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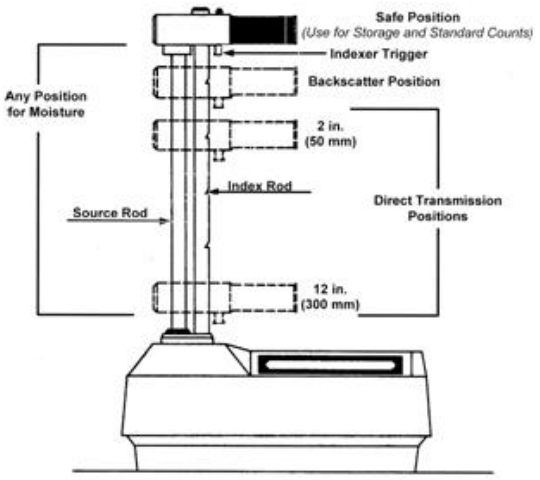

RADIATION SAFETY CERTIFICATION COURSE

VERSION 18.5

Division of Materials and Tests 2018

TDOT Radiation Safety Certification

Why are you here?

- Operators must be trained as required by Federal and State law
- TDOT nuclear gauge policies
- SAFETY of operators, co-workers and the public.

Radiation Safety Course

- Radioactivity Awareness
- Nuclear Gauge Uses
- Nuclear Gauge Storage
- Transportation Requirements

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Instructors

- Matthew Chandler
  Matthew.Chandler@tn.gov
- Ulises Martinez
  Ulises.Martinez@tn.gov
- Jimmy Britt
  Jimmy.Britt@tn.gov
- Rocky Kelley
  Rocky.Kelley@tn.gov

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Class Organization

- Classroom
- Test:
  - **40** questions
  - Open book/notes
  - To Pass: Must get 70% overall on written exam

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ADA Notice of Requirements

- Can be found at the following website:
  - http://www.tn.gov/tdot/topic/transportation-americans-with-disabilities-notice
- To be in compliance with TDOTs requirements listed on the website above, it is our goal to provide reasonable accommodations to those who identify themselves as having a disability and request such accommodations.
- Please feel free to bring it to any of the course instructors and accommodations will be administered as discretely as possible.

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No Tobacco Related Product Inside Building!!!!!!!!!!!!!!!

No Electronic Cigarette
No Chewing Tobacco Allowed
Spitting into a bottle disturbs others

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Radiation Safety Officers

Headquarters Radiation Safety Officer (RSO):
Rocky Kelley
(615)-924-6254

Regional RSOs

Region 1: Billy Goins	(865) 806-1935
Region 2: Jeff Yarworth	(423) 322-0649
Region 3: Mark Hand	(615) 806-9123
Region 4: Marc Turner	(731) 352-5327

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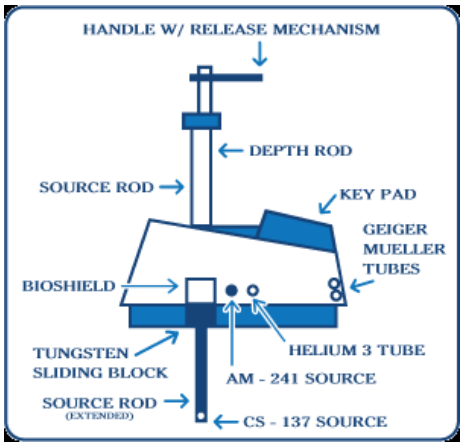
The Basics of any Gauge



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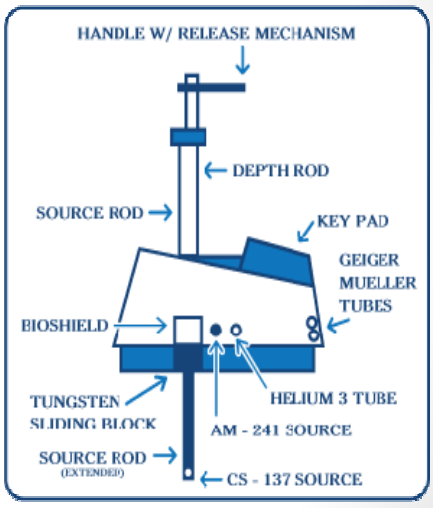
Radioactivity

- A small amount of radioactive material is embedded at the end of the detection rod of these gauges 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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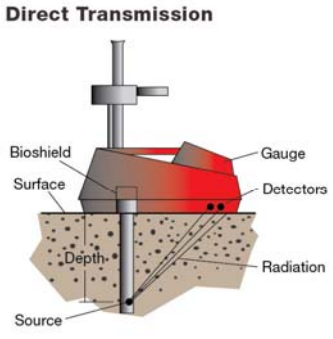
What are they used for?

Moisture Density Gauge



Measuring in place density of embankment and base stone…

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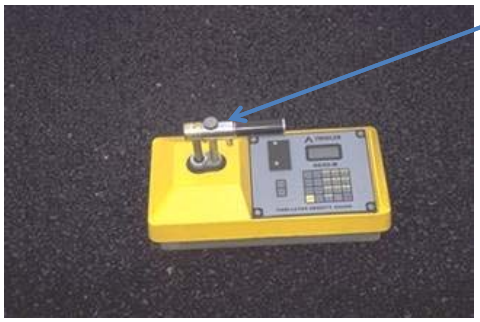
What are they used for?



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

… and in place density of Asphalt Pavements

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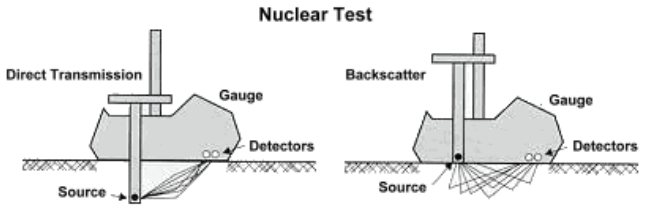
Direct Transmission vs. Backscatter Modes



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Radiation Awarness Training

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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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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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Radioactivity

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. UNLESS…

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Radioactivity

Declared Pregnant Workers shall be limited to 0.5 rems of exposure during the pregnancy

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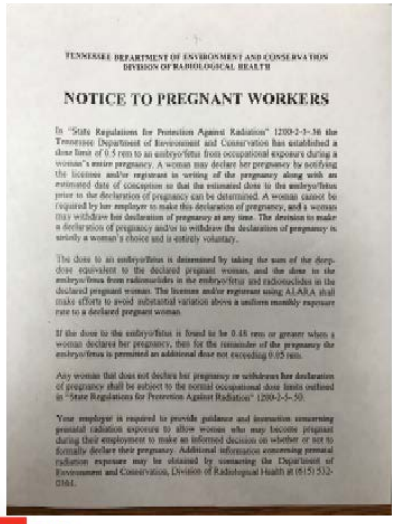
Radioactivity



TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF RADIOLOGICAL HEALTH

NOTICE TO PREGNANT WORKERS

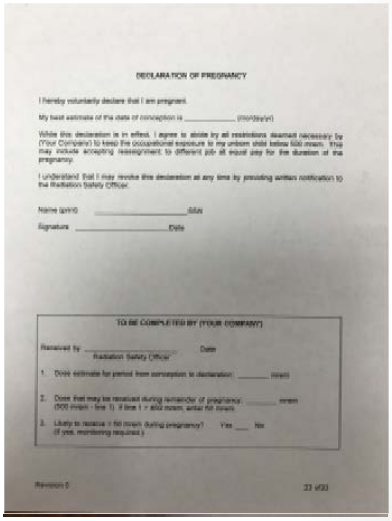
In "State Regulations for Protection Against Radiation" 1200-2-3-.16 the Tennessee Department of Environment and Conservation has established a dose limit of 0.5 rem to an embryo/fetus from occupational exposure during a woman's entire pregnancy. A woman may declare her pregnancy by notifying the licensee and/or registrant in writing of the pregnancy along with an estimated date of conception so that the estimated dose to the embryo/fetus prior to the declaration of pregnancy can be determined. A woman cannot be required by her employer to make this declaration of pregnancy, and a woman may withdraw her declaration of pregnancy at any time. The decision to make a declaration of pregnancy and/or to withdraw the declaration of pregnancy is strictly a woman's choice and is entirely voluntary.

The dose to an embryo/fetus is determined by taking the sum of the deep-dose equivalent to the declared pregnant woman, and the dose to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman. The licensee and/or registrant using ALARA shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman.

If the dose to the embryo/fetus is found to be 0.45 rem or greater when a woman declares her pregnancy, then for the remainder of the pregnancy the embryo/fetus is permitted an additional dose not exceeding 0.05 rem.

Any woman that does not declare her pregnancy or withdraws her declaration of pregnancy shall be subject to the normal occupational dose limits outlined in "State Regulations for Protection Against Radiation" 1200-2-3-.50.

Your employer is required to provide guidance and instruction concerning prenatal radiation exposure to allow women who may become pregnant during their employment to make an informed decision on whether or not to formally declare their pregnancy. Additional information concerning prenatal radiation exposure may be obtained by contacting the Department of Environment and Conservation, Division of Radiological Health at (615) 532-0364.



DECLARATION OF PREGNANCY

I hereby voluntarily declare that I am pregnant.

My best estimate of the date of conception is _____ (month/day/yr)

While this declaration is in effect, I agree to abide by all restrictions deemed necessary by (Your Company) to keep the occupational exposure to my unborn child below 500 mrem. This may include accepting reassignment to different job at equal pay for the duration of the pregnancy.

I understand that I may revoke this declaration at any time by providing written notification to the Radiation Safety Officer.

Name (print) _____ date

Signature _____ Date

TO BE COMPLETED BY (YOUR COMPANY)

Received by _____ Date
Radiation Safety Officer

1. Dose estimate for period from conception to declaration: _____ mrem
2. Dose that may be received during remainder of pregnancy: _____ mrem (500 mrem - line 1). If line 1 > 500 mrem, enter 0 mrem.
3. Likely to receive > 50 mrem during pregnancy? Yes ___ No ___
(If yes, monitoring required.)

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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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Personal Dosimetry Film Badges

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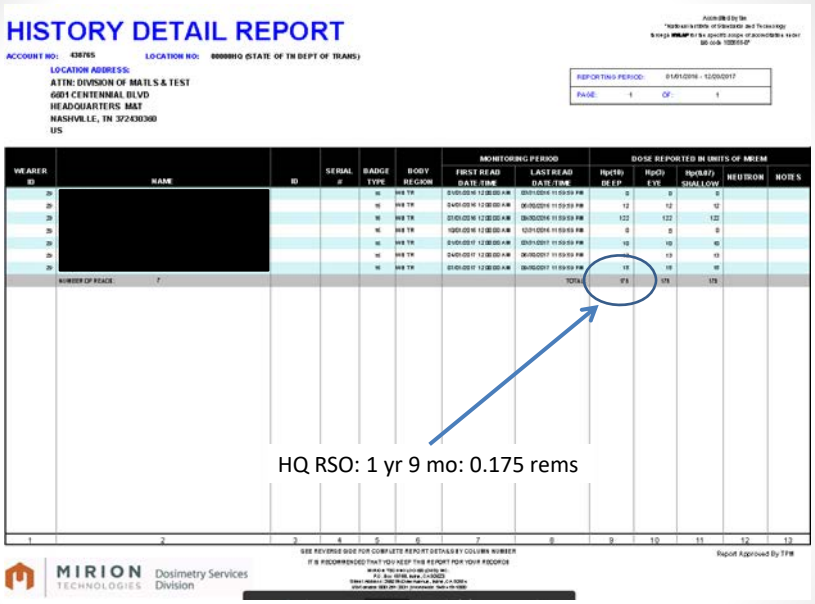

The ALARA Philosophy

- As Low as Reasonably Achievable –
- 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 should wear “personal dosimetry film badges” which help monitor whether technicians are absorbing radiation.

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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
- This license lists all radioactive sources owned and maintained by TDOT and dictates how they will be transported and monitored.
- This license is owned and operated by personnel within the HQ Materials and Tests Field Operations Section.

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Storing the Gauge

- The handle shall be locked and the gauge stored in its transport case.
- The transport case shall be locked.
- 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" (can be obtained from HQ RSO).

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Storage Site

- **Do not store a nuclear gauge in a motor vehicle except:**
  - The actively working on a project. Overnight is okay between days where nuclear gauge readings will be taken.
- **A log of all gauges stored at the site will be maintained at the storage site. All gauges must be checked in when stored and checked out by the operator when in use.**
- Storage site must be enclosed (four walls and a roof) and it must protect gauges from the elements.
- 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 storaged site.

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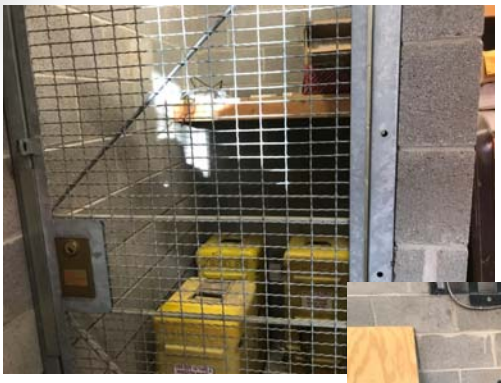

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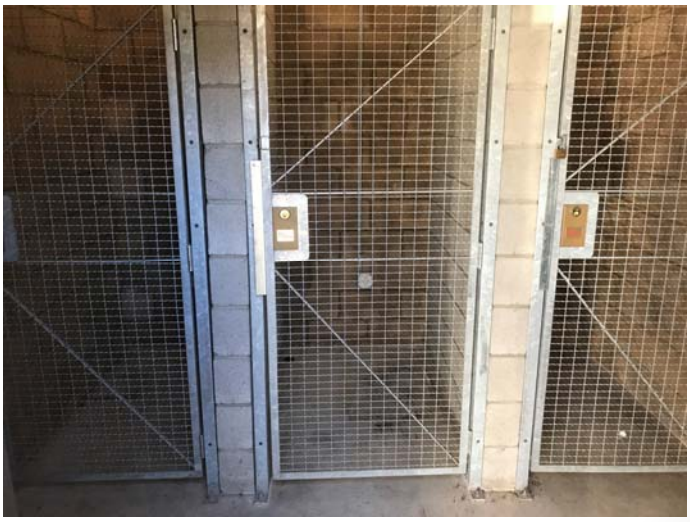

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Transporting the Gauge

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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 shut.
- DO NOT USE or TRANSPORT the gauge unless the sliding block is completely closed. Increased radiation levels may violate transportation regulations and cause excessive personal radiation exposure.

