

DEPARTMENT OF TRANSPORTATION
ENGINEERING SERVICE CENTER
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METHOD OF DEVELOPING DENSITY AND MOISTURE CALIBRATION TABLES FOR THE NUCLEAR GAGE

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Part 4 of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

OVERVIEW

This is a procedure for developing density and moisture calibration tables for nuclear gages. Gage count ratios are related to six California Transportation Laboratory Master Standard Density Blocks (CTLMSDB), located in Sacramento, California. These blocks are the standard reference blocks for the California Department of Transportation (Caltrans).

Density calibration tables may also be developed by relating gage count ratios to two reference standard blocks located in 11 of 12 Caltrans districts. District blocks are correlated to the six CTLMSDB at least once every 15 months as described in this procedure.

NOTE: District 12 does not have standard calibration blocks. It uses the blocks from District 7.

Moisture calibration tables can be developed by relating gage count ratios to the two moisture standards located at the Transportation Laboratory in Sacramento or to the two moisture standards located in the Caltrans districts. Correlations to field moistures may also be developed where this relationship is desired.

This method is divided into the following parts:

1. Procedure for Correlating the Six Transportation Laboratory Master Standard Density Blocks and the Two Caltrans District Blocks
2. Procedure for Determination of Direct Transmission and Backscatter Density Calibration Tables
3. Procedure for Determination of Moisture Calibration Tables
4. Safety and Health

PART 1. PROCEDURE FOR CORRELATING THE SIX TRANSPORTATION LABORATORY BLOCKS AND THE TWO CALTRANS DISTRICT BLOCKS

A. APPARATUS

1. The nuclear gage and the manufacturer's standard block are required.
2. The six CTLMSDB and the two Caltrans district blocks are required.

B. STANDARDIZATION OF GAGE FOR DENSITY

1. Set the standardizing devices 1.5 m from any object and 8 m from any gage. Place the gage on the standardizing device in the safe position and take eight density counts. The eight measurements taken are part of the warm-up procedure and are entered in a gage log book, but are not used in the subsequent parts of this procedure. After the warm-up, take four or more 1-min. counts for density. Record the data on the form shown in Figure 1 and in the gage log book. The average of the four measurements is the *standard count* for the gage.
2. When the nuclear gage is equipped with electronic circuitry capable of automatically averaging four 1-min. density counts, place the gage on the standardizing block in the safe position and take two 4-min. (warm-up) counts and record the data in the gage log book. After the warm-up, take a 4-min. count for density. Record this average count on the form shown in Figure 1 and in the gage log book.

C. CALIBRATION PROCEDURE FOR DENSITY

1. Set the rod at the desired depth and position the gage on one of the two Caltrans district reference standard blocks with the rod in the hole provided for this purpose. All blocks must be spaced at least 8 m apart unless there is proper shielding between the blocks.
2. Adjust the gage so that the rod is firmly against the side of the hole nearest to the gage.
3. Take four 1-min. counts or the average of four 1-min. counts for the gages referred to in Section B-2 at backscatter, 50, 75, 100, 125, 150, 175 and 200 mm nominal direct transmission depths. Nominal direct transmission depth defines the

approximate depth at which the rod is placed.

The direct transmission depth is the nominal direct transmission depth ± 3 mm and is defined as the actual depth setting at which the soil density gage rod is manufactured to stop. Repeat the measurements on the second Caltrans district block. Record all data on the form shown in Figure 1.

4. Repeat the procedures described in Sections C-1, C-2, and C-3 on the six CTLMSDB and record all data on Form shown in Figure 2.

NOTE: All operative Caltrans nuclear gages within the district should be included in this correlation procedure.

5. The calibration data from a gage on the six CTLMSDB (Figure 2) are plotted as gage count ratios versus known densities of the CTLMSDB. The *count ratio* is the average block count divided by the standard count. The example on Figure 3 shows a plot of the 200-mm reading.

The calibration of the same gage on the two district blocks (Figure 1) is plotted so that the count ratio of the gage falls on the average CTLMSDB calibration curve for the particular mode of test (Figure 3). The corresponding density for the particular count ratio is then determined by reading the density on the abscissa.

