: Layout ten test strip test locations such that the full length and width of the test strip is covered. Mark test location and test number on pavement with spray paint after running the test. Write down the density (lb/ft^3) at every location and mark the location so we can cut cores.

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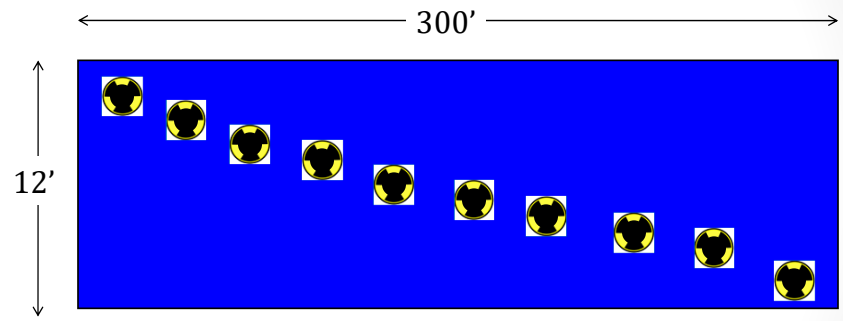
Test Strip Calibration (Asphalt)



Step 3: Cores shall be cut at same locations as nuclear density tests and tested by TDOT Plant Technician for laboratory density in accordance with AASHTO T166. (NOTE: The contractor’s technician shall not conduct this testing)

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Test Strip Calibration

- Now we can run the density of the cores in the lab to find the TRUE density of what we tested.

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Test Strip Calibration (Asphalt)

- Step 5: The nuclear gauge correction factor shall be the difference between the average of ten nuclear gauge readings and the average of ten core density values.

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Test Strip Calibration

Nuclear Gauge Results:

- 140.5 lb/ft^3
- 139.7
- 139.3
- 134.3
- 137.8
- 143.1
- 135.4
- 138.1
- 134.1
- 137.6

$\frac{1379.9}{10} = 138.0$

Core Density:

- 142.1
- 142.7
- 142.3
- 139.1
- 141.1
- 141.6
- 140.4
- 141.2
- 137.8
- 140.2

$\frac{1408.5}{10} = 140.9$

C.F. = Core – Gauge

C.F. = 140.9 – 138.0 = 2.9 pcf

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Test Strip Calibration

- What this means is that any time we use THIS nuclear gauge on THIS mix on THIS project, we should add ____2.9____to our reading.
- This correction factor ONLY applies to THIS PROJECT and THIS MIX DESIGN.

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Test Strip Calibration (Asphalt)

- **A new test strip will be required when:**
  - There is a change in job mix formulas
  - A change in the source of materials occurs
  - A change in the material from the same source is observed
  - There is reason to believe that the test strip density is not representative of the mixture being placed. For example, test results are consistently above 100% density or test results have been consistent for a steady number of days and had suddenly changed significantly.
  - A change in paving or compaction equipment occurs.

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Acceptance Testing

- Now that the gauge is confirmed to be operating correctly and we have a correction factor, we can test.

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Testing Policy

- Soil/Aggregate
  - Test shall be 1 minute in duration
  - Direct Transmission
  - Rod embedded approximately half the lift thickness being measured.
- Asphalt
  - Tests shall be 15 seconds
  - 4 tests per location, rotate gauge 90 degrees between tests
  - Backscatter Mode, all mixes

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Aspahlt "four 90s method"

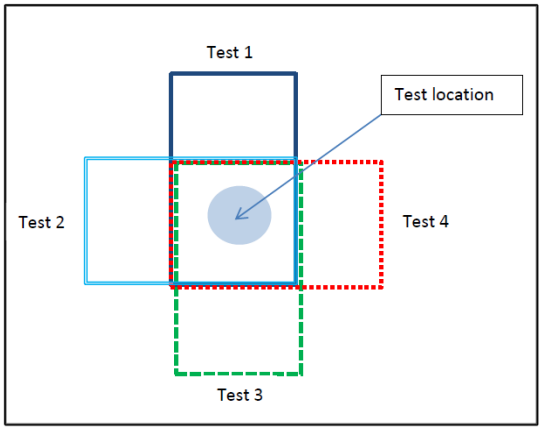

Figure 1. Testing at four 90° locations

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Quality Acceptance Testing:

General Procedure

- Identify Density/Moisture Requirements
- Based on type of material being placed
- Determine Required Lot Size/Number of Tests
- Determine Test Locations
- Perform Test(s)
- Report Results

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Identify Density/Moisture Requirements

- Acceptance criteria are different for Embankment, Aggregate Base, Asphalt Pavements, Etc.
- This information can be found in the corresponding section in the TDOT specs.
- The target values (soils/aggregate)are determined by TDOT Materials and Tests personnel and will be made available in the proctor density report
- The target values (asphalt) are determined by the JMF and the level of traffic, see **407.15**.