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Transporting Gauge to Project

- The handle for the gauge shall be locked into the safe position during transport.
- The nuclear gauge shall be locked inside the transport case during transport.
- Transport the nuclear gauge in the rearmost part of the bed of a truck inside either:
  - A locked bed cover with the device secured in place with heavy chain to prevent the case from moving or
  - A mounted transportation box, specifically designed for the nuclear gauge case.
- No one other than Dosimeter Badge wearer with Hazmat Training is allowed in the vehicle while the nuclear gauge is in the vehicle.

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Transporting Gauge to Project

- While in transit the following paperwork must be in the vehicle and readily accessible by the driver:
  - Nuclear gauge bill of lading (BOL),
  - Operator's nuclear safety certificate,
  - Nuclear gauge shipping paper,
  - TDOT Radiation Safety Plan (SOP 7-2),
- At any time the vehicle is parked while the gauge is stowed for transit, the shipping paper must be place face up in the driver's seat.

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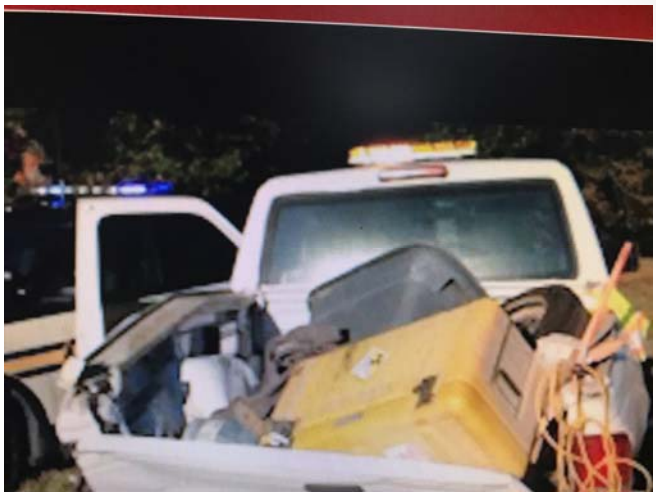

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While Using the Gauge

- Follow SOP 7-1 for use (later)
- Remove Gauge only while in use.
- Anytime Gauge is out of the case, 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-badged personnel shall be 30’ from gauge while in use.

While Using the Gauge

- Once operator has set the gauge to read, step away.
- Can use truck to move gauge on site, but gauge must be placed back into it's case and in bed of truck, but do not have to lock case

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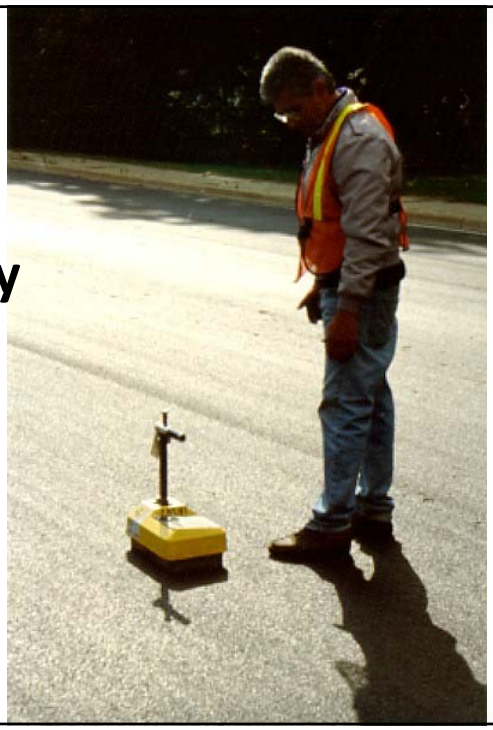
Nothing to see here, step away until it beeps



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Name 3 things bad

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EMERGENCY RESPONSE PLAN

- An Accident Happened.
- What now?

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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 not immediate threat to life or property:
  - Visually inspect gauge for damage
  - Locate source rod if missing
  - Secure Area, if gauge is damaged or source rod is unshielded. Evacuate everyone to min 15' radius.
  - If can't find source: evacuate larger area

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EMERGENCY RESPONSE PLAN

- If not immediate threat to life or property:
  - If vehicle/construction equipment is involved in incident, detain it until it can be inspected for contamination
  - ASAP after the above actions contact your regional RSO/HQ RSO

NOTE: Copy of these instructions are in the transportation papers.

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APPENDIX

TDOT Standard Operating Procedures, Specifications, Supplemental Specifications, Special Provisions, & Circular Letters

Standard Operating Procedures

- SOP 1-1: Sampling and Testing Guide
- SOP 7-1: Nuclear Gauge Operation
- SOP 7-2: Nuclear Gauge Safety Plan

TDOT Specifications

- 407.15 Test Strip

Supplemental Specifications

- Section 400

TDOT Forms

- Density Worksheet – Nuclear Method (Aggregate, Soil) DT-0314
- Daily Asphalt Density Report DT-0315
- Daily Report on Soil and Aggregate Stabilization DT-0298
- Daily Report on Embankments DT-0304
- Daily Report on Mineral Aggregate DT-0307

Tennessee Department of Transportation
Division of Materials and Tests

Part Five: Using Random Numbers for Sampling and Testing
(With Examples and Random Number Tables)

Significance

The selection of test locations is critical in ensuring control of materials and construction work. If the results from the test locations conform to specified tests, the rest of the work is assumed to conform as well.

Test sites, then, are samples of construction work under your inspection. Their locations should be random and representative of the entire lot of material.

The procedures outlined below will help you to choose random and representative test locations using random number tables. Random numbers may also be generated by the use of a random number function on a calculator, a spreadsheet program, etc.

Random Number Tables

Randomness in transportation construction inspection indicates unpredictability in the time or location of sampling and testing of a material or procedure in a construction phase.

Random numbers occur in no pattern or sequence. When you review a series of random numbers, you do not know what number may come next; there is no particular order in which random numbers occur.

A sample random-number table is shown below.

	A		B		C		D		E		
	0.814	0.759	0.651	0.947	0.965	0.994	0.581	0.877	0.500	0.208	
	0.105	0.015	0.323	0.630	0.223	0.616	0.070	0.469	0.672	0.931	
1	0.035	0.841	0.590	0.184	0.488	0.794	0.909	0.940	0.062	0.031	1
	0.741	0.336	0.346	0.926	0.237	0.967	0.385	0.657	0.521	0.921	
	0.278	0.697	0.423	0.365	0.010	0.210	0.264	0.745	0.378	0.337	
	0.834	0.355	0.952	0.924	0.591	0.003	0.280	0.363	0.175	0.254	
	0.204	0.159	0.006	0.006	0.764	0.020	0.768	0.209	0.959	0.147	
2	0.426	0.860	0.160	0.009	0.978	0.033	0.394	0.445	0.682	0.600	2
	0.990	0.330	0.581	0.946	0.129	0.047	0.384	0.363	0.038	0.275	
	0.837	0.658	0.140	0.344	0.189	0.047	0.675	0.923	0.101	0.122	
	0.537	0.505	0.909	0.794	0.249	0.339	0.850	0.326	0.510	0.961	
	0.286	0.447	0.286	0.975	0.458	0.484	0.992	0.078	0.947	0.756	
3	0.492	0.633	0.262	0.660	0.451	0.511	0.255	0.439	0.185	0.712	3
	0.428	0.126	0.884	0.203	0.199	0.222	0.638	0.492	0.062	0.967	
	0.443	0.927	0.626	0.542	0.746	0.683	0.822	0.242	0.481	0.077	
	0.343	0.529	0.955	0.122	0.692	0.721	0.393	0.774	0.986	0.485	
	0.070	0.948	0.408	0.338	0.921	0.355	0.252	0.916	0.255	0.456	
4	0.832	0.666	0.385	0.337	0.918	0.098	0.209	0.163	0.921	0.241	4
	0.858	0.470	0.756	0.923	0.799	0.250	0.101	0.615	0.891	0.120	
	0.153	0.773	0.722	0.819	0.626	0.393	0.340	0.202	0.120	0.793	
	0.142	0.636	0.217	0.005	0.597	0.628	0.994	0.150	0.375	0.969	
	0.882	0.905	0.272	0.637	0.201	0.768	0.002	0.568	0.176	0.702	
5	0.369	0.985	0.930	0.070	0.891	0.835	0.340	0.283	0.863	0.566	5
	0.423	0.658	0.311	0.795	0.174	0.419	0.909	0.600	0.885	0.145	
	0.461	0.878	0.363	0.644	0.890	0.278	0.219	0.312	0.585	0.923	
	A		B		C		D		E		

Lot sizes vary depending on the type of construction and the material. For example, a lot for earthwork construction is defined by the width and length of roadway, while concrete tests for bridge decks (slump, temperature, and air content) are determined by the volume of concrete delivered to the site.

Determine the lot size and the number of samples and tests required per lot from the Sampling and Testing (S&T) Guide and Schedule (SOP 1-1).

Knowing the type of construction and the material to be tested, use the S&T Schedule to determine the type of test and frequency of testing.

This SOP changes as construction materials, equipment, and practices change, so you must consult the current Part 2: Acceptance Sampling &Test Schedule.

Below are three examples using random numbers.

Example 1: Moisture and density must be measured on a lift of aggregate for subgrade preparation of a roadbed. The proposed roadway is 48-feet wide.

According to the Sampling and Testing Schedule (SOP 1-1, Part 2, shown below), five tests for moisture and density are required for every 10,000-square-yard lot of aggregate placed.

Subgrade Preparation	Soil	Proctor Density & Optimum Moisture	Materials & Tests	As required by material changes.	May be sampled before grading construction or after grading prior to sub-grade preparation.	
		Density, Moisture	Project Inspector	5 tests per10, 000 yd^2 lot for top 6 inches.	Immediately before placing pavement structure.	Average of 5 tests in lot used to determine pass-fail, with no individual test below 95% of Proctor. Average lot to be no less than 100%.

Since the project is 48 feet wide, the lot length will be, *at most,*

$$\frac{10000\ \text{yd}^2\ \text{area of aggregate} \times 9\frac{\text{ft}^2}{\text{yd}^2}}{48\ \text{feet wide}} = 1875\ \text{feet per lot}$$

We decide to use 1000 linear feet of roadway as our designated lot since this is shorter than the allowable lot length of 1875 feet.

Using the table of random numbers shown below, we randomly choose a block of numbers, say, block C2.

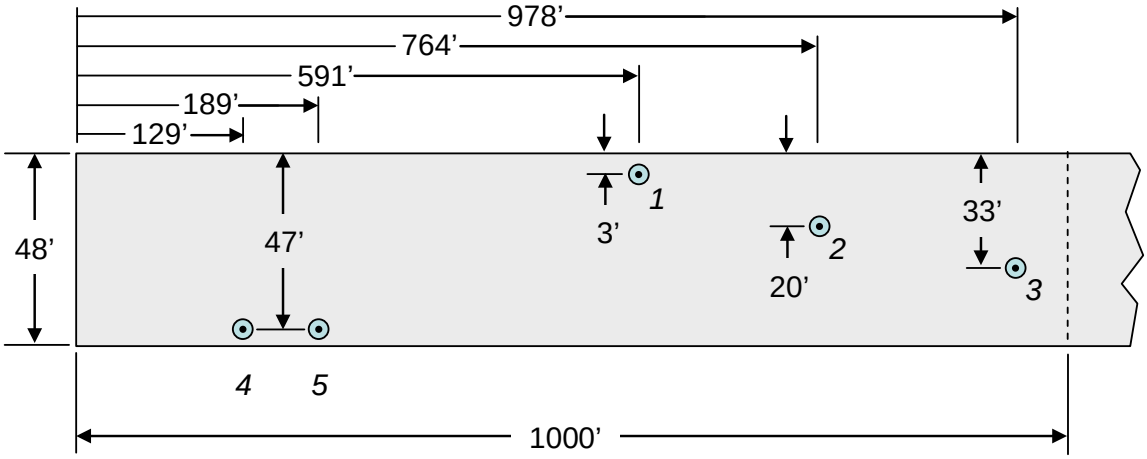
	A		B		C		D		E		
	0.271	0.584	0.674	0.883	0.379	0.976	0.555	0.083	0.967	0.812	
	0.185	0.905	0.686	0.491	0.424	0.566	0.724	0.582	0.393	0.176	
1	0.283	0.202	0.692	0.475	0.436	0.304	0.375	0.660	0.731	0.384	1
	0.567	0.800	0.642	0.205	0.827	0.129	0.598	0.216	0.124	0.787	
	0.703	0.621	0.893	0.063	0.755	0.194	0.133	0.110	0.795	0.824	
	0.103	0.338	0.620	0.594	0.591	0.069	0.639	0.203	0.313	0.733	
	0.536	0.826	0.362	0.321	0.764	0.408	0.487	0.515	0.591	0.676	
2	0.017	0.218	0.365	0.209	0.978	0.688	0.546	0.490	0.795	0.241	2
	0.840	0.594	0.341	0.006	0.129	0.986	0.350	0.437	0.927	0.782	
	0.161	0.720	0.366	0.219	0.189	0.985	0.899	0.501	0.793	0.889	
	0.251	0.496	0.741	0.314	0.014	0.839	0.124	0.209	0.292	0.099	
	0.380	0.901	0.262	0.180	0.459	0.843	0.640	0.720	0.131	0.132	
3	0.637	0.274	0.959	0.050	0.924	0.773	0.314	0.390	0.819	0.410	3
	0.310	0.324	0.111	0.760	0.706	0.165	0.930	0.515	0.639	0.116	
	0.568	0.379	0.600	0.362	0.697	0.006	0.080	0.680	0.028	0.206	
	0.378	0.392	0.910	0.202	0.512	0.156	0.336	0.465	0.813	0.471	
	0.805	0.641	0.118	0.878	0.932	0.196	0.018	0.094	0.419	0.211	
4	0.830	0.106	0.643	0.706	0.720	0.299	0.252	0.598	0.955	0.021	4
	0.367	0.538	0.050	0.448	0.896	0.669	0.968	0.984	0.890	0.117	
	0.274	0.509	0.848	0.645	0.890	0.998	0.389	0.611	0.586	0.137	
	0.566	0.802	0.283	0.151	0.399	0.316	0.559	0.684	0.318	0.516	
	0.078	0.505	0.541	0.962	0.868	0.007	0.192	0.610	0.255	0.081	
5	0.458	0.811	0.454	0.476	0.156	0.385	0.198	0.102	0.762	0.372	5
	0.486	0.345	0.786	0.759	0.465	0.222	0.487	0.355	0.935	0.223	
	0.783	0.432	0.275	0.218	0.942	0.054	0.641	0.278	0.957	0.778	
	A		B		C		D		E		