The count ratio for District Block No. 6 is 1.091 for the 200-mm direct transmission mode. Draw a line from 1.091 perpendicular to the ordinate until it intersects the average line for the 6-block calibration. Draw a line from the intersection parallel to the ordinate and read a density of 1746 kg/m^3 on the abscissa. Following this procedure, the density for a count ratio of 0.439 is 2387 kg/m^3 .

6. Repeat the above procedure for the count ratios on the two district blocks for all test modes.
7. A tabulation is made of all individual densities for all gages in the district and an average value is calculated for each test mode and district block.
8. The assigned values for the district block will be the average value calculated in Step 7 plus 8 kg/m^3 .

NOTE: The required data described in Sections C-5 through C-8 can be performed on a computer.

9. No adjustment to the assigned values of the Caltrans district blocks shall be made if the annual calibration is within $\pm 8 \text{ kg/m}^3$ of the previous year's calibration.

PART 2. PROCEDURE FOR DETERMINATION OF DIRECT TRANSMISSION AND BACKSCATTER DENSITY CALIBRATION TABLES

A. APPARATUS

1. The nuclear gage and the manufacturer's standard block are required.
2. The six CTLMsDB or the two Caltrans district blocks are required.

B. STANDARDIZATION OF GAGE FOR DENSITY

1. Follow the procedure specified in Part 1, Section B.
2. The *count ratio* (average block count divided by the standard count) related to block density is used for preparing a calibration table.

Any subsequent standard count must be within $\pm \text{ADL}$ of the value used to prepare the calibration table. If it is not, a new ADL and calibration table should be established after the gage is checked and repaired if necessary.

NOTE: The acceptable deviation limit (ADL) is defined in this test method as $\text{ADL} = 3\sqrt{n}$ where n = number of counts indicated on the gage. This relationship is valid when the number of counts is over 10,000. Table 1 shows values of ADL for various counts.

C. CALIBRATION PROCEDURE FOR DENSITY USING THE TWO CALTRANS DISTRICT BLOCKS

1. Follow the procedure specified in Part 1, Sections C-1 through C-3.
2. Calculate the average of the four counts for each test mode for each block and determine count ratio by dividing the average block count by the standard count (Figure 1).
3. Table 2 shows the printout for a 200-mm direct transmission mode based on data from the two Caltrans district blocks (Figure 1).
4. A computer-calculated calibration table of count ratios and corresponding densities for each test mode can also be developed using the data from the six CTLMsDB at the Transportation Laboratory in Sacramento, California.

PART 3. DETERMINATION OF MOISTURE CALIBRATION TABLES

A. APPARATUS

1. The nuclear gage and the manufacturer's standard block are required.
2. The two moisture standards located at the Transportation Laboratory or the two moisture standards in Caltrans district.

B. CALIBRATION PROCEDURE

1. Follow the procedure in Part 1, Section B, except take moisture readings instead of density readings. Record the data on Form shown in Figure 1. The warm-up and afternoon standard counts for moisture can be recorded in the space

provided for the density standard counts. These counts are not necessary if the density counts were already made during the same day.

2. Place the gage on the moisture standard in the backscatter position and take four 1-min. counts for the gages referred to in Part 2, Section B-2.
3. Repeat the test on the second moisture standard.
4. Record the data Form shown in Figure 1, calculate the average, and determine count ratio by dividing the average count on the moisture calibration standard by the standard count for moisture.
5. Table 3 shows the printout for the moisture based on the data shown on Figure 1. This table may not give moisture content comparable to oven drying (California Test 226). If this correlation is needed, the table must be verified by performing nuclear gage field moisture tests and relating test results to oven-dry moistures and field densities.

C. FIELD MOISTURE CALIBRATION PROCEDURE

1. Follow the procedure described in Part 3, Sections A, B-1, B-2, B-3 and B-4.
2. Plot the data from Part 3, Section B-4 and draw a curve (Figure 4).
3. Take at least 10 nuclear gage field moisture and density tests (California Test 231).
4. At these same sites, take representative soil samples and determine oven-dry moistures (California Test 226).
5. Plot the field gage count ratios versus field moistures (Figure 4).
6. Draw a best fit curve through the points and parallel to the standard curve determined in Part 3, Section B.