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Determine Required: Lot Size/Number of Tests

- S.O.P. 1-1: Sampling and Testing Guide
  - Describes the testing frequency for all materials
  - Lists the person responsible for either obtaining the sample of performing the test.
  - Available in PDF format at:

http://www.tdot.state.tn.us/materials/fieldops/sop/default.htm

(see example in Part Four of S.O.P. 1-1)

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TDOT Sampling Procedure (Asphalt)

- **SOP 1-1**

ASPHALT						
Asphalt Plant Mix Pavements	Aggregate	Fractured Face Count	Project Inspector	Per project	Coarse aggregate stockpiles	Plus No. 4 (4.75 mm) sieve material, gravel mixes only.
		Glassy Particles by mass				Plus No. 4 (4.75 mm) sieve material, slag mixes only.
	All Plant Mix Asphalt	Mix Temperature		Every 5th load	From the truck prior to leaving the plant and on the roadway prior to deposit into the paver or the material transfer device	Temperatures on the roadway are to be recorded on the delivery ticket.
		10 Minute Boil Test		Per day	From the truck at the asphalt plant	
	Plant Mix Asphalt (Grading A, B, BM, BM2, C, CW, D, E, E-Shoulder)	Density		Every 1,000 tons	As soon as practical after compaction	Each lot shall be divided into 5 equal sub-lots, and one test shall be performed per sub-lot.

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TDOT Sampling Procedure

EMBANKMENT/SUBGRADE						
Embankment	Soil	Proctor Density & Optimum Moisture	Project Inspector	As required by material changes	Cuts sampled prior to construction. Borrow pits sampled as required prior to placement.	Submit 50-75 pound sample to M&T.
		Density, Moisture		Five tests each 10 inches of lift not to exceed 1,500 feet of roadway or 5,000 cubic yards Exception: Within 50 feet of a bridge end (deck or box), one test will be performed for each lift. The test will be performed alternately on the embankment and on the backfill material.	During construction, immediately after compaction.	Density tests will not be required for embankment containing more than 50% of plus ¾ inch sieve material.
Subgrade Preparation	Soil	Proctor Density & Optimum Moisture	Project Inspector	As required by material changes	May be sampled before grading construction or after grading prior to sub-grade preparation	Submit 50-75 pound sample to M&T.
		Density, Moisture		Five tests per 10,000 square-yard lot for top 6 inches	Immediately before placing pavement	
Subgrade Treatment (Lime) OR Soil-Cement Base	Soil-Cement Mixture OR Soil-Lime Mixture	Proctor Density, Optimum Moisture	Project Inspector	Prior to beginning of construction	At beginning of compaction	Additional tests may be required to account for material changes. Submit 50-75 pound sample to M&T.
		Pulverization		Every 10,000 square yards	After mixing, before compaction	Sieve test requirement. See Standard Specs. 304.06.
		Density, Moisture		Five tests per 10,000 square-yard lot	Immediately following compaction	
		Thickness			After final finish of base	

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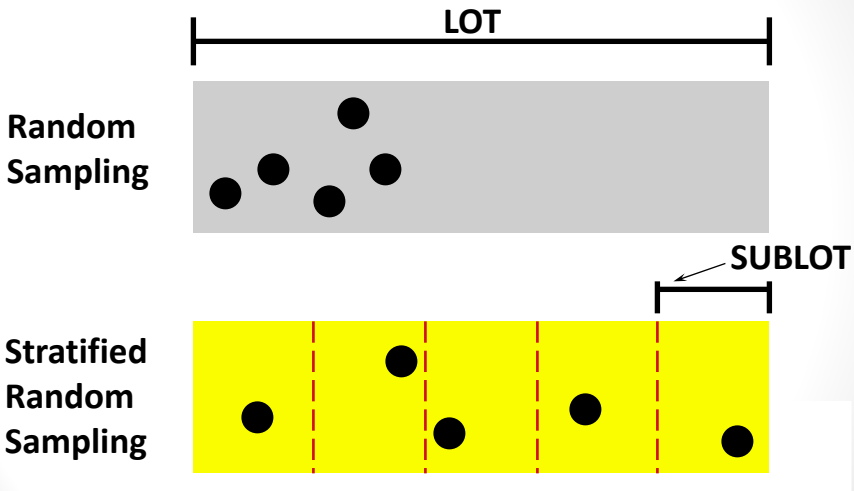
Lots and Sublots