Using block C2, we have 10 random numbers that range between 0 and 1 carried to the thousandth decimal place. We will use these as multiplication factors to determine our test locations in the following table. The left-hand column of numbers in block C2 will be used to determine the longitudinal coordinates (length of the proposed roadway) by multiplying the lot length by the random number, then rounding to the nearest whole number. The right-hand column of numbers in block C2 will be used to determine the lateral coordinates (perpendicular to the proposed roadway) by multiplying the lot width by the random number, then rounding to the nearest whole number.

SAMPLE NO.	LENGTH	RANDOM NO.	LONGITUDINAL COORDINATE
1	1000	0.591	591
2	1000	0.764	764
3	1000	0.978	978
4	1000	0.129	129
5	1000	0.189	189

SAMPLE NO.	WIDTH	RANDOM NO.	LATERAL COORDINATE
1	48	0.069	3
2	48	0.408	20
3	48	0.688	33
4	48	0.986	47
5	48	0.985	47

Now, we simply match the first longitudinal coordinate with the first lateral coordinate to locate the first test location. Then, we match the remainder of the longitudinal and lateral coordinates to determine the remaining 4 test locations. The figure below shows the locations of the tests on the roadbed.



PLAN VIEW OF TEST AREA
(NOT TO SCALE)

Example 2: Nuclear gauge tests of density on 3.5 inches of Grading 307-A asphalt pavement that is 12 feet wide. The spread rate for 3.5 inches is 402.5 lbs/yd^2.

According to the Sampling and Testing Schedule (SOP 1-1, Part 2, shown below), five tests for density are required for every 1,000 ton lot of asphalt placed.

Bituminous Plant Mix Pavements	Plant Mix Asphalt Gradings A, B, BM, BM2, C, CW, D, E, and E Shoulder	Density	Project Inspector	1,000 tons	As soon as practical after compaction, when nuclear method is used. When used, cores will be obtained in accordance with SP407DEN.	Each lot shall be divided into 5 equal-sized sublots, and one test should be performed per each sublot. Longitudinal test locations should be determined randomly. No single transverse test location shall be duplicated within any single lot.

Since the lot size is 1,000 tons, the maximum lot size will be,

$$\frac{1{,}000 \text{ tons} \times 2{,}000 \dfrac{\text{lb}}{\text{ton}}}{402.5 \dfrac{\text{lb}}{\text{yd}^2}} = 4{,}969 \text{ square yards}$$

Converting this into square feet,

$$4{,}969 \text{ yd}^2 \times 9 \frac{\text{ft}^2}{\text{yd}^2} = 44{,}721 \text{ft}^2$$

Since the project is 12 feet wide, the maximum lot will be,

$$44{,}721 \text{ft}^2 \div 12 \text{ ft wide} = 3{,}726.8 \text{ ft}$$

Dividing this lot into five equal sub-lots, $3727 \text{ ft} \div 5 = 745 \text{ feet per sub - lot}$

LOT SIZE (yd^2)		LANE WIDTH (ft)			
		10	11	12	13
5,000	LOT LENGTH	4500	4091	3750	3462
	SUB-LOT LENGTH	900	818	750	692
10,000	LOT LENGTH	9000	8182	7500	6923
	SUB-LOT LENGTH	1800	1636	1500	1385

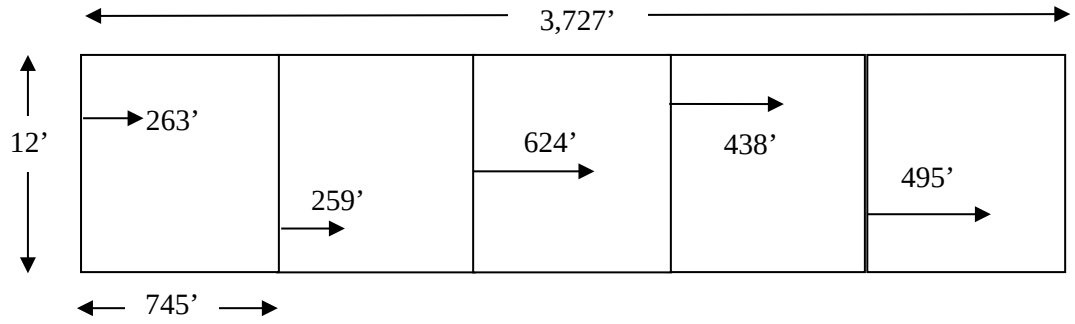
Using the table of random numbers shown below, we randomly choose a block of numbers, say, block D5.

	A		B		C		D		E		
	0.781	0.437	0.811	0.662	0.105	0.135	0.509	0.792	0.137	0.779	
	0.311	0.114	0.878	0.378	0.984	0.741	0.177	0.558	0.725	0.807	
1	0.746	0.926	0.294	0.674	0.952	0.597	0.559	0.685	0.891	0.909	1
	0.381	0.729	0.057	0.378	0.166	0.332	0.807	0.034	0.628	0.090	
	0.954	0.130	0.447	0.548	0.199	0.658	0.897	0.349	0.396	0.742	
	0.265	0.732	0.808	0.566	0.484	0.163	0.114	0.631	0.992	0.934	
	0.769	0.313	0.280	0.451	0.035	0.787	0.223	0.994	0.111	0.777	
2	0.729	0.963	0.946	0.178	0.198	0.252	0.085	0.630	0.677	0.055	2
	0.140	0.111	0.712	0.641	0.576	0.558	0.407	0.384	0.653	0.181	
	0.923	0.316	0.508	0.284	0.406	0.228	0.920	0.875	0.403	0.503	
	0.602	0.516	0.251	0.954	0.268	0.197	0.809	0.004	0.769	0.678	
	0.138	0.246	0.819	0.198	0.418	0.126	0.835	0.187	0.680	0.855	
3	0.178	0.399	0.550	0.565	0.071	0.916	0.560	0.219	0.537	0.856	3
	0.613	0.157	0.218	0.001	0.535	0.576	0.146	0.010	0.215	0.190	
	0.097	0.155	0.388	0.403	0.252	0.987	0.775	0.596	0.365	0.231	
	0.373	0.974	0.929	0.104	0.447	0.449	0.447	0.147	0.424	0.195	
	0.880	0.803	0.036	0.846	0.058	0.834	0.010	0.314	0.011	0.621	
4	0.749	0.231	0.217	0.206	0.869	0.810	0.804	0.426	0.157	0.881	4
	0.020	0.048	0.404	0.368	0.917	0.374	0.444	0.214	0.432	0.827	
	0.052	0.601	0.318	0.016	0.766	0.513	0.623	0.065	0.409	0.816	
	0.777	0.941	0.140	0.401	0.171	0.139	0.353	0.481	0.209	0.735	
	0.406	0.017	0.252	0.730	0.476	0.188	0.347	0.656	0.945	0.149	
5	0.044	0.413	0.782	0.032	0.459	0.856	0.838	0.594	0.322	0.654	5
	0.980	0.185	0.574	0.166	0.025	0.962	0.588	0.134	0.198	0.704	
	0.237	0.162	0.155	0.373	0.673	0.104	0.665	0.070	0.849	0.957	
	A		B		C		D		E		

Using block D5, we have 10 random numbers that range between 0 and 1 carried to the thousandth decimal place. We will use the multiplication factors in the left-hand column to determine our longitudinal test locations. Transverse locations are determined randomly with one test 12" off each edge, one test in each wheel path, and one test in the center of the lane.

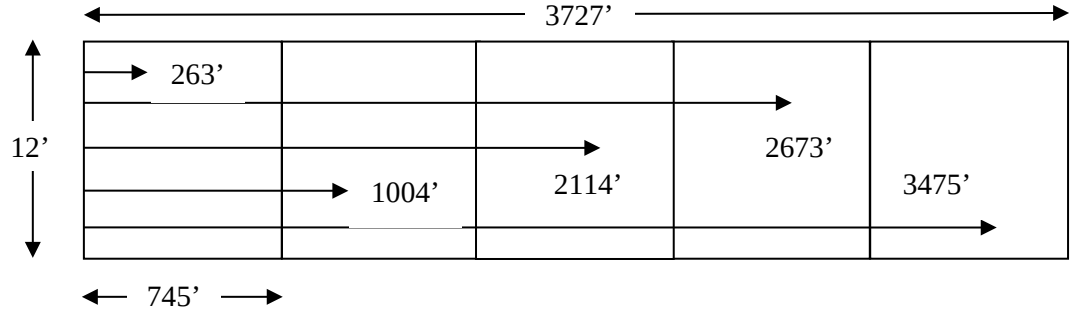
The distances into each sublot,

$$745\,\text{ft} * 0.353 = 263\,\text{ft}$$
$$745\,\text{ft} * 0.347 = 259\,\text{ft}$$
$$745\,\text{ft} * 0.588 = 438\,\text{ft}$$
$$745\,\text{ft} * 0.838 = 624\,\text{ft}$$
$$745\,\text{ft} * 0.665 = 495\,\text{ft}$$



If we wanted to know the total distance into the 3750’ lot for each test:

$$\text{Test } 1 = 263 \text{ ft}$$
$$\text{Test } 2 = 745 \text{ ft} + 259 \text{ ft} = 1004 \text{ ft}$$
$$\text{Test } 3 = 745 \text{ ft} + 745 \text{ ft} + 624 \text{ ft} = 2114 \text{ ft}$$
$$\text{Test } 4 = 745 \text{ ft} + 745 \text{ ft} + 745 \text{ ft} + 438 \text{ ft} = 2673 \text{ ft}$$
$$\text{Test } 5 = 745 \text{ ft} + 745 \text{ ft} + 745 \text{ ft} + 745 \text{ ft} + 495 \text{ ft} = 3475 \text{ ft}$$



Example 3: Slump, temperature, and air content of concrete from mixing trucks delivering concrete to a bridge deck pour that is expected to use 1300 cubic yards of concrete.

According to the Sampling and Testing Schedule (SOP 1-1, Part 2, shown below), one complete set of tests for air content, slump, and temperature are required for the first three loads of concrete delivered.

One pair of cylinders must be cast from one of the three passing loads. For each additional 50 cubic yards of concrete, a pair of cylinders must be made and tests for air content, slump, and temperature must be performed.

Completed Concrete Mix	Cylinders (28-day) Slump, Air Content, and Mix Temperature *All early break cylinders shall comply with acceptance cylinders	Project Inspector	*A complete set of tests and pair of cylinders for each 100 yd^3 placed per critical unit of structure. For Class D or L, One complete set of tests for each of the first three loads. One pair of cylinders shall be cast from one of the first three passing loads; additional tests and sets of cylinders to be made for each additional 50 yd^3.	Randomly selected during placement.	Determine Slump and Air Content from the same sample of concrete that cylinders are made from. For Class D or L, Bridge Deck Concrete per SOP 4-1; concrete placed by pumping shall be checked for air content at the discharge end of the truck chute immediately prior to pumping. ***Complete set of tests shall be performed on the initial load for quality control/ informational purposes, not for acceptance.** The volumes of noncritical items may be combined when utilizing the same ready mix plant.	Completed Concrete Mix

Now we'll use the random number tables in a different way. We must decide which loads of concrete to test. First, we'll assume each truck is hauling 10 cubic yards of concrete. Subsequent to the first 30 cubic yards, we'll test from truck loads by first choosing a random block of numbers from the following table. We'll choose block A3.