7. Take a count ratio at 0.3 and 1.0 and the corresponding moistures at these two points. Use this data to obtain a moisture calibration printout. Each gage should be checked for density and moisture calibration at least once a year, or more often if variations in standard counts exceed the limits of Part 2, Section B or when the gage is repaired.

PART 4. SAFETY AND HEALTH

All rules and regulations in the operators manual and the State of California Administration Code, Title 17, of the State of California, Department of Health Services shall be followed.

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part a (Section 5.0), Part B (Section: 5.0, 6.0 and 10.0) and Part C (Section 2.0) of Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

REFERENCES:

California Tests 121, 226 and 231

End of Text (California Test 111 contains 11 pages)

CALIBRATION FOR NUCLEAR GAGE

DISTRICT 06 DATE 5/10/96 TESTS BY F.C.C. GAGE No. 715
 MOIST. CALIB. STANDARD NO. 0 301
 STD. COUNTS MOISTURE

WARMUP		A.M.		P.M.		STD. COUNTS MOISTURE		MOIST. CALIB. STANDARD NO.		
1	41900	1	42040	1	41880	1	5560	1	410	4220
2	42180	2	41690	2	42070	2	5460	2	450	4330
3	41910	3	41960	3	41760	3	5550	3	430	4380
4	41800	4	42080	4	42040	4	5620	4	480	4350
5	42240	5	41660	5	42030	5	5610	5		
6	41790	SUM	209430	SUM	209780	SUM	27800	6		
7	42040	AVG.	41885	AVG.	41955	AVG.	5560	SUM	1170	17280
8	41850							AVG.	443	4320
9	42090							C R	0.080	0.777
10	41610									
SUM	419410									
AVG.	41940									

Note: 1. PM Standard Count taken to check gage stability
 2. CR = Average test count / Average AM Standard Count

Remarks _____

		BS	50 mm	75 mm	100 mm	125 mm	150 mm	175 mm	200 mm
BLK	1	15030	102160	102770	95970	83910	69650	57180	45320
	2	14950	101600	102600	95760	84230	69100	56480	46080
	3	14980	101910	102690	96030	84210	69560	57060	45590
	4	15140	101780	102650	95310	84160	69510	57030	45740
	5								
	6								
	SUM	60100	407450	410710	383070	336510	277820	227750	182730
	AVG.	15025	101863	102678	95768	84128	69455	56938	45683
	C R	0.359	2.432	2.451	2.286	2.008	1.658	1.359	1.091
BLK	1	8810	60280	58880	51670	42440	33730	25410	18500
	2	8820	60230	58700	51540	42510	33310	25350	18320
	3	8820	60270	58730	51240	42790	33390	25270	18430
	4	8690	60480	58730	51720	42590	33270	25340	18290
	5								
	6								
	SUM	35140	241260	235040	206170	170330	133700	101370	73540
	AVG.	8785	60315	58760	51543	42583	33425	25343	18385
	C R	0.210	1.440	1.403	1.231	1.017	0.798	0.605	0.439