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Random Sampling

- Any portion of the population has equal chance of being selected
- Bias is introduced when judgment is used
- Use random number tables or other means.

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Random Number Table

.20	.68	.98	.30	.27	.84	.54	.31	.05	.88
.61	.17	.38	.62	.55	.59	.67	.73	.43	.23
.27	.38	.84	.99	.72	.51	.48	.81	.77	.76
.24	.38	.40	.34	.76	.87	.60	.75	.49	.56
.88	.52	.25	.51	.79	.41	.33	.08	.32	.47
.62	.36	.97	.61	.28	.50	.81	.29	.75	.82
.94	.83	.35	.66	.42	.70	.44	.30	.54	.45

**For additional random # tables, see SOP 1-1*

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Testing Locations

- STEP 1-
  - Determine LOT size, and with known lane width, determine LOT and sublot lengths
- STEP 2-
  - With known beginning station, determine beginning sublot stations

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Testing Locations

- STEP 3-
  - Using random number table, or calculator, select 5 numbers.
- STEP 4-
  - Multiply a random number by the sublot Length.
- STEP 5-
  - Add to beginning sublot stations to determine longitudinal testing locations. *A second random number is used to find transverse location for S&A*

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Testing Locations

STATIONS

- A “station” is a unit used in roadway construction to indicate a longitudinal location along the roadway.
- One station = 100 feet
- i.e. Station 1+00 equals 100 feet

  Station 4+50 equals 450 feet

  Station 105+60 equals 10,560 feet

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Example Problem

- Situation
  - Placing D-mix, lane is 12 feet wide
  - Spread Rate is 132.5 lb/yd^2
  - Beginning Station 100+00

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Asphalt Lots and Sublots

Spread (lb/SY)	Lot/ Sublot	Mat Width (Feet)									
		4	6	8	9	10	11	12	14	15	16
132.5	Lot	34000	22600	17000	15100	13600	12300	11300	9700	9100	8500
	Sublot	6800	4520	3400	3020	2720	2460	2260	1940	1820	1700
154.5	Lot	29100	19400	14600	12900	11700	10600	9700	8300	7800	7300
	Sublot	5820	3880	2920	2580	2340	2120	1940	1660	1560	1460
226	Lot	19900	13300	10000	8800	8000	7200	6600	5700	5300	5000
	Sublot	3980	2660	2000	1760	1600	1440	1320	1140	1060	1000
254.25	Lot	17700	11800	8800	7900	7100	6400	5900	5100	4700	4400
	Sublot	3540	2360	1760	1580	1420	1280	1180	1020	940	880
282.5	Lot	15900	10600	8000	7100	6400	5800	5300	4600	4200	4000
	Sublot	3180	2120	1600	1420	1280	1160	1060	920	840	800
310.75	Lot	14500	9700	7200	6400	5800	5300	4800	4100	3900	3600
	Sublot	2900	1940	1440	1280	1160	1060	960	820	780	720
345	Lot	13000	8700	6500	5800	5200	4700	4300	3700	3500	3300
	Sublot	2600	1740	1300	1160	1040	940	860	740	700	660
460	Lot	9800	6500	4900	4300	3900	3600	3300	2800	2600	2400
	Sublot	1960	1300	980	860	780	720	660	560	520	480

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Example Problem (cont.)