	A		B		C		D		E		
	0.818	0.696	0.758	0.117	0.827	0.567	0.974	0.487	0.874	0.665	
	0.565	0.826	0.141	0.229	0.996	0.003	0.783	0.079	0.145	0.827	
1	0.926	0.785	0.743	0.669	0.411	0.702	0.949	0.460	0.434	0.201	1
	0.776	0.529	0.397	0.450	0.851	0.569	0.157	0.571	0.097	0.556	
	0.333	0.996	0.810	0.562	0.053	0.975	0.122	0.055	0.702	0.609	
	0.626	0.783	0.145	0.210	0.591	0.003	0.493	0.136	0.036	0.223	
	0.291	0.607	0.048	0.788	0.764	0.020	0.991	0.719	0.948	0.727	
2	0.950	0.570	0.324	0.232	0.978	0.033	0.803	0.534	0.367	0.897	2
	0.521	0.642	0.912	0.464	0.129	0.047	0.359	0.497	0.382	0.993	
	0.235	0.611	0.262	0.783	0.189	0.047	0.241	0.252	0.706	0.886	
	0.537	0.505	0.557	0.919	0.939	0.579	0.351	0.525	0.304	0.092	
	0.286	0.447	0.366	0.025	0.454	0.643	0.647	0.958	0.887	0.702	
3	0.492	0.633	0.937	0.229	0.556	0.078	0.468	0.850	0.233	0.009	3
	0.428	0.126	0.767	0.250	0.740	0.976	0.835	0.280	0.808	0.401	
	0.443	0.465	0.666	0.947	0.372	0.412	0.408	0.589	0.170	0.211	
	0.970	0.183	0.800	0.534	0.702	0.508	0.295	0.397	0.391	0.421	
	0.198	0.464	0.847	0.596	0.228	0.450	0.671	0.787	0.169	0.648	
4	0.727	0.087	0.544	0.354	0.630	0.454	0.687	0.320	0.852	0.593	4
	0.272	0.647	0.553	0.886	0.761	0.396	0.059	0.207	0.014	0.331	
	0.284	0.210	0.344	0.355	0.060	0.158	0.536	0.940	0.365	0.546	
	0.027	0.134	0.910	0.121	0.186	0.452	0.081	0.231	0.400	0.598	
	0.818	0.052	0.867	0.848	0.497	0.386	0.485	0.976	0.283	0.388	
5	0.010	0.387	0.919	0.694	0.693	0.272	0.859	0.959	0.613	0.065	5
	0.112	0.245	0.158	0.294	0.690	0.704	0.273	0.389	0.075	0.676	
	0.949	0.172	0.810	0.381	0.307	0.129	0.552	0.162	0.016	0.047	
	A		B		C		D		E		

The table below shows one way to determine, using the random numbers above, the truck numbers from which samples will be taken.

SAMPLE NO.	DELIVERED CONCRETE (yd^3)	TOTAL AMOUNT OF CONCRETE (yd^3)	TOTAL LOADS OF CONCRETE (A)	RANDOM NO. (B)	LOAD NUMBER $[(A_n-A_{n-1})xB]+A_{n-1}$
1	10	10	1	NA	1
2	10	20	2	NA	2
3	10	30	3	NA	3
4	50	80	8	0.492	5
5	50	130	13	0.428	10
6	50	180	18	0.443	15
7	50	230	23	0.505	21
8	50	280	28	0.447	25
9	50	330	33	0.633	31
10	50	380	38	0.126	34

Example 4: Slump, temperature, and air content of concrete from mixing trucks delivering concrete to a structural footing that is expected to use 550 cubic yards of concrete.

According to the Sampling and Testing Schedule (SOP 1-1, Part 2, shown below), one complete set of tests for air content, slump, and temperature are required for the first load of concrete delivered each day for quality control/informational purposes. For each additional 100 cubic yards of concrete, a pair of cylinders must be made and tests for air content, slump, and temperature must be performed.

Completed Concrete Mix	Cylinders (28-day) Slump, Air Content, and Mix Temperature *All early break cylinders shall comply with acceptance cylinders	Project Inspector	*A complete set of tests and pair of cylinders for each 100 yd^3 placed per critical unit of structure. For Class D or L, One complete set of tests for each of the first three loads. One pair of cylinders shall be cast from one of the first three passing loads; additional tests and sets of cylinders to be made for each additional 50 yd^3.	Randomly selected during placement.	Determine Slump and Air Content from the same sample of concrete that cylinders are made from. For Class D or L, Bridge Deck Concrete per SOP 4-1; concrete placed by pumping shall be checked for air content at the discharge end of the truck chute immediately prior to pumping. ***Complete set of tests shall be performed on the initial load for quality control/informational purposes, not for acceptance.** The volumes of noncritical items may be combined when utilizing the same ready mix plant.	Completed Concrete Mix

Now we'll use the random number tables in a different way. We must decide which loads of concrete to test. First, we'll assume each truck is hauling 10 cubic yards of concrete. Subsequent to the first 10 cubic yards, we'll test from truck loads by first choosing a random block of numbers from the following table. We'll choose block C1.

	A		B		C		D		E		
	0.815	0.125	0.006	0.653			0.968	0.103	0.150	0.154	
	0.872	0.226	0.619	0.637			0.331	0.028	0.369	0.751	
1	0.685	0.964	0.937	0.948			0.194	0.425	0.852	0.500	1
	0.427	0.348	0.222	0.129			0.996	0.115	0.681	0.569	
	0.181	0.115	0.519	0.715			0.525	0.584	0.694	0.427	
	0.917	0.628	0.054	0.928	0.817	0.812	0.264	0.776	0.756	0.610	
	0.759	0.891	0.311	0.612	0.247	0.044	0.668	0.389	0.953	0.931	
2	0.510	0.632	0.371	0.037	0.667	0.681	0.730	0.638	0.965	0.925	2
	0.836	0.525	0.342	0.752	0.638	0.403	0.687	0.245	0.403	0.785	
	0.669	0.875	0.824	0.842	0.565	0.756	0.401	0.371	0.576	0.689	
	0.931	0.450	0.955	0.323	0.696	0.790	0.021	0.127	0.753	0.550	
	0.771	0.631	0.896	0.968	0.870	0.312	0.764	0.665	0.113	0.610	
3	0.855	0.525	0.056	0.255	0.921	0.282	0.301	0.401	0.775	0.246	3
	0.897	0.753	0.246	0.763	0.259	0.293	0.613	0.154	0.743	0.574	
	0.393	0.878	0.401	0.459	0.134	0.655	0.433	0.323	0.393	0.038	
	0.965	0.130	0.181	0.909	0.940	0.399	0.200	0.724	0.673	0.397	
	0.745	0.233	0.460	0.361	0.935	0.018	0.405	0.945	0.183	0.576	
4	0.204	0.623	0.771	0.120	0.859	0.314	0.880	0.447	0.680	0.938	4
	0.804	0.213	0.903	0.488	0.425	0.685	0.584	0.676	0.717	0.220	
	0.526	0.018	0.323	0.978	0.407	0.197	0.827	0.102	0.641	0.302	
	0.620	0.343	0.587	0.878	0.922	0.977	0.162	0.523	0.011	0.409	
	0.558	0.383	0.880	0.541	0.422	0.466	0.186	0.004	0.457	0.446	
5	0.128	0.893	0.685	0.864	0.349	0.413	0.273	0.971	0.970	0.311	5
	0.455	0.032	0.141	0.835	0.705	0.898	0.958	0.945	0.095	0.779	
	0.790	0.312	0.258	0.518	0.141	0.448	0.185	0.599	0.546	0.751	
	A		B		C		D		E		

The table below shows one way to determine, using the random numbers above, the truck numbers from which samples will be taken for acceptance.

SAMPLE NO.	TOTAL AMOUNT OF CONCRETE (yd^3)	TOTAL LOADS OF CONCRETE (A)	RANDOM NO. (B)	LOAD NUMBER $[(A_n-A_{n-1}) \times B]+A_{n-1}$
1	0-100	10	0.273	3
2	101-200	20	0.614	16
3	201-300	30	0.585	26
4	301-400	40	0.969	40
5	401-500	50	0.690	47
6	501-550	55	0.383	52

	A		B		C		D		E		
	0.678	0.694	0.141	0.441	0.836	0.182	0.274	0.829	0.365	0.881	
	0.023	0.158	0.948	0.763	0.555	0.741	0.157	0.869	0.811	0.789	
1	0.504	0.635	0.730	0.899	0.719	0.357	0.284	0.140	0.644	0.082	**1**
	0.704	0.941	0.361	0.863	0.882	0.404	0.704	0.933	0.667	0.571	
	0.830	0.617	0.154	0.081	0.109	0.741	0.503	0.974	0.301	0.911	
	0.247	0.737	0.402	0.169	0.871	0.830	0.069	0.276	0.998	0.499	
	0.710	0.346	0.012	0.836	0.233	0.885	0.077	0.341	0.607	0.719	
2	0.205	0.290	0.040	0.804	0.638	0.987	0.353	0.539	0.208	0.676	**2**
	0.980	0.629	0.424	0.081	0.002	0.761	0.185	0.940	0.997	0.568	
	0.360	0.766	0.117	0.032	0.588	0.049	0.407	0.388	0.535	0.464	
	0.120	0.852	0.163	0.852	0.201	0.487	0.713	0.696	0.914	0.080	
	0.413	0.327	0.839	0.949	0.724	0.728	0.508	0.471	0.327	0.850	
3	0.955	0.924	0.285	0.028	0.299	0.064	0.953	0.791	0.437	0.745	**3**
	0.131	0.616	0.223	0.213	0.027	0.024	0.484	0.030	0.533	0.552	
	0.037	0.500	0.803	0.546	0.093	0.401	0.750	0.189	0.417	0.078	
	0.096	0.483	0.713	0.576	0.935	0.281	0.506	0.994	0.014	0.491	
	0.818	0.855	0.950	0.195	0.142	0.392	0.380	0.786	0.063	0.423	
4	0.689	0.685	0.742	0.863	0.906	0.966	0.617	0.375	0.908	0.685	**4**
	0.443	0.857	0.239	0.770	0.181	0.241	0.982	0.373	0.150	0.316	
	0.020	0.898	0.158	0.365	0.497	0.139	0.864	0.937	0.392	0.026	
	0.245	0.510	0.670	0.082	0.483	0.403	0.524	0.338	0.387	0.406	
	0.658	0.596	0.690	0.737	0.899	0.567	0.655	0.231	0.508	0.374	
5	0.107	0.682	0.077	0.763	0.593	0.877	0.094	0.929	0.268	0.973	**5**
	0.057	0.478	0.230	0.623	0.339	0.942	0.239	0.839	0.074	0.854	
	0.312	0.193	0.428	0.947	0.185	0.197	0.642	0.537	0.590	0.876	
	A		**B**		**C**		**D**		**E**		

	A		B		C		D		E		
	0.439	0.107	0.450	0.340	0.181	0.794	0.186	0.814	0.350	0.112	
	0.460	0.661	0.706	0.123	0.648	0.988	0.750	0.968	0.955	0.196	
1	0.631	0.799	0.355	0.746	0.842	0.268	0.445	0.942	0.430	0.324	**1**
	0.398	0.177	0.993	0.666	0.377	0.609	0.533	0.840	0.271	0.270	
	0.258	0.732	0.905	0.314	0.200	0.640	0.736	0.970	0.804	0.352	
	0.099	0.586	0.938	0.597	0.883	0.855	0.489	0.003	0.290	0.397	
	0.024	0.789	0.120	0.111	0.274	0.627	0.731	0.654	0.482	0.637	
2	0.536	0.280	0.146	0.968	0.044	0.326	0.097	0.326	0.228	0.370	**2**
	0.087	0.955	0.770	0.328	0.492	0.940	0.554	0.913	0.888	0.758	
	0.192	0.771	0.968	0.688	0.247	0.770	0.194	0.621	0.847	0.848	
	0.183	0.040	0.020	0.172	0.625	0.262	0.170	0.501	0.930	0.626	
	0.605	0.948	0.688	0.893	0.686	0.840	0.799	0.047	0.936	0.752	
3	0.924	0.795	0.113	0.148	0.316	0.956	0.536	0.701	0.440	0.702	**3**
	0.569	0.213	0.626	0.960	0.240	0.823	0.196	0.335	0.663	0.630	
	0.799	0.128	0.560	0.843	0.951	0.600	0.609	0.256	0.292	0.681	
	0.597	0.815	0.412	0.439	0.189	0.094	0.782	0.515	0.809	0.303	
	0.014	0.033	0.240	0.170	0.824	0.248	0.118	0.570	0.344	0.203	
4	0.916	0.958	0.802	0.089	0.958	0.677	0.515	0.843	0.127	0.868	**4**
	0.989	0.291	0.184	0.927	0.089	0.780	0.214	0.277	0.105	0.138	
	0.545	0.849	0.884	0.192	0.617	0.416	0.763	0.558	0.027	0.098	
	0.227	0.322	0.069	0.477	0.984	0.112	0.207	0.110	0.196	0.615	
	0.342	0.472	0.531	0.716	0.337	0.880	0.593	0.881	0.195	0.188	
5	0.059	0.058	0.688	0.504	0.418	0.197	0.894	0.298	0.843	0.959	**5**
	0.056	0.926	0.214	0.016	0.050	0.692	0.256	0.966	1.000	0.084	
	0.033	0.489	0.768	0.354	0.855	0.839	0.670	0.853	0.934	0.012	
	A		**B**		**C**		**D**		**E**		