FIGURE 1

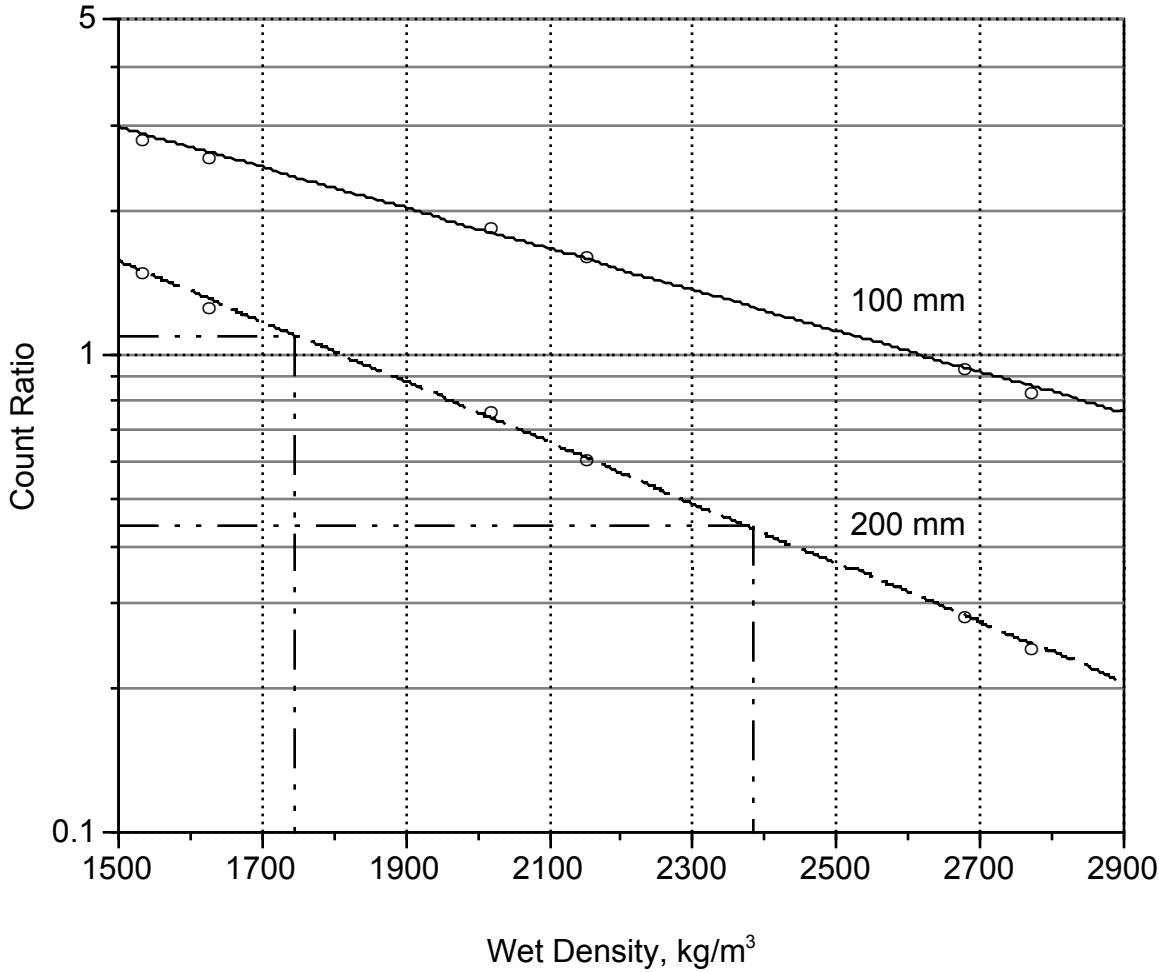
CALIBRATION FOR NUCLEAR GAGE

DISTRICT 06 DATE 5/10/96 TESTS BY F.C.C. STANDARD COUNT 41885 GAGE No. 715

		BS	50 mm	75 mm	100 mm	125 mm	150 mm	175 mm	200 mm
S-1 1530	1	19710	122920	124550	119910	106470	92020	77080	62560
	2	19840	123360	125070	119210	106420	92220	77230	62560
	3	19660	122930	125570	119290	106640	91800	76870	63020
	4	19550	122920	125330	119340	106660	91880	77330	63260
	SUM	78760	492130	500520	477750	426190	367920	308510	251400
	AVG.	19690	123033	125130	119438	106548	91980	77128	62850
	C R	0.470	2.937	2.987	2.852	2.544	2.196	1.841	1.501
S-2 2020	1	13120	87100	85180	77740	65910	54180	41940	32340
	2	12970	87180	85220	77800	65870	53930	42400	32140
	3	13130	86840	85440	77710	66560	53840	42390	32070
	4	13190	87410	85450	77820	66300	54010	42500	32390
	SUM	52410	348530	341290	311070	264640	215960	169230	128940
	AVG.	13103	87133	85323	77768	66160	53990	42308	32235
	C R	0.313	2.080	2.037	1.857	1.580	1.289	1.010	0.770
S-3 2680	1	7600	48380	45620	39070	31430	23580	17000	11970
	2	7490	48560	45740	39350	31220	23500	16750	11930
	3	7520	48930	45780	39560	31040	23460	17250	12060
	4	7340	48390	45190	39580	31150	23580	16940	11830
	SUM	29950	194260	182330	157560	124840	94120	67940	47790
	AVG.	7488	48565	45583	39390	31210	23530	16985	11948
	C R	0.179	1.159	1.088	0.940	0.745	0.562	0.406	0.285
C-1 1630	1	18330	119800	117960	108580	95200	80310	66440	52900
	2	18380	120140	117930	108330	94860	80760	66620	53310
	3	18560	119210	117920	109000	95410	80550	66670	53270
	4	18400	119940	118560	108630	94830	80260	66050	52770
	SUM	73670	479090	472370	434540	380300	321880	265780	212250
	AVG.	18418	119773	118093	108635	95075	80470	66445	53063
	C R	0.440	2.860	2.819	2.594	2.270	1.921	1.586	1.267
C-2 2150	1	11390	77590	75010	67860	55370	43830	33810	25610
	2	11360	77520	74960	67810	55560	44160	34020	25700
	3	11500	77850	75240	67710	55660	44350	33920	25700
	4	11480	77460	74960	68020	56040	44290	34210	25420
	SUM	45730	310420	300170	271400	222630	176630	135960	102430
	AVG.	11433	77605	75043	67850	55658	44158	33990	25608
	C R	0.273	1.853	1.792	1.620	1.329	1.054	0.812	0.611
C-3 2770	1	7000	44810	41530	35510	27750	21000	15160	10320
	2	7030	44920	41690	35620	28250	20880	14830	10270
	3	6910	44790	41910	35130	27810	20840	14930	10160
	4	6890	44770	41540	35440	27950	20720	15110	10180
	SUM	27830	179290	166670	141700	111760	83440	60030	40930
	AVG.	6958	44823	41668	35425	27940	20860	15008	10233
	C R	0.166	1.070	0.995	0.846	0.667	0.498	0.358	0.244