- STEP 1- Determine Lot Length
  - 1,000 Ton lot
  - 132.5 lb/yd2
  - 12-feet wide
  - Begin Station = 100+00
  - From Table
    - Lot Length = 11,300 feet
    - Sublot Length = 2,260 feet

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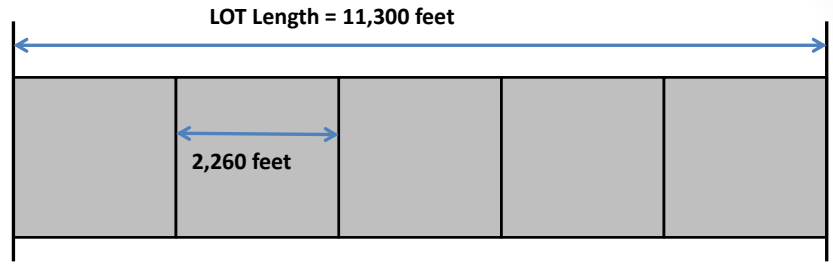
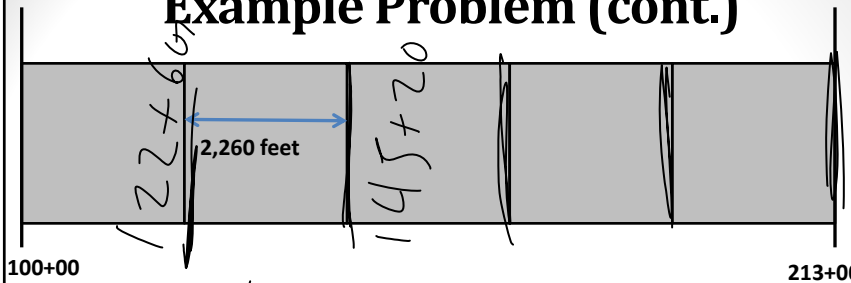
Example Problem (cont.)



10000
+ 11300
213+00

97

Example Problem (cont.)



12260
+ 2260
145+20

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Example Problem (cont.)

- **STEP 1-**

  LOT= 11,300’ SUB-LOT=2,260’

- **STEP 2- (Beginning Station 100+00)**
  - [100+00]+2,260 = 10,000+2,260 = 12,260 = 122+60
  - [122+60]+2,260 = 12,260+2,260 = 14,520 = 145+20
  - [145+20]+2,260 = 14,520+2,260 = 167+80
  - [167+80]+2,260 = 190+40
  - [190+40]+2,260 = 213+00
  - [100+00]+11,300 = 213+00

End of Lot

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Example Problem (cont.)

- **STEP 3-** Using a random number table, select 5 numbers

.20	.68	.98	.30	.27	.84	.54	.31	.05	.88
.61	.17	**.38**	.62	.55	.59	.67	.73	.43	.23
.27	.38	.84	.99	.72	.51	.48	.81	.77	**.76**
.24	.38	.40	.34	.76	.87	.60	.75	.49	.56
.88	.52	.25	.51	.79	.41	.33	.08	.32	.47
.62	.36	.97	**.61**	.28	**.50**	.81	.29	.75	.82
.94	.83	.35	.66	.42	.70	.44	.30	.54	.45

Random Number Table

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Example Problem (cont.)

- **STEP 4-** Determine the distance within each sublot that each test will be located using both the sublot length and a random number.
  - Round to the nearest whole number.

  - Sublot #1 = (2,260' x 0.38) = **859 feet**
  - Sublot #2 = (2,260' x 0.50) = **1,130 feet**
  - Sublot #3 = (2,260' x 0.61) = **1,379 feet**
  - Sublot #4 = (2,260' x 0.76) = **1,718 feet**
  - Sublot #5 = (2,260' x 0.20) = **452 feet**

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Example Problem (cont.)

- **STEP 5-** Determine where the gauge reading will be taken by adding each length to the start of each sublot.

  - Sublot #1 = (10,000') + 859' = 10,859' = **108+59**
  - Sublot #2 = (12,260') + 1,130' = 13,390' = **133+90**
  - Sublot #3 = (14,520') + 1,379' = 15,899' = **158+99**
  - Sublot #4 = (16,780') + 1,718' = 18,498' = **184+98**
  - Sublot #5 = (19,040') + 452' = 19,492' = **194+92**