	A		B		C		D		E		
	0.001	0.411	0.562	0.371	0.511	0.010	0.189	0.340	0.529	0.991	
	0.095	0.690	0.070	0.561	0.412	0.123	0.060	0.580	0.614	0.151	
1	0.742	0.355	0.526	0.217	0.848	0.774	0.923	0.542	0.653	0.385	**1**
	0.914	0.676	0.912	0.868	0.085	0.281	0.924	0.704	0.371	0.600	
	0.257	0.536	0.951	0.713	0.939	0.987	0.637	0.536	0.129	0.917	
	0.586	0.163	0.710	0.254	0.744	0.846	0.979	0.344	0.333	0.481	
	0.271	0.577	0.487	0.484	0.408	0.704	0.901	0.347	0.850	0.286	
2	0.480	0.538	0.017	0.074	0.427	0.225	0.452	0.049	0.233	0.846	**2**
	0.967	0.187	0.657	0.775	0.251	0.877	0.169	0.977	0.879	0.635	
	0.471	0.416	0.107	0.334	0.565	0.735	0.549	0.763	0.850	0.113	
	0.398	0.095	0.496	0.726	0.650	0.498	0.266	0.727	0.355	0.209	
	0.265	0.801	0.509	0.718	0.181	0.286	0.928	0.200	0.588	0.881	
3	0.937	0.348	0.446	0.688	0.955	0.834	0.796	0.045	0.292	0.019	**3**
	0.999	0.804	0.217	0.945	0.601	0.122	0.897	0.535	0.170	0.606	
	0.871	0.270	0.269	0.056	0.555	0.907	0.732	0.709	0.224	0.424	
	0.550	0.650	0.779	0.280	0.914	0.303	0.377	0.896	0.428	0.791	
	0.262	0.325	0.785	0.248	0.748	0.291	0.552	0.560	0.806	0.450	
4	0.194	0.754	0.700	0.244	0.521	0.673	0.196	0.495	0.227	0.995	**4**
	0.484	0.315	0.295	0.267	0.637	0.202	0.082	0.750	0.626	0.107	
	0.925	0.002	0.940	0.406	0.756	0.942	0.745	0.665	0.398	0.519	
	0.769	0.126	0.227	0.521	0.395	0.853	0.606	0.467	0.716	0.376	
	0.786	0.339	0.246	0.850	0.310	0.413	0.966	0.387	0.222	0.035	
5	0.121	0.278	0.807	0.006	0.872	0.081	0.317	0.163	0.942	0.763	**5**
	0.794	0.721	0.766	0.883	0.285	0.936	0.363	0.154	0.021	0.304	
	0.138	0.381	0.875	0.566	0.802	0.077	0.888	0.634	0.880	0.916	
	A		**B**		**C**		**D**		**E**		

	A		B		C		D		E		
	0.213	0.416	0.998	0.713	0.003	0.826	0.353	0.763	0.835	0.398	
	0.761	0.812	0.959	0.598	0.771	0.105	0.414	0.251	0.305	0.385	
1	0.071	0.848	0.185	0.978	0.881	0.329	0.822	0.690	0.779	0.126	**1**
	0.745	0.888	0.662	0.041	0.589	0.145	0.125	0.617	0.474	0.200	
	0.619	0.972	0.230	0.780	0.224	0.463	0.846	0.098	0.541	0.002	
	0.770	0.801	0.055	0.852	0.289	0.381	0.023	0.911	0.736	0.387	
	0.794	0.193	0.499	0.827	0.235	0.046	0.168	0.789	0.543	0.594	
2	0.768	0.053	0.915	0.063	0.541	0.687	0.848	0.742	0.891	0.091	**2**
	0.752	0.363	0.172	0.583	0.183	0.234	0.105	0.650	0.456	0.330	
	0.746	0.920	0.088	0.285	0.125	0.514	0.795	0.366	0.144	0.758	
	0.676	0.579	0.181	0.237	0.249	0.376	0.805	0.306	0.050	0.951	
	0.524	0.502	0.975	0.401	0.741	0.518	0.312	0.284	0.444	0.002	
3	0.408	0.575	0.505	0.360	0.774	0.546	0.635	0.758	0.440	0.299	**3**
	0.875	0.176	0.145	0.011	0.174	0.516	0.317	0.560	0.775	0.488	
	0.045	0.320	0.449	0.079	0.726	0.455	0.934	0.341	0.912	0.963	
	0.589	0.945	0.644	0.339	0.984	0.115	0.517	0.414	0.834	0.261	
	0.338	0.428	0.777	0.803	0.755	0.264	0.481	0.030	0.186	0.953	
4	0.034	0.715	0.499	0.896	0.934	0.827	0.601	0.527	0.282	0.758	**4**
	0.642	0.976	0.896	0.449	0.361	0.777	0.297	0.484	0.949	0.629	
	0.864	0.440	0.059	0.265	0.072	0.879	0.779	0.421	0.657	0.146	
	0.979	0.318	0.153	0.682	0.066	0.806	0.003	0.163	0.249	0.012	
	0.253	0.995	0.678	0.459	0.166	0.223	0.132	0.558	0.377	0.663	
5	0.922	0.764	0.313	0.247	0.330	0.167	0.098	0.416	0.378	0.585	**5**
	0.711	0.516	0.731	0.061	0.387	0.520	0.865	0.596	0.456	0.745	
	0.341	0.350	0.431	0.984	0.583	0.321	0.142	0.508	0.040	0.741	
	A		**B**		**C**		**D**		**E**		

	A		B		C		D		E		
	0.764	0.375	0.774	0.880	0.109	0.349	0.121	0.861	0.612	0.200	
	0.614	0.527	0.172	0.266	0.018	0.374	0.036	0.623	0.341	0.427	
1	0.017	0.694	0.456	0.638	0.812	0.271	0.423	0.329	0.644	0.041	**1**
	0.823	0.132	0.112	0.039	0.319	0.312	0.565	0.634	0.124	0.199	
	0.001	0.938	0.180	0.639	0.207	0.918	0.905	0.490	0.938	0.019	
	0.281	0.761	0.733	0.457	0.424	0.063	0.159	0.247	0.546	0.975	
	0.503	0.360	0.556	0.533	0.829	0.490	0.527	0.286	0.557	0.078	
2	0.689	0.948	0.589	0.816	0.370	0.794	0.913	0.324	0.529	0.041	**2**
	0.260	0.313	0.841	0.771	0.752	0.282	0.669	0.749	0.420	0.451	
	0.204	0.118	0.165	0.209	0.865	0.429	0.366	0.493	0.509	0.945	
	0.546	0.394	0.643	0.855	0.104	0.120	0.201	0.987	0.640	0.240	
	0.230	0.569	0.865	0.696	0.044	0.494	0.030	0.699	0.204	0.105	
3	0.808	0.107	0.645	0.308	0.094	0.288	0.391	0.885	0.069	0.994	**3**
	0.423	0.022	0.370	0.008	0.125	0.774	0.091	0.523	0.700	0.599	
	0.819	0.415	0.405	0.856	0.065	0.079	0.408	0.541	0.723	0.309	
	0.212	0.347	0.045	0.359	0.420	0.422	0.720	0.767	0.983	0.589	
	0.444	0.389	0.427	0.634	0.055	0.337	0.519	0.444	0.644	0.703	
4	0.224	0.571	0.271	0.859	0.636	0.175	0.255	0.080	0.027	0.877	**4**
	0.840	0.401	0.917	0.099	0.600	0.715	0.332	0.335	0.405	0.983	
	0.233	0.580	0.966	0.419	0.092	0.243	0.175	0.179	0.743	0.611	
	0.668	0.678	0.304	0.650	0.646	0.623	0.290	0.246	0.680	0.359	
	0.430	0.392	0.388	0.807	0.455	0.004	0.586	0.442	0.179	0.162	
5	0.309	0.373	0.239	0.392	0.490	0.549	0.773	0.695	0.917	0.797	**5**
	0.681	0.901	0.637	0.195	0.392	0.093	0.091	0.642	0.389	0.492	
	0.134	0.119	0.276	0.503	0.096	0.319	0.135	0.225	0.953	0.169	
	A		**B**		**C**		**D**		**E**		

	A		B		C		D		E		
	0.975	0.023	0.046	0.500	0.806	0.260	0.202	0.319	0.813	0.862	
	0.600	0.130	0.373	0.995	0.048	0.501	0.552	0.519	0.846	0.403	
1	0.536	0.018	0.935	0.372	0.090	0.931	0.311	0.579	0.466	0.979	**1**
	0.567	0.042	0.182	0.483	0.143	0.473	0.838	0.578	0.894	0.070	
	0.956	0.913	0.130	0.915	0.895	0.415	0.558	0.554	0.975	0.636	
	0.348	0.419	0.682	0.262	0.536	0.984	0.886	0.878	0.009	0.877	
	0.141	0.217	0.422	0.261	0.384	0.716	0.326	0.212	0.353	0.610	
2	0.625	0.370	0.164	0.966	0.722	0.236	0.548	0.137	0.851	0.053	**2**
	0.357	0.688	0.676	0.757	0.630	0.527	0.817	0.041	0.235	0.790	
	0.114	0.741	0.129	0.805	0.802	0.800	0.615	0.417	0.741	0.455	
	0.515	0.566	0.935	0.755	0.055	0.412	0.083	0.253	0.174	0.826	
	0.557	0.484	0.163	0.242	0.221	0.150	0.397	0.763	0.868	0.113	
3	0.787	0.758	0.735	0.302	0.391	0.540	0.043	0.991	0.537	0.459	**3**
	0.111	0.507	0.695	0.634	0.251	0.587	0.386	0.533	0.585	0.449	
	0.824	0.682	0.521	0.056	0.088	0.302	0.128	0.562	0.334	0.244	
	0.597	0.828	0.318	0.337	0.736	0.029	0.891	0.709	0.700	0.134	
	0.768	0.644	0.400	0.481	0.528	0.573	0.928	0.824	0.537	0.445	
4	0.778	0.664	0.687	0.607	0.493	0.515	0.269	0.363	0.662	0.947	**4**
	0.833	0.812	0.289	0.346	0.923	0.478	0.941	0.580	0.976	0.509	
	0.635	0.995	0.723	0.558	0.349	0.432	0.155	0.276	0.129	0.326	
	0.880	0.025	0.952	0.801	0.596	0.565	0.407	0.303	0.620	0.153	
	0.624	0.276	0.934	0.715	0.372	0.111	0.823	0.740	0.650	0.676	
5	0.084	0.459	0.616	0.230	0.955	0.787	0.486	0.817	0.420	0.599	**5**
	0.028	0.943	0.707	0.336	0.442	0.751	0.009	0.025	0.406	0.638	
	0.257	0.953	0.580	0.071	0.474	0.137	0.481	0.277	0.533	0.292	
	A		**B**		**C**		**D**		**E**		

	A		B		C		D		E		
	0.772	0.571	0.975	0.511	0.489	0.398	0.089	0.964	0.379	0.313	
	0.838	0.849	0.592	0.814	0.914	0.928	0.438	0.875	0.712	0.507	
1	0.447	0.478	0.176	0.084	0.317	0.169	0.755	0.741	0.821	0.134	**1**
	0.960	0.192	0.970	0.442	0.856	0.621	0.500	0.912	0.814	0.895	
	0.941	0.780	0.393	0.912	0.252	0.713	0.386	0.158	0.941	0.599	
	0.819	0.432	0.555	0.447	0.866	0.737	0.363	0.382	0.615	0.705	
	0.937	0.970	0.331	0.751	0.633	0.711	0.234	0.174	0.518	0.644	
2	0.408	0.983	0.714	0.499	0.782	0.417	0.849	0.013	0.325	0.064	**2**
	0.848	0.718	0.096	0.035	0.021	0.484	0.146	0.233	0.744	0.090	
	0.814	0.540	0.268	0.199	0.913	0.387	0.614	0.335	0.493	0.194	
	0.373	0.229	0.458	0.544	0.138	0.753	0.825	0.441	0.521	0.304	
	0.748	0.235	0.421	0.304	0.568	0.329	0.098	0.348	0.371	0.646	
3	0.365	0.098	0.826	0.053	0.931	0.166	0.835	0.384	0.716	0.951	**3**
	0.711	0.021	0.531	0.549	0.727	0.539	0.111	0.627	0.036	0.867	
	0.111	0.106	0.980	0.418	0.757	0.475	0.157	0.525	0.793	0.326	
	0.171	0.226	0.276	0.734	0.265	0.190	0.452	0.998	0.520	0.857	
	0.749	0.458	0.832	0.004	0.218	0.492	0.375	0.428	0.966	0.285	
4	0.074	0.807	0.868	0.560	0.526	0.077	0.236	0.430	0.861	0.112	**4**
	0.463	0.256	0.120	0.567	0.237	0.012	0.136	0.075	0.617	0.974	
	0.903	0.948	0.531	0.315	0.050	0.839	0.977	0.882	0.196	0.982	
	0.611	0.524	0.293	0.749	0.367	0.958	0.348	0.109	0.780	0.254	
	0.438	0.791	0.982	0.027	0.170	0.127	0.820	0.943	0.075	0.887	
5	0.973	0.410	0.313	0.035	0.949	0.848	0.720	0.672	0.530	0.799	**5**
	0.382	0.458	0.800	0.781	0.242	0.564	0.019	0.139	0.338	0.176	
	0.751	0.263	0.344	0.467	0.941	0.795	0.019	0.880	0.515	0.415	
	A		**B**		**C**		**D**		**E**		