FIGURE 2

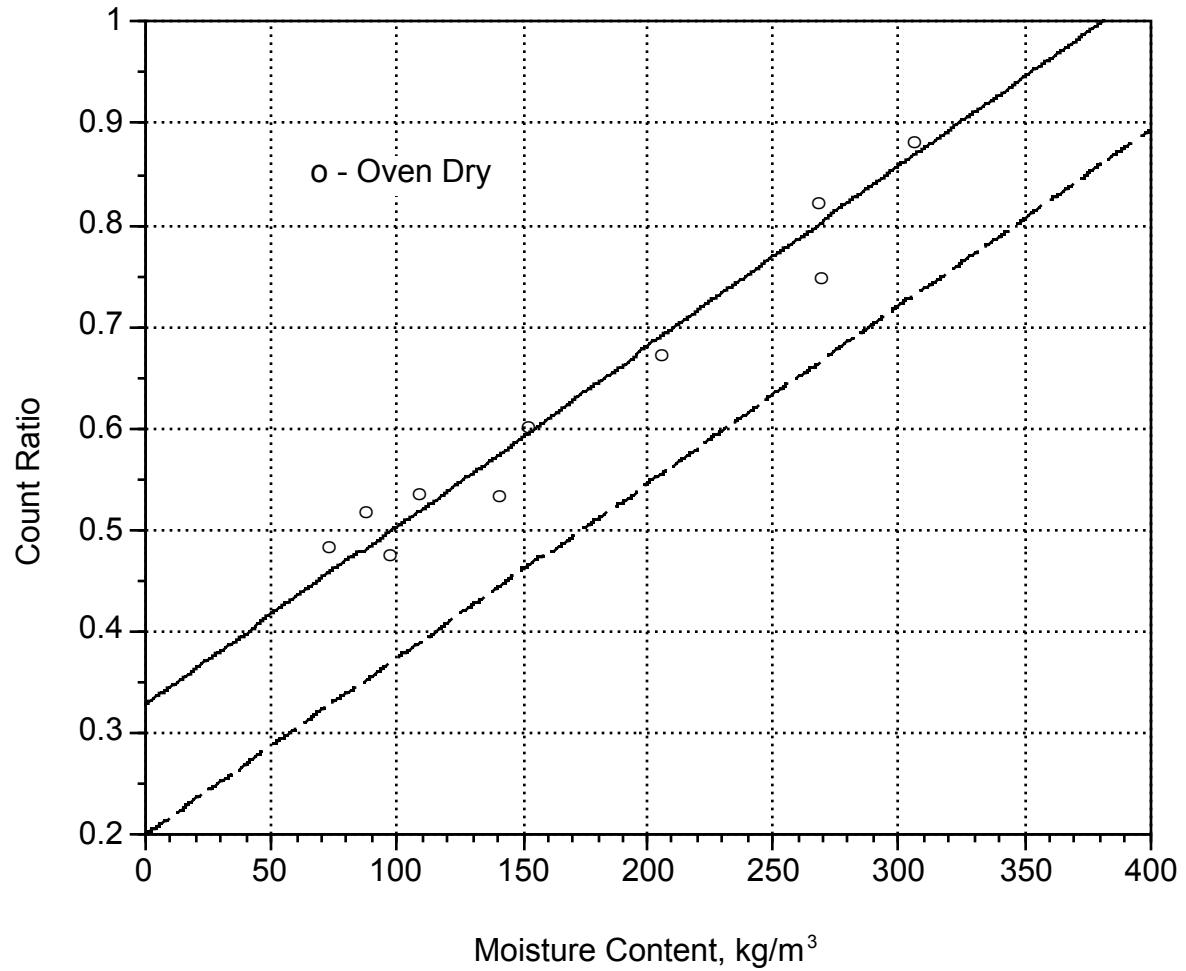
ILLUSTRATIVE EXAMPLE ONLY



Density versus Count Ratio on Six Standard Blocks

FIGURE 3

ILLUSTRATIVE EXAMPLE ONLY



Moisture Calibration Curve

FIGURE 4

TABLE 1 – ACCEPTABLE DEVIATION LIMIT (ADL) FOR VARIOUS GAGE COUNTS

n	ADL	n	ADL	n	ADL	n	ADL	n	ADL
≤10100	300								
10101-10302	303	19741-20022	423	32581-32942	543	48621-49062	663	67861-68382	783
10303-10506	306	20023-20306	426	32943-33306	546	49063-49506	666	68383-68906	786
10507-10712	309	20307-20592	429	33307-33672	549	49507-49952	669	68907-69432	789
10713-10920	312	20593-20880	432	33673-34040	552	49953-50400	672	69433-69960	792
10921-11130	315	20881-21170	435	34041-34410	555	50401-50850	675	69961-70490	795
11131-11342	318	21171-21462	438	34411-34782	558	50851-51302	678	70491-71022	798
11343-11556	321	21463-21756	441	34783-35156	561	51303-51756	681	71023-71556	801
11557-11772	324	21757-22052	444	35157-35532	564	51757-52212	684	71557-72092	804
11773-11990	327	22053-22350	447	35533-35910	567	52213-52670	687	72093-72630	807
11991-12210	330	22351-22650	450	35911-36290	570	52671-53130	690	72631-73170	810
12211-12432	333	22651-22952	453	36291-36672	573	53131-53592	693	73171-73712	813
12433-12656	336	22953-23256	456	36673-37056	576	53593-54056	696	73713-74256	816
12657-12882	339	23257-23562	459	37057-37442	579	54057-54522	699	74257-74802	819
12883-13110	342	23563-23870	462	37443-37830	582	54523-54990	702	74803-75350	822
13111-13340	345	23871-24180	465	37831-38220	585	54991-55460	705	75351-75900	825
13341-13572	348	24181-24492	468	38221-38612	588	55461-55932	708	75901-76452	828
13573-13806	351	24493-24806	471	38613-39006	591	55933-56406	711	76453-77006	831
13807-14042	354	24807-25122	474	39007-39402	594	56407-56882	714	77007-77562	834