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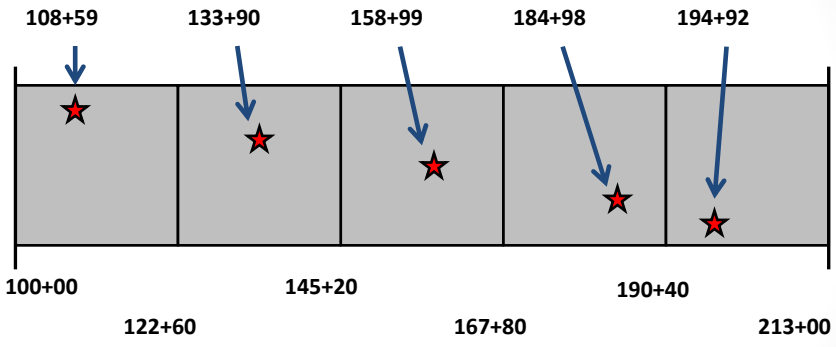
Example Problem (cont.)



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Soils/Aggregate Example Problem

Situation

- Placing Type A Base Material
- Typical base stone cross-section is 30 Feet
- Beginning Station 100+00

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Example Problem (Continued)

- STEP 1- **(Per SOP 1-1)**
  - 10,000 SY LOT
  - LOT Length: 10,000 yd^2 x 9 = 90,000 ft^2
    90,000 ft^2 / 30 ft = 3000 ft length
  - SUB-LOT Length: 3000 ft / 5 = 600 ft

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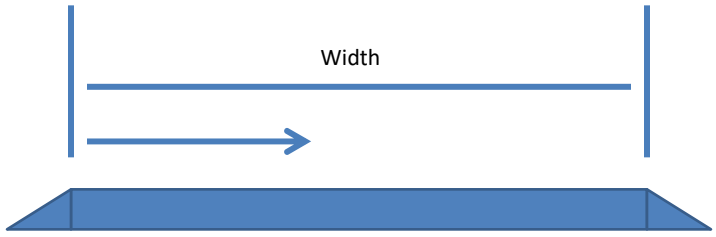
Soils/Aggregate Continued

- Transverse location must also be random



Transverse Location = Width X Random Number

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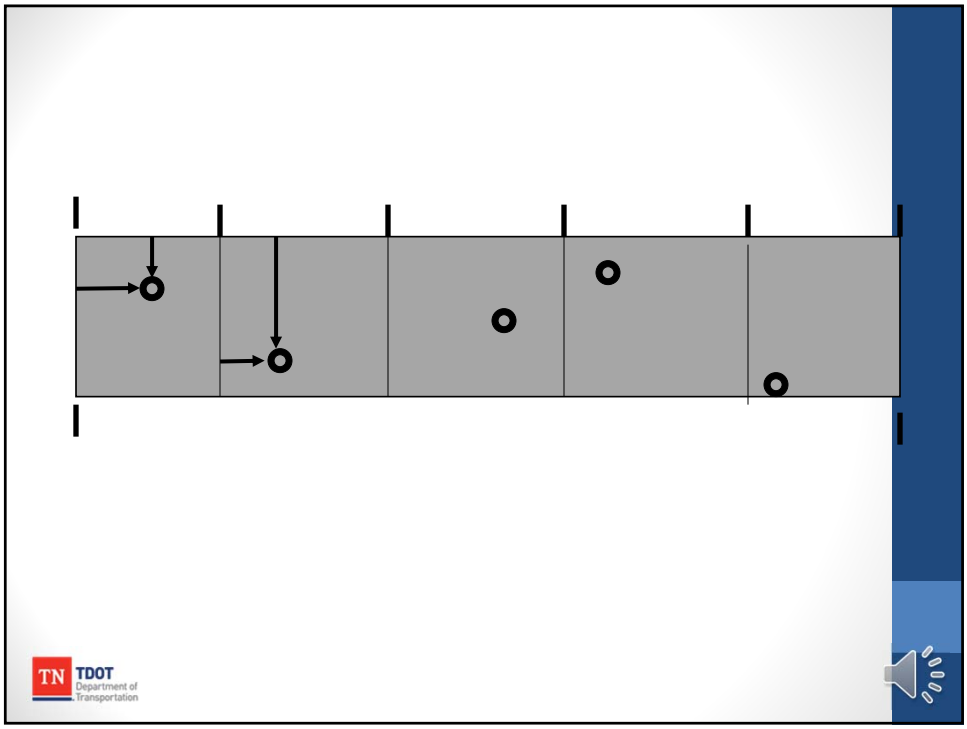

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