	A		B		C		D		E		
	0.817	0.093	0.254	0.779	0.563	0.409	0.263	0.244	0.026	0.340	
	0.267	0.817	0.444	0.908	0.830	0.238	0.270	0.990	0.287	0.607	
1	0.287	0.574	0.016	0.879	0.159	0.232	0.440	0.553	0.799	0.461	**1**
	0.416	0.330	0.913	0.890	0.426	0.746	0.078	0.374	0.190	0.396	
	0.116	0.197	0.178	0.223	0.794	0.327	0.401	0.499	0.666	0.475	
	0.554	0.784	0.841	0.113	0.606	0.687	0.319	0.268	0.793	0.461	
	0.777	0.671	0.420	0.990	0.215	0.825	0.222	0.591	0.264	0.230	
2	0.215	0.696	0.455	0.127	0.976	0.774	0.761	0.437	0.664	0.164	**2**
	0.174	0.315	0.788	0.300	0.037	0.258	0.464	0.286	0.575	0.581	
	0.262	0.845	0.246	0.789	0.815	0.539	0.766	0.646	0.034	0.860	
	0.372	0.973	0.530	0.319	0.021	0.337	0.755	0.423	0.182	0.877	
	0.696	0.264	0.848	0.895	0.963	0.121	0.620	0.738	0.446	0.657	
3	0.551	0.612	0.469	0.596	0.767	0.900	0.050	0.859	0.210	0.652	**3**
	0.940	0.828	0.328	0.224	0.861	0.612	0.640	0.783	0.952	0.292	
	0.493	0.163	0.854	0.979	0.858	0.562	0.690	0.143	0.796	0.904	
	0.963	0.877	0.075	0.714	0.414	0.351	0.829	0.246	0.447	0.060	
	0.441	0.183	0.880	0.986	0.755	0.034	0.642	0.540	0.393	0.665	
4	0.558	0.228	0.709	0.238	0.572	0.599	0.504	0.971	0.698	0.744	**4**
	0.811	0.758	0.092	0.848	0.312	0.436	0.017	0.438	0.916	0.304	
	0.017	0.260	0.953	0.564	0.947	0.011	0.425	0.468	0.083	0.789	
	0.178	0.881	0.468	0.731	0.604	0.324	0.398	0.753	0.278	0.130	
	0.979	0.811	0.476	0.125	0.423	0.314	0.456	0.090	0.189	0.066	
5	0.057	0.136	0.483	0.100	0.712	0.204	0.372	0.385	0.918	0.405	**5**
	0.717	0.633	0.348	0.744	0.255	0.781	0.443	0.625	0.300	0.705	
	0.305	0.247	0.661	0.493	0.889	0.764	0.577	0.169	0.261	0.398	
	A		**B**		**C**		**D**		**E**		

	A		B		C		D		E		
	0.815	0.125	0.006	0.653	0.614	0.455	0.968	0.103	0.150	0.154	
	0.872	0.226	0.619	0.637	0.585	0.566	0.331	0.028	0.369	0.751	
1	0.685	0.964	0.937	0.948	0.969	0.454	0.194	0.425	0.852	0.500	**1**
	0.427	0.348	0.222	0.129	0.690	0.911	0.996	0.115	0.681	0.569	
	0.181	0.115	0.519	0.715	0.508	0.308	0.525	0.584	0.694	0.427	
	0.917	0.628	0.054	0.928	0.817	0.812	0.264	0.776	0.756	0.610	
	0.759	0.891	0.311	0.612	0.247	0.044	0.668	0.389	0.953	0.931	
2	0.510	0.632	0.371	0.037	0.667	0.681	0.730	0.638	0.965	0.925	**2**
	0.836	0.525	0.342	0.752	0.638	0.403	0.687	0.245	0.403	0.785	
	0.669	0.875	0.824	0.842	0.565	0.756	0.401	0.371	0.576	0.689	
	0.931	0.450	0.955	0.323	0.696	0.790	0.021	0.127	0.753	0.550	
	0.771	0.631	0.896	0.968	0.870	0.312	0.764	0.665	0.113	0.610	
3	0.855	0.525	0.056	0.255	0.921	0.282	0.301	0.401	0.775	0.246	**3**
	0.897	0.753	0.246	0.763	0.259	0.293	0.613	0.154	0.743	0.574	
	0.393	0.878	0.401	0.459	0.134	0.655	0.433	0.323	0.393	0.038	
	0.965	0.130	0.181	0.909	0.940	0.399	0.200	0.724	0.673	0.397	
	0.745	0.233	0.460	0.361	0.935	0.018	0.405	0.945	0.183	0.576	
4	0.204	0.623	0.771	0.120	0.859	0.314	0.880	0.447	0.680	0.938	**4**
	0.804	0.213	0.903	0.488	0.425	0.685	0.584	0.676	0.717	0.220	
	0.526	0.018	0.323	0.978	0.407	0.197	0.827	0.102	0.641	0.302	
	0.620	0.343	0.587	0.878	0.922	0.977	0.162	0.523	0.011	0.409	
	0.558	0.383	0.880	0.541	0.422	0.466	0.186	0.004	0.457	0.446	
5	0.128	0.893	0.685	0.864	0.349	0.413	0.273	0.971	0.970	0.311	**5**
	0.455	0.032	0.141	0.835	0.705	0.898	0.958	0.945	0.095	0.779	
	0.790	0.312	0.258	0.518	0.141	0.448	0.185	0.599	0.546	0.751	
	A		**B**		**C**		**D**		**E**		

	A		B		C		D		E		
	0.982	0.498	0.720	0.906	0.269	0.565	0.296	0.393	0.537	0.124	
	0.636	0.192	0.769	0.017	0.448	0.457	0.458	0.148	0.917	0.987	
1	0.499	0.185	0.016	0.919	0.847	0.967	0.794	0.258	0.641	0.288	**1**
	0.364	0.861	0.261	0.407	0.639	0.643	0.277	0.830	0.989	0.178	
	0.141	0.417	0.721	0.393	0.860	0.021	0.952	0.944	0.606	0.721	
	0.947	0.752	0.693	0.734	0.577	0.119	0.499	0.032	0.834	0.328	
	0.923	0.669	0.770	0.400	0.790	0.700	0.758	0.099	0.198	0.201	
2	0.885	0.025	0.563	0.815	0.063	0.269	0.244	0.711	0.418	0.517	**2**
	0.925	0.002	0.216	0.406	0.812	0.309	0.596	0.883	0.385	0.725	
	0.793	0.877	0.783	0.064	0.047	0.225	0.891	0.588	0.179	0.565	
	0.397	0.152	0.590	0.640	0.534	0.558	0.191	0.466	0.655	0.062	
	0.366	0.478	0.991	0.455	0.152	0.652	0.480	0.136	0.072	0.729	
3	0.537	0.039	0.970	0.382	0.927	0.865	0.663	0.873	0.119	0.835	**3**
	0.211	0.621	0.042	0.023	0.155	0.347	0.124	0.371	0.589	0.016	
	0.103	0.030	0.040	0.042	0.556	0.822	0.376	0.970	0.938	0.386	
	0.773	0.420	0.378	0.039	0.905	0.484	0.544	0.225	0.554	0.459	
	0.543	0.777	0.482	0.921	0.940	0.841	0.738	0.763	0.096	0.528	
4	0.996	0.200	0.554	0.421	0.334	0.556	0.359	0.592	0.237	0.736	**4**
	0.799	0.698	0.399	0.104	0.422	0.949	0.157	0.505	0.772	0.341	
	0.309	0.918	0.954	0.852	0.639	0.035	0.226	0.409	0.116	0.945	
	0.109	0.364	0.613	0.650	0.741	0.248	0.628	0.157	0.318	0.069	
	0.362	0.657	0.943	0.683	0.948	0.675	0.367	0.288	0.914	0.896	
5	0.651	0.328	0.501	0.552	0.218	0.951	0.936	0.198	0.531	0.307	**5**
	0.770	0.936	0.461	0.907	0.282	0.864	0.880	0.444	0.499	0.223	
	0.800	0.658	0.705	0.107	0.561	0.076	0.355	0.604	0.847	0.205	
	A		**B**		**C**		**D**		**E**		

REV NOV 2, 2017

Tennessee Department of Transportation
Division of Materials and Tests

Nuclear Density Testing (SOP 7-1)

Purpose: The purpose of this document is to provide guidance for conducting nuclear density tests on hot mix asphalt, backfill, soil, aggregate base, embankments, and other materials requiring density tests in accordance with SOP 1-1.

Discussion: Many compacted materials on TDOT projects are accepted by means of testing with nuclear density gauges. This document intends to provide guidance and define best practices for operation of these gauges to unify testing operations statewide. Testing details of common concern include proper setup of gauge information, depth of test probes, time length of tests, and recording of data.

Basic Procedure: All test procedures shall be in accordance with AASHTO T310, "*In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)"* and ASTM D2950, "*Standard Test Method for Density of Bituminous Concrete In-Place by Nuclear Methods"* except as revised herein.

Specific instructions on conducting standard counts, entering maximum specific gravity values, offsets, correction factors, and proctor information can be found in the users' manuals corresponding to the make and model of the gauge in use.

PART ONE – ACCEPTANCE TESTING

Hot Mix Asphalt

Mixtures: 307-A, 307-B, 307-BM, 307-BM2, 307-C, 307-CW, 411-D, 411-Es

Step 1: Conduct Standard Count

Step 2: Enter maximum specific gravity (Gmm) value from asphalt mix design.

Step 3: Enter gauge correction factor from test strip. See Part Two for determining correction factors. (Note: testing may be done prior to obtaining the correction factor, however all tests done during this time must be corrected as soon as possible and prior to finalizing the records for acceptance or assurance tests.)

Step 4: Set gauge setting to Backscatter.

Step 5: Place gauge in location to be tested.

Footnote 1: For guidance on testing frequencies, random numbers, and selecting test locations, see SOP 1-1.

Step 6: Activate a test. When collecting a density test, the following approach **shall** be used:

- *"Four Nineties" Test:* Four tests shall be conducted at a single location, rotating around the test location 90 degrees at a time, as shown in Figure 1. The four test results will then be averaged to obtain a single test value for that location. Test counts for this approach shall be 15 seconds or longer.

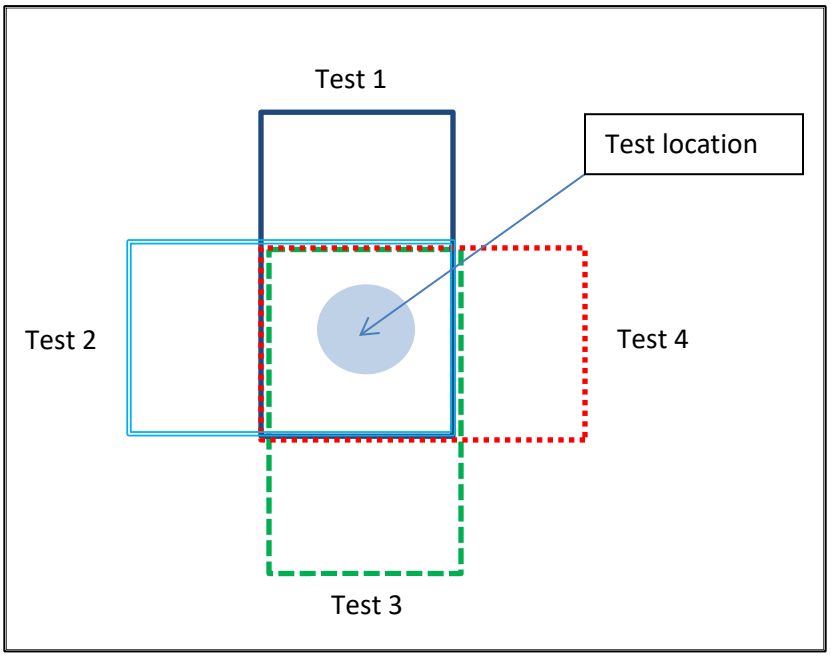


Figure 1. Testing at four 90° locations

Step 7: Record the test value into the appropriate paperwork.

- DT-0315, Daily Asphalt Density Report

Soil and Aggregate Materials

Materials: Backfill (Earth retaining structures), Select granular backfill (Earth retaining structures), Embankments, Subgrade preparation, Lime-treated subgrade, Soil-Cement Base, Mineral Aggregate Base and Surface, Aggregate for Underdrains, Aggregate-Cement base course, Aggregate Lime fly ash base course, & Conditioned mineral aggregate base.

Step 1: Conduct Standard Count

Step 2: Enter maximum dry density and optimum moisture content from Proctor Density report.

Step 3: Select Test location. Create a test hole using the scraper plate and drill rod provided with the gauge.

Footnote 2: For guidance on selecting test locations, see SOP 1-1.

Step 4: Set gauge setting to Direct Transmission at a depth reasonably close to one half the depth of the compacted lift.

Step 5: Place gauge in location to be tested and insert test probe into test hole at a depth reasonably close to one half the depth of the compacted lift. Pull gauge back to ensure probe makes contact with material being tested.

Step 6: Activate a test. When collecting a density test, the following approach shall be used:

Single Count Test: A single test shall be conducted at any test location, given that the test count is greater than or equal to 60 seconds.

Step 7: Record the test value into the appropriate paperwork.

- DT-0298, Daily Report on Soil and Aggregate Stabilization
- DT-0304, Daily Report on Embankment
- DT-0307, Daily Report on Mineral Aggregate Base
- DT-0314, Density Worksheet – Nuclear Method (Aggregate, Soil)

PART TWO – DETERMINATION OF ASPHALT CALIBRATION FACTORS

- Conduct test strips in accordance with most current version of TDOT Standard specifications, subsection 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.
- Test strips are required for the following mixtures:
  307-A, 307-B, 307-BM, 307-BM2, 307-C, 307-CW, 411-D, 411-Es
- The minimum size of a single test strip is 400 yd^2, but a larger area is recommended. The following roadway lengths provide an area of 400 yd^2 :
  - 9’ wide= 400’ long
  - 10’ wide= 360’ long
  - 11’ wide= 330’ long
  - 12’ wide= 300’ long
- Compaction of the test strip shall commence immediately after placement of the bituminous mixture.
- TDOT form DT-0316, Density and Roller Pattern Test Strip

Step 1: Compact test strip area

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

Step 3: Conduct and record ten sets of uncorrected density (4 90s test method) tests on the compacted test strip area and record test information

Step 4: 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)

Footnote 3: Only Method A of T166 shall apply when testing test strip cores for density. Cores shall be COMPLETELY DRY before testing. Accelerated drying in accordance with ASTM D 7227 (core drying device) is permitted.

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.

Additional notes on test strips and correction factors:

- Nuclear gauges are specific to an individual gauge, mix, and project. DO NOT develop a correction factor with a different gauge unit than the one to be used during mainline acceptance testing.
- Developing correction factors based on cores that were not allowed to dry completely will influence results in a manner that can mislead test results into appearing as if they are higher than they actually are. In other words, wet cores appear heavier or denser than they actually are.
- In accordance with TDOT Specifications, a new test strip is 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.