14043-14280	357	25123-25440	477	39403-39800	597	56883-57360	717	77563-78120	837
14281-14520	360	25441-25760	480	39801-40200	600	57361-57840	720	78121-78680	840
14521-14762	363	25761-26082	483	40201-40602	603	57841-58322	723	78681-79242	843
14763-15006	366	26083-26406	486	40603-41006	606	58323-58806	726	79243-79806	846
15007-15252	369	26407-26732	489	41007-41412	609	58807-59292	729	79807-80372	849
15253-15500	372	26733-27060	492	41413-41820	612	59293-59780	732	80373-80940	852
15501-15750	375	27061-27390	495	41821-42230	615	59781-60270	735	80941-81510	855
15751-16002	378	27391-27722	498	42231-42642	618	60271-60762	738	81511-82082	858
16003-16256	381	27723-28056	501	42643-43056	621	60763-61256	741	82083-82656	861
16257-16512	384	28057-28392	504	43057-43472	624	61257-61752	744	82657-83232	864
16513-16770	387	28393-28730	507	43473-43890	627	61753-62250	747	83233-83810	867
16771-17030	390	28731-29070	510	43891-44310	630	62251-62750	750	83811-84390	870
17031-17292	393	29071-29412	513	44311-44732	633	62751-63252	753	84391-84972	873
17293-17556	396	29413-29756	516	44733-45156	636	63253-63756	756	84973-85556	876
17557-17822	399	29757-30102	519	45157-45582	639	63757-64262	759	85557-86142	879
17823-18090	402	30103-30450	522	45583-46010	642	64263-64770	762	86143-86730	882
18091-18360	405	30451-30800	525	46011-46440	645	64771-65280	765	86731-87320	885
18361-18632	408	30801-31152	528	46441-46872	648	65281-65792	768	87321-87912	888
18633-18906	411	31153-31506	531	46873-47306	651	65793-66306	771	87913-88506	891
18907-19182	414	31507-31862	534	47307-47742	654	66307-66822	774	88507-89102	894
19183-19460	417	31863-32220	537	47743-48180	657	66823-67340	777	89103-89700	897
19461-19740	420	32221-32580	540	48181-48620	660	67341-67860	780	89701-90300	900