May 1, 2017
Feb 14, 2018

Tennessee Department of Transportation
Division of Materials and Tests
Standard Operating Procedure 7-2
Nuclear Gauge Safety Plan

Purpose - The purpose of this document is to establish guidelines on nuclear density gauge daily usage, gauge transportation, and outline an Emergency Response Plan for TDOT Radiation Safety Technicians. A TDOT Radiation Safety Technician is an individual who has successfully completed the TDOT Radiation Safety training and demonstrated a basic understanding of: radiation safety and compliance, nuclear density gauge operation, testing procedures, and maintenance.

Background- Tennessee Radioactive Material License No. R-19017-K16 requires that TDOT technicians attend the appropriate training to operate and transport nuclear density gauges. The license also requires TDOT to have a radiation safety emergency response plan.

Each Regional Materials and Tests Office has a regional Radiation Safety Officer (RSO) in the Materials and Tests Office as well as the Statewide RSO in Headquarters Materials and Tests. Each gauge operator is responsible for knowing the current contact information of their regional RSO.

1 Storage Site

1.1 The handle shall be locked and the gauge stored in its transport case.

1.2 The transport case shall be locked.

1.3 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).

1.4 The storage area shall be marked with a radiation sign that reads "CAUTION RADIOACTIVE MATERIALS" (can be obtained from HQ RSO).

1.5 Do not store a nuclear gauge in a motor vehicle except:

1.5.1 The nuclear gauge may be stored inside the gauge operator's truck when not in use on a construction site or at a location in transit between the permanent storage site and the project site. With permission of the gauge operator's supervisor, the gauge operator may store the gauge overnight in their truck, provided it is secured per section 4, at a location between the permanent storage site and the project site. In all other cases the gauge operator shall return the gauge to the permanent storage location.

1.5.2 Any time the gauge is stored in the truck it shall be secured for transport per section 4.

1.6 A log of all gauges stored at the site will be maintained at the storage site. All gauges must be checked in when not stored and checked out by the operator when in use.

1.7 Storage site must be enclosed (four walls and a roof) and it must protect gauges from the elements.

1.8 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.

2 Inspections:

2.1 Inspect the gauge before use to ensure proper operation of all safety features as follows:

2.1.1 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 shut.

If any portion of the opening is uncovered, the clean the sliding block before using, transporting, or storing the gauge.

2.1.2 Do not store or transport the gauge unless the sliding block is completely closed. Increased radiation levels may violate transportation regulations and cause excessive personal radiation exposure.

2.1.3 If a radiation survey instrument is available, verify that the radioactive gamma source is in place by measuring the exposure rate at the surface of the gauge. If the exposure rate is not in the approximately range of 10 - 20 mrem per hour contact the regional RSO and discontinue use of the gauge until further notice.

2.2 Biannual Inspection

2.2.1 Gauges shall be leak tested every April and October. The Regional RSO shall conduct a 'swipe' test and submit the sample to the HQ RSO who will submit all samples to the lab for testing. In conjunction with the 'swipe' test, an inventory check must be completed. This means that the gauge must be physically located and accounted for.

3 Operator Certification and Monitoring:

3.1 Anyone operating a nuclear gauge shall be a certified TDOT Radiation Safety Technician.

3.2 The technician must wear their assigned dosimeter while operating or transporting the nuclear gauge. Dosimeter may not be shared between individuals and may only be used by the person who is named on the dosimeter.

3.3 Badges shall be turned in every March, June, September, and December to the regional RSO to be checked for individual exposure.

4 Transporting Nuclear Gauge to Project

4.1 The handle for the gauge shall be locked into the safe position during transport.

4.2 The nuclear gauge shall be locked inside the transport case during transport.

4.3 Transport the nuclear gauge in the rearmost part of the bed of a truck inside either:

4.3.1 a locked bed cover with the device secured in place with heavy chain to prevent the case from moving or

4.3.2 a mounted transportation box, specifically designed for the nuclear gauge case.

4.4 No one other than DOSIMETER BADGE WEARER with HAZMAT TRAINING is allowed in the vehicle while the nuclear gauge is in the vehicle.

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

- nuclear gauge bill of lading (BOL),
- operator's nuclear safety certificate,
- nuclear gauge shipping paper,
- TDOT Radiation Safety Plan (SOP 7-2),

4.6 At any time the vehicle is parked while the gauge is stowed for transit, the shipping paper must be place face up in the driver's seat.

5 Operating Nuclear Gauge at the Project

5.1 See SOP 7-1 for instructions on how to calibrate and run tests.

5.2 Only remove the nuclear gauge from the truck when testing is eminent.

5.3 If the gauge is unsecured (i.e. not stored for transport per section 4 or stored per section 1), it shall be in the possession of the operator. The nuclear gauge shall never be left unattended on site.

5.4 If it becomes necessary to move between locations inside the project, lock the handle into the SAFE position and replace the nuclear gauge into the transport case and place in the rear of truck bed. At no time shall the nuclear gauge be placed into the cab of the tuck.

5.4.1 It is not necessary to lock the case and bed cover for short trips inside the project limits

5.5 When the nuclear gauge is in operation all personnel must be a minimum of 30' away from the gauge except if they are wearing a dosimeter badge.

5.6 Once the operator has set the gauge and it is reading, the operator shall walk a minimum distance of 3' away from the gauge.

6 Emergency Response Plan: In the case of accident, damage, loss, or theft of nuclear gauge adhere to the following procedure:

6.1 Priority Response Actions To Be Taken By Gauge Operator

6.1.1 FIRST PRIORITY: Render aid as necessary for lifesaving, first aid, control of fire and other hazards. (Note: Radiation presents minimal risks to lives of persons during transportation accidents. Packages identified as "Type A" by markings on the shipping containers contain only non-life endangering amounts of radioactive materials.)

6.1.2 ADDITIONAL ACTIONS BY GAUGE OPERATOR:

6.1.2.1 Visually inspect gauge for damage, including visual inspection of source rod. Determine if sources are, or can be placed in their shielded positions.

6.1.2.2 Locate sources if separated from the gauge. **DO NOT TOUCH OR MOVE RADIOACTIVE SOURCES.** Locate, mark, and secure but do not pick up with bare hands.

6.1.2.3 Secure Area – Evacuate an area of at least a 15 ft. radius around the damaged gauge and/or radioactive sources. (Note: if a source cannot be located, THEN evacuate and secure an area large enough to include any possible locations where the source might be located. Prevent entry by all unauthorized persons into the evacuated area.

6.1.2.4 If a vehicle or construction equipment is involved in the incident, detain the equipment until it is determined that there is no contamination.

6.1.2.5 As soon as possible after these actions have been accomplished, notify the RSO of the incident.

6.1.2.6 Describe in detail the incident, condition of the gauge, and actions taken. Follow any additional instructions given by the RSO as soon as possible.

6.2 **Response Actions to Be Taken By the Regional RSO**

6.2.1 Give additional advice to gauge operator (if needed).

6.2.2 Notify the police, fire, or other emergency agencies as needed or required.

6.2.3 Notify the HQ RSO

6.2.4 The HQ RSO will notify the Tennessee Department of Environmental Conservation Division of Radiological Health at (615) 532-0364.

6.2.5 The HQ RSO will notify the following as needed or if required:

TEMA
1 (800) 262-3300
Troxler 24-Hour Hazmat Emergency
(919) 549-9539

Humboldt 24-Hour Hazmat Emergency
1 (800) 535-5053
U.S. DOT
1 (800) 424-8802

6.2.6 Travel to the accident site and perform the following:
- 6.2.6.1 Confirm the actions taken by the operator to be correct.
- 6.2.6.2 Conduct a visual inspection of the gauge, shielding, and source rod to determine if radioactive sources are still in the gauge.
- 6.2.6.3 If radioactive sources are found to be missing, or damage to the shielding is suspected:
  - 6.2.6.3.1 Use survey meter to conduct a radiation survey of the gauge to assess the integrity of the source encapsulation and shielding. Compare the survey radiation levels to the gauge radiation profile. If the any reading is greater than the listed values you can suspect that the source shielding has been violated.
  - 6.2.6.3.2 If source(s) are not present in the gauge, perform the necessary surveys to locate and properly secure the source(s). (Note: DO NOT pick up radioactive sources with your hands. Use tongs or pliers to place the source in a properly shielded container. Container may be a source “pig”. The source may also be returned to the gauge shielding if uncompromised.
  - 6.2.6.3.3 Perform a leak test on the gauge and source rod.
  - 6.2.6.3.4 With gauge sources at least 30 feet away, check leak test filters with a survey meter and proceed as follows: If the wipe shows a reading greater than background reading, STOP all other actions. Leave any suspected contaminated material in the secured area and notify the appropriate regulatory agency. Increase the secured area and maintain security until proper authorities arrive.
  - 6.2.6.3.5 If no contamination is found, notify the Regional RSO and request permission to transport the gauge. Once gauge has been approved for transporting, any involved vehicle or equipment may be released and the secure area re-opened.
  - 6.2.6.3.6 Document all actions taken, or not taken, and provide sketches and/or photos.

6.3 **Follow Up Actions Taken By Regional Radiation Safety Officer**
- 6.3.1 Take photos of the damaged gauge prior to shipping for repairs or disposal.
- 6.3.2 Place gauge in secure storage location until approved for shipment to manufacturer if needed.
- 6.3.3 Notify the gauge manufacturer of gauge damage and accident.
- 6.3.4 Send photos of the gauge along with leak test info to the manufacturer for clearance and shipping instructions.
- 6.3.5 Document any actions and instructions given for records.
- 6.3.6 Notify by telephone or mail/email ALL regulatory agencies as required of post-accident corrective actions and safety precautions taken.
- 6.3.7 Ship the damaged gauge to manufacturer per instructions given. (Note: NEVER ship a damaged nuclear gauge until it has been leak tested and the wipe cleared.

6.3.8 Review accident causes and measures taken. Establish new or revised guidelines to prevent similar future occurrences.

407.15 Compaction

A. General

After spreading and striking-off the bituminous mixture and adjusting surface irregularities, thoroughly compact the mixture using methods approved by the Engineer and that are capable of achieving the specified density while the material is in a workable condition. When no density requirements are specified, use a system of compaction for roadway pavements that has previously produced the required bituminous pavement densities. The Engineer may require a control strip and random density samples to evaluate the system.

In general, accomplish compaction using a combination of the equipment specified in **407.07**. As a minimum, meet the following roller requirements, but increase the number of rollers if the required results are not being obtained.

1. Except as noted below, each paving train shall consist of a minimum of three rollers meeting **407.07**. The intermediate roller in each train shall be a pneumatic type. If the surface course contains a latex or polymer additive, the Contractor may use a steel wheel type roller for intermediate rolling instead of a pneumatic type provided the surface course meets density requirements.

2. Provide a minimum of two rollers when placing 307 CS, 411 TL, or 411 TLD mixtures. Perform breakdown rolling, as soon as possible and while the mixture is sufficiently hot, using a pneumatic tire roller having a minimum contact pressure of 85 pounds per square inch. Do not substitute a combination roller for a pneumatic roller when placing CS mix. Regulate the paver speed so rollers can maintain proper compaction of the mixture as determined by the Engineer.

3. With the Engineer's approval, the Contractor may reduce the minimum number of rollers listed above to one roller of either the steel-wheel or vibratory type on the following types of construction and projects:

    a. Shoulder construction,

b. Incidental construction such as bridge approaches and driveways, and

c. Projects containing less than 10,000 square yards of bituminous pavement.

4. Compaction of 411-OGFC mixtures shall consist of a minimum of two passes with a steel double drum asphalt roller with minimum weight of 10 tons, before the material temperature has fallen below 185 °F. Provide a minimum of two roller units so as to accomplish the compaction promptly following the placement of the material. At no time shall a pneumatic tire roller be used or a steel wheel roller be used in vibratory mode. If the roller begins to break the aggregate, immediately stop rolling.

Unless otherwise directed by the Engineer, begin rolling at the low side and proceed longitudinally parallel to the road centerline. When paving in echelon or abutting a previously placed lane, roll the longitudinal joint first, followed by the regular rolling procedure. When paving in echelon, rollers shall not compact within 6 inches of an edge where an adjacent lane is to be placed. Operate rollers at a slow uniform speed with the drive wheels nearer the paver, and keep the rollers as nearly as possible in continuous operation. Continue rolling until all roller marks are eliminated. Do not park rollers on the bituminous pavement.

To prevent adhesion of the mixture to the rollers, keep the wheels properly moistened with water or water mixed with very small quantities of detergent or other approved material. Limit excess use of liquid.

Do not refuel rollers on bituminous pavements.

Along forms, curbs, headers, walls and other places not accessible to the rollers, compact the mixture thoroughly using hot hand tampers, smoothing irons, or with mechanical tampers. On depressed areas, the Contractor may use a trench roller to compact the mix.

B. Density Requirements

Meet the applicable density requirements specified in Tables 407.15-1 to 407.15-4.

Table 407.15-1: Density Requirements for ADT 1,000 or less

Mix Type	% of Maximum Theoretical Density (Average)	No Single Test Less Than, %
A	90	87
B, BM & BM2	90	87
C & CW	90	87
D	90	87
E	90	87

Table 407.15-2: Density Requirements for ADT 1,000 to 3,000

Mix Type	% of Maximum Theoretical Density (Average)	No Single Test Less Than, %
A	91	89
B, BM & BM2	91	89
C & CW	91	89
D	91	89
E	91	89

Table 407.15-3: Density Requirements for ADT 3,000 or greater

Mix Type	% of Maximum Theoretical Density (Average)	No Single Test Less Than, %
A	92	90
B, BM & BM2	92	90
C & CW	92	90
D	92	90
E	92	90

Table 407.15-4: Density Requirements for any ADT

Mix Type	% of Maximum Theoretical Density (Average)	No Single Test Less Than, %
Shoulder Mix (B, BM, BM2, D or E)	88	85
AS and A-CRL	None [1]	None
CS	None [1]	None
TL, TLD, and OGFC	None	None

[1] The Department will waive density requirements on Bituminous Plant Mix Base Grading ACRL, Grading AS and Bituminous Plant Mix Leveling Course, Grading CS; however, the Contractor shall use a system of compaction for roadway pavements that has been approved by the Engineer. When placing Bituminous Plant Mix Base Grading ACRL and Grading AS, the Contractor may replace the specified intermediate roller (pneumatic tire) with a steel-wheel type if irreparable damage to the pavement is occurring.

Correct base or surface course that tests below the minimum density so that the density of the area is equal to or above the minimum, at which point it can be used to determine the average density of the lot. Do not place any successive layers until the area has been corrected. As necessary to determine the classification of open graded or dense graded mixes and to measure segregation, use AASHTO T 269 or ASTM D3203.

Repair or replace defective mixture to the satisfaction of the Engineer and at no cost to the Department.

The Department will perform density testing in accordance with **407.20.B.5**.

C. Test Strips

Construct test strips for all A, B, BM, BM2, C, CW, D, and E mixes to establish rolling patterns, to calibrate nuclear gauges, to verify that the base course or surface course meets the density requirements of the specifications, and for mix design and production verification as required.

Before constructing the test strip, obtain the Engineer's approval of the underlying base or other pavement course. Compact the test strip using equipment as specified in this subsection and **407.07**.

Construct the test strip at the beginning of work on the pavement course. Prepare new test strips when:

1. A change in the JMF is necessary;

2. A change in the source of materials occurs;

3. A change in the material from the same source is observed;

4. There is reason to believe that the test strip density is not representative of the bituminous mixture being placed; and when

5. A change in paving or compaction equipment occurs.

With the approval of the Engineer, the Contractor may construct additional test strips.

Construct each test strip with approved bituminous mixture. The test strip shall remain in place as a section of the completed work. Construct each test strip to be 1 paver width wide, with an area of at least 400 square yards and of the depth specified for the pavement course concerned.

Immediately after placing the bituminous mixture, begin compacting the test strip. Perform compaction in a continuous and uniform manner over the entire test strip.

Continue compacting the test strip until additional roller coverage will produce no appreciable increase in density (1 pound per cubic foot), as measured using a nuclear gauge. Use the roller coverage necessary to obtain this maximum density as the rolling pattern for the remainder of the project.

Take cores on the test strip at ten randomly selected locations as designated by the Engineer. Do not take cores within 2 feet of the longitudinal edges for calibration. Provide these cores to the Department for use in calibrating the nuclear gauge and to verify that

the average density of the test strip meets the density requirements of the specifications. The Department will report all densities using the corrected nuclear gauge readings. Correction factors are specific to the nuclear gauges used during the test strip construction. If a different nuclear gauge needs to be used for acceptance, it will be necessary to cut new cores from the ongoing pavement construction to calibrate the new gauge.

When testing test strip cores, the Department will determine density (bulk specific gravity) in accordance with AASHTO T 166, Method A only. All core samples shall be completely dry before testing. Air drying is permitted provided core samples are weighed at 2-hour intervals until dry in accordance with AASHTO T166, Section 6.1. Cores may also be dried in accordance with ASTM D7227.

If the density of the asphaltic concrete in the test strip does not meet specification requirements, make whatever changes are necessary to obtain the specified density. Use other sources and combinations of aggregates as necessary, subject to the Engineer's approval, to produce a mix meeting the required density.

407.16 Joints

Place bituminous paving as continuously as possible. Do not pass rollers over the unprotected end of a freshly laid mixture unless approved by the Engineer. Form transverse joints by cutting back on the previous run to expose the full depth of the course. Use a brush or sprayed coat of bituminous material on contact surfaces of longitudinal and transverse joints just before placing additional mixture against the previously rolled material.

407.17 Pavement Samples

When directed, cut samples from the compacted pavement for testing by the Engineer. Take samples of the mixture for the full depth of the course at locations selected by the Engineer. Cut the samples with a power saw or core drill. Samples shall have a top surface area of at least 10 inches.

Fill holes left by taking samples with the same type mixture that was used to construct the course sampled, and compact to conform to the surrounding pavement. Cut samples and repair sample holes at no cost to the Department.

a Cold Weather Paving and Compaction Plan. All projects requiring a Cold Weather Paving and Compaction Plan shall utilize Intelligent Compaction to demonstrate proper coverage and compaction temperature at no additional cost to the Department; with the exception of small quantity projects, such as, but not limited to, bridge approaches, intersections, and temporary traffic shifts. Upon completion, the documentation showing appropriate coverage and compaction temperature shall be provided to the Department. Submit requests in writing at least one week before the anticipated need, and include a Paving and Compaction Plan for Cold Weather that meets the Department's Procedure. The plan shall identify what practices and precautions the Contractor intends to use to ensure the mixture is placed and compacted to meet the specifications. The plan shall include compaction cooling curves estimating the time available for compaction, the intended production, haul, and compaction rates, with paver and roller speeds estimated. The Contractor may consider using such practices as the addition of rollers, reduced production and paving rates, insulated truck beds, and heating the existing surface.

In no cases will a cold weather paving and compaction plan or seasonal limitation waiver be approved for 411-OGFC, 411-TL, or 411-TLD.

If the specified densities are not obtained, stop all paving operations and develop a new plan. All mixture failing to meet specifications will be subject to price adjustments or removal and replacement at no cost to the Department.

Subsection 407.11 (pg. 332) 12-2-16; Add the following to the paragraph below Table 407.11-1:

"Minimum temperature for OGFC mixes shall be 280º."

Subsection 407.15, C. Test Strips. (pg. 340-341) 11-16-15; Add the following paragraph after the 7th paragraph of the subsection:

"Take an additional 3 cores after placement of the surface layer on the tack coat test strip described in subsection **403.05.B**. Include the underlying pavement layer for shear testing. These cores will be for informational testing only. Not required for mats less than one inch thick"

Subsection 407.15 (pg. 341) 6-27-16; remove the 2nd sentence of the 8th paragraph:

"Take cores on the test strip at ten randomly selected locations as designated by the Engineer. Provide these cores to the Department for use in calibrating the nuclear gauge and to verify that the average density of the test strip meets the density requirements of the specifications. The Department will report all densities using the corrected nuclear gauge readings. Correction factors are specific to the nuclear gauges used during the test strip construction. If a different nuclear gauge needs to be used for acceptance, it will be necessary to cut new cores from the ongoing pavement construction to calibrate the new gauge."

Subsection 407.15 (pg. 341) 12-2-16; remove "randomly selected" from 1st sentence of the 8th paragraph as follows:

"Take cores on the test strip at ten locations as designated by the Engineer."

Subsection 407.15 A. 3. c. (pg. 337-338) 5-15-17; update 10,000 square yards to 1,000 tons:

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
6601 CENTENNIAL BLVD.
NASHVILLE, TENNESSEE 37243-0360

DENSITY WORKSHEET - NUCLEAR METHOD

Project Reference No. _____ Date _____
Project No. _____ County _____ Region _____
Nuclear gauge no. _____ Contract No. _____
Item Number _____

Lot No.					
Test No.					
Station					
Offset (ft.)					
Feet Below Grade					
Thickness					
Moisture Standard Count					
Moisture Count					
Moisture Count Ratio					
Probe Depth					
Density Standard Count					
Density Count					
Density Count Ratio					
Unit Weight Wet (pcf)					
Moisture (pcf)					
Unit Weight Dry (pcf)					
Percent Moisture					
Cut Station					
Sample Number					
Proctor Density (pcf)					
Optimum Moisture, %					
Dry Weight of +4 Material					
Dry Weight of Total Material					
Percent +4 Material					
Sp. Gravity of +4 Material					
Corrected Proctor Density					
Corrected Optimum Moisture					
Percent Compaction					

Signature _____
Title _____

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
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NASHVILLE, TENNESSEE 37243-0360

Item No. _____ Grading _____

Report No. _____ ASPHALT DENSITY REPORT Date _____

Contract No. _____

Project Reference No. _____ County _____ Region _____

Project No. _____ Contractor _____

Gauge No.	Standard Count	Theoretical or Laboratory Density	Core Correction	Percent Required Density
		5.0		

Lot No. _____ From Sta. _____ To Sta. _____ Lin. M (ft.) _____ Width _____ Lift _____ Lane _____

Date	Test No	Sta No	Location	Den. Test 1	Den. Test 2	Den. Test 3	Den. Test 4	Avg	Corrected Density	Density (%)
			1' From Left							
			Left Wheel							
			Center							
			Right Wheel							
			1' From Right							

Tons in Lot _____ Mix Running Total _____

Lot No. _____ From Sta. _____ To Sta. _____ Lin. M (ft.) _____ Width _____ Lift _____ Lane _____

Date	Test No	Sta No	Location	Den. Test 1	Den. Test 2	Den. Test 3	Den. Test 4	Avg	Corrected Density	Density (%)
			1' From Left							
			Left Wheel							
			Center							
			Right Wheel							
			1' From Right							

Tons in Lot Mix Running Total

Lot No. _____ From Sta. _____ To Sta. _____ Lin. M (ft.) _____ Width _____ Lift _____ Lane _____

Date	Test No	Sta No	Location	Den. Test 1	Den. Test 2	Den. Test 3	Den. Test 4	Avg	Corrected Density	Density (%)
			1' From Left							
			Left Wheel							
			Center							
			Right Wheel							
			1' From Right							

Tons in Lot _____ Mix Running Total _____

Remarks:

lb/yd^2 (kg/yd^2) _____	
Lot No.	Avg. % Density

Original to:
Headquarters Materials and Tests
Copies to:
Regional Materials and Tests
Project Supervisor
Form DT-0315 (Rev. 07-17)

Signature _____

Title _____

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
6601 CENTENNIAL BLVD.
NASHVILLE, TENNESSEE 37243-0360

DAILY REPORT ON SOIL AND AGGREGATE STABILIZATION

Date _____

Project Reference No. _____ County _____ Region _____

Project No. _____ Contract No. _____

Report No. _____ Contractor _____

Producer _____ Producer Location _____

Item Numbers _____ Temp. Max _____ ^{O}F Min. _____ ^{O}F

Type of Construction _____ Type of Mixing _____

Percent Cement Design _____ Design Depth _____ Average Depth _____

Lbs./Square Yd. Cement Design _____ Lbs./Square Yd. Cement Used _____

From Station _____ To Station _____ Excluding Stations _____

Linear Feet _____ Width _____ Square Yards _____

Tons of Cement _____ Tons of Aggregate Delivered _____

Quantity (moisture in excess of 3% of optimum moisture content has been deducted): _____ Tons

SCREEN ANALYSIS

Percent Passing Square Sieves

3"	2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	4	8	16	40	100	200	% Moisture at Plant

COMPACTION DATA

Lot No.	No. of Tests	STATION		Lane	Lift	Test Depth	Field Density	Theoretical Density	Optimum Moisture	Ave. Percent Theoretical Density
		From	To							

Remarks:

Original to:
Headquarters Materials and Tests
Copies to:
Regional Materials and Tests
Project Supervisor
Form DT-0298 (Rev. 11-12)

Approved:

_____ Project Supervisor

_____ Project Inspector

Original to:
Headquarters Materials and Tests
Copies to:
Regional Materials and Tests
Project Supervisor
Form DT-0304 (Rev. 08-17)

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
6601 CENTENNIAL BLVD.
NASHVILLE, TENNESSEE 37243-0360

FIELD DENSITY REPORT ON SOILS OR AGGREGATES

Type of Material _____

Project Reference No. _____
Project No. _____ Contract No. _____
Contractor _____ Density Report No. _____ Region _____
Subcontractor _____ County _____

FIELD TESTS							INFORMATION FROM EMBANKMENT FORM DT-0332			Percent Proctor Density DT-0314
Date	Test No.	Station	Offset	Feet Below Grade	Percent Moisture	Field Density	Lab Serial **OR** Report Number	Optimum Moisture	Proctor Density	
RETEST AFTER WORKING AREA THAT FAILED										

Remarks:

Approved by _____
Project Supervisor

_____
Project Inspector

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS

6601 CENTENNIAL BLVD.
NASHVILLE, TENNESSEE 37243-0360

Item No. _____ DAILY REPORT ON MINERAL AGGREGATE BASE Date _____

Contract No. _____

Report No. _____ County _____ Region _____

Project Reference No. _____

Project No. _____

From Sta. _____ To Sta. _____ Lin M (ft.) _____ Width _____ Lift _____ Lane _____

m^2 _____ Method of Mixing _____ Type _____ Class _____ Grading _____

Contractor _____ Producer and Location _____

Tons of Aggregate Delivered _____ Tonnes (Tons)

Quantity (moisture in excess of 3% of optimum moisture content has been deducted): _____ Tonnes (Tons)

SCREEN ANALYSIS

Percent Passing Square Sieve

75.0 mm 3"	63.0 mm 2.5"	50.0 mm 2"	37.5 mm 1.5"	25.0 mm 1"	19.0 mm 3/4"	12.5 mm 1/2"	9.5 mm 3/8"	4.75 mm #4	2.36 mm #8	1.18 mm #16	0.425 mm #40	0.15 mm #100	0.075 mm #200	% Moisture at Plant

Sampled from _____ Signature _____

Title _____

COMPACTION DATA

Lot No.	No. of Tests	Station		Lane	Lift	Test Depth	Theoretical Density	Average Field Density	Average % Theoretical
		From	To						

Remarks:

Original to:
Headquarters Materials and Tests
Copies to:
Regional Materials and Tests
Project Supervisor
Form DT-0307 (Rev. 11-12)

Signature _____

Title _____

Approved _____