TABLE 2 - COUNT RATIO VS. DENSITY FOR NUCLEAR GAGE NO. 715

DISTRICT 6 MAY 10, 1996 STD. CT 41 885 200 mm D/T BY F. CHAMPION
 BASED ON: DENSITY kg/m³ 1784 2399
 COUNT RATIO 1.091 0.439

CR	To	CR	kg/m ³	CR	To	CR	kg/m ³	CR	To	CR	kg/m ³
1.869	-	1.895	1400	1.060	-	1.074	1800	0.592	-	.601	2200
1.843	-	1.868	1410	1.045	-	1.059	1810	0.583	-	0.591	2210
1.817	-	1.842	1420	1.030	-	1.044	1820	0.574	-	0.582	2220
1.792	-	1.816	1430	1.015	-	1.029	1830	0.566	-	0.573	2230
1.766	-	1.791	1440	1.001	-	1.014	1840	0.557	-	0.565	2240
1.741	-	1.765	1450	0.987	-	1.000	1850	0.548	-	0.556	2250
1.717	-	1.740	1460	0.973	-	0.986	1860	0.540	-	0.547	2260
1.693	-	1.716	1470	0.959	-	0.972	1870	0.532	-	0.539	2270
1.669	-	1.692	1480	0.946	-	0.958	1880	0.524	-	0.531	2280
1.645	-	1.668	1490	0.932	-	0.945	1890	0.516	-	0.523	2290
1.622	-	1.644	1500	0.919	-	0.931	1900	0.508	-	0.515	2300
1.599	-	1.621	1510	0.906	-	0.918	1910	0.500	-	0.507	2310
1.577	-	1.598	1520	0.894	-	0.905	1920	0.492	-	0.499	2320
1.554	-	1.576	1530	0.881	-	0.893	1930	0.485	-	0.491	2330
1.533	-	1.553	1540	0.869	-	0.880	1940	0.477	-	0.484	2340
1.511	-	1.532	1550	0.856	-	0.868	1950	0.470	-	0.476	2350
1.490	-	1.510	1560	0.844	-	0.855	1960	0.463	-	0.469	2360
1.469	-	1.489	1570	0.832	-	0.843	1970	0.456	-	0.462	2370
1.448	-	1.468	1580	0.821	-	0.831	1980	0.449	-	0.455	2380
1.428	-	1.447	1590	0.809	-	0.820	1990	0.442	-	0.448	2390
1.407	-	1.427	1600	0.798	-	0.808	2000	0.435	-	0.441	2400
1.388	-	1.406	1610	0.786	-	0.797	2010	0.429	-	0.434	2410
1.368	-	1.387	1620	0.775	-	0.785	2020	0.422	-	0.428	2420
1.349	-	1.367	1630	0.764	-	0.774	2030	0.416	-	0.421	2430
1.330	-	1.348	1640	0.754	-	0.763	2040	0.409	-	0.415	2440
1.311	-	1.329	1650	0.743	-	0.753	2050	0.403	-	0.408	2450
1.293	-	1.310	1660	0.733	-	0.742	2060	0.397	-	0.402	2460
1.274	-	1.292	1670	0.722	-	0.732	2070	0.391	-	0.396	2470
1.256	-	1.273	1680	0.712	-	0.721	2080	0.385	-	0.390	2480
1.239	-	1.255	1690	0.702	-	0.712	2090	0.379	-	0.384	2490
1.221	-	1.238	1700	0.691	-	0.701	2100	0.373	-	0.378	2500
1.204	-	1.220	1710	0.680	-	0.690	2110	0.367	-	0.372	2510
1.187	-	1.203	1720	0.670	-	0.679	2120	0.362	-	0.366	2520
1.170	-	1.186	1730	0.660	-	0.669	2130	0.356	-	0.361	2530
1.154	-	1.169	1740	0.650	-	0.659	2140	0.351	-	0.355	2540
1.137	-	1.153	1750	0.640	-	0.649	2150	0.345	-	0.350	2550
1.121	-	1.136	1760	0.630	-	0.639	2160	0.340	-	0.344	2560
1.106	-	1.120	1770	0.620	-	0.629	2170	0.335	-	0.339	2570
1.090	-	1.105	1780	0.611	-	0.619	2180	0.330	-	0.334	2580
1.075	-	1.089	1790	0.602	-	0.610	2190	0.325	-	0.329	2590

TABLE 3 - COUNT RATIO VS. MOISTURE FOR NUCLEAR GAGE NO. 715

DISTRICT 6 MAY 10, 1996 STD. CT 5560 BY F. CHAMPION
 BASED ON: MOISTURE kg/m³ 0 301
 COUNT RATIO 0.080 0.777

CR To CR	kg/m ³	CR To CR	kg/m ³	CR To CR	kg/m ³
0.069 - 0.092	00	0.532 - 0.554	200	0.995 - 1.017	400
0.093 - 0.115	10	0.555 - 0.578	210	1.018 - 1.041	410
0.116 - 0.138	20	0.579 - 0.601	220	1.042 - 1.061	420
0.139 - 0.161	30	0.302 - 0.324	230	1.065 - 1.087	430
0.162 - 0.184	40	0.625 - 0.647	240	1.088 - 1.110	440
0.185 - 0.207	50	0.648 - 0.670	250	1.111 - 1.133	450
0.208 - 0.230	60	0.671 - 0.693	260	1.134 - 1.156	460
0.231 - 0.254	70	0.694 - 0.717	270	1.157 - 1.179	470
0.255 - 0.277	80	0.718 - 0.740	280	1.180 - 1.203	480
0.278 - 0.300	90	0.741 - 0.763	290	1.204 - 1.226	490
0.301 - 0.323	100	0.764 - 0.786	300	1.227 - 1.249	500
0.324 - 0.346	110	0.787 - 0.809	310	1.250 - 1.272	510
0.347 - 0.369	120	0.810 - 0.832	320	1.273 - 1.295	520
0.370 - 0.392	130	0.833 - 0.855	330	1.296 - 1.318	530
0.393 - 0.416	140	0.856 - 0.879	340	1.319 - 1.341	540
0.417 - 0.439	150	0.880 - 0.902	350	1.342 - 1.365	550
0.440 - 0.462	160	0.903 - 0.925	360	1.366 - 1.388	560
0.463 - 0.485	170	0.926 - 0.948	370	1.389 - 1.411	570
0.486 - 0.508	180	0.949 - 0.971	380	1.412 - 1.434	580
0.509 - 0.531	190	0.972 - 0.994	390	1.435 - 1.457	590