APPENDIX

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Section 01 Definitions of Terms

Abrasion Wearing away by friction.

Admixture That which is added and mixed. For example: Calcium or sodium chloride, clay, sand, etc., added to a gravel road surface.

Aggregate Road materials composed of mineral substances, such as gravel, crushed stone, slag, sand, or combinations of these, used for various purposes in highway maintenance and construction.

Asphalt A brown to black solid bituminous substance, soluble in gasoline or naphtha.

Backfill Material used in filling an excavation or the act of filling an excavation.

Base Course The supporting layer immediately under the surfacing.

Basement Soil The material in excavations, embankments and embankment foundations immediately below the first layer of subbase, base, or pavement, and to such depth as may affect structural design.

Binder Material used to stabilize or cement together loose soil or aggregates.

Bitumen Any of several flammable hydrocarbon substances, which may be liquid, semisolid, or solid. For road maintenance work, bitumen commonly means any of several road oils, either asphalt or tar, covered by various specifications.

Bituminous Pavement A pavement composed of crushed rock or other aggregate cemented together with bitumen.

Blading Planing or smoothing the surface of various parts of the roadway by means of a motor driven adjustable steel blade.

Bleeding The exuding of excess bituminous material on the roadway surface, caused by heat or the use of excessive quantities of bituminous material in construction, patching or resurfacing.

Borrow Pit A location where fill or base material may be, or has been, excavated. No borrow pits shall be constructed within 500 feet of the center line of a highway right of way.

Bridge Structures of a span of more than 20 feet, measured under the copings along the centerline of the road and multiple span structures where the individual spans are in excess of 10 feet, from center to center of supports along the centerline of the road.

Bulking Swelling, separation of particles and increased volume of aggregate due to the presence of a small percentage of moisture.

Camber To cause to arch slightly, or curve upward toward the center, as the middle of a bridge or culvert.

Check Dam A structure, usually made of timbers, stone or concrete placed in a watercourse to retard the flow of water, thereby reducing erosion. Check dams may be used singly or in series.

Checking or Alligatoring Myriad cracks or checks in bituminous surfaces extending over areas of variable proportions and resulting from a yielding of wet subgrade or from the drying out of the surface.

Cold Patch A mixture of bituminous material and aggregate used for general maintenance pavement patching and applied at normal temperatures.

Concrete, Bituminous A mixture of bitumen and mineral aggregate used as a wearing surface. Placed either hot or cold.

Concrete, Portland Cement A mixture usually composed of portland cement, an aggregate of hard, inert particles and water.

Consistency The degree of cohesion of particles. Some of the terms used to express consistency are; Firm, hard, pliable, sticky, soft.

Course A layer of road material, separately compacted, used as a wearing surface or as a base for a wearing surface.

Creosote An oily liquid, used in wood preservation, colorless when pure but usually colored yellow or brown by impurity or exposure.

Crown A measure of the elevation of the center of the road in relation to the outside edges of the road surface.

Culvert All waterway structures not defined as bridges.

Cutback Bituminous material mixed with light, volatile oil to reduce viscosity and increase workability.

Cut Section That part of the roadway which when constructed, is lower in elevation than the original ground.

Deadman A buried object, serving as an anchor, such as cable guard rail guy anchors.

Deciduous Having leaves which are shed at the end of the growing season; opposed to evergreen.

Density
1) The degree of consolidation or compactness.
2) The ratio of weight to volume of a substance.

Dust Palliative
1) Any chemical, in flake form or in solution, used to control dust.
2) Liquid asphaltic oil.

Expressway A divided arterial highway for through traffic with full or partial control of access.

Flash Point That particular temperature at which a material gives off flammable vapor in sufficient quantity to burn instantaneously at the approach of a flame or spark.

Freeway An expressway with full control of access and all grade crossings eliminated.

Grout Mortar composed of sand, cement, and water, of such consistency that it can be worked easily.

Hydrophilic A term spoken of an aggregate having a greater affinity for mixing with water than with oil.

Impervious A bed or stratum of material through which water will not move under ordinary hydrostatic pressure.

Miscibility Ability of a substance to be mixed.

Mudsills Logs or timber placed in a horizontal position on the ground or in a stream bed to support timber bents built up with vertical and diagonal members.

Noxious Injurious, destructive, objectionable, as noxious weeds or odors.

Outcrop The cropping out of a rock stratum, exposed at or near the surface of the ground.

Pervious A bed or stratum of material through which water will move under ordinary hydrostatic pressure.

Pigment Any substance used to impart color; specifically, an insoluble, dry coloring matter which, when mixed with suitable medium, forms paint.

Plasticity Index	The range of moisture content through which the soil material is plastic, expressed as the difference between the liquid limit and the plastic limit, which are expressed as a percentage of the weight of the completely dried soil material.
Portland Cement	A hydraulic cement consisting of compounds of silica, lime and alumina, so called from its resemblance in color, when set, to the portland stone of England.
Pot Hole	A pit or hole extending into the wearing surface.
Premix	1) To mix, in a central mixing plant or elsewhere, previous to placing. 2) Any prepared bituminous patching or surfacing material that can be applied either hot or cold.
Prime Coat	A bituminous application to seal, bind together and waterproof the top portion of a gravel or crushed aggregate base subsequent to the placing of a surface course.
Profile	A longitudinal section of a highway, drainage course, etc.
Quartering	Dividing into four equal parts, so that each part is truly representative of the whole. Applied generally in obtaining representative samples.
Raveling	The progressive loosening of the material in the surface course of a road.
Retread	A surface composed of bituminous materials and aggregate placed on an existing surface.
Road Material	Any road material, such as concrete, gravel, crushed stone, slag, etc., which is used for a wearing surface.
Serrated	Having teeth or scalloped edges.
Shoe, Bridge	A bridge corner support.
Skew	Oblique, not at right angles.
Slip	Section of roadway fill which slips out or moves down below its normal elevation.
Spalling	Chipping along the edges, as at joints in concrete pavements and structures.
Specific Gravity	The ratio of the weight of any volume of a substance to the weight of an equal volume of water at 4 degrees Centigrade taken as a standard.

Stabilize To bind aggregates, etc., together by adding and thoroughly mixing the proper amount of clay or other binding materials, also to increase bearing power of clay, soil, etc., by mixing sand or aggregate, as in shoulder stabilization.

Station A standard of length, usually 100 feet, measured along the center line of a road or along a survey line.

Subbase An auxiliary course to furnish needed stability, usually due to poor subgrade.

Subgrade That portion of the roadbed on which pavement, surfacing, base, subbase, or a layer of any other material which may be specified, is to be placed.

Subsoil The bed of earth immediately below the surface soil.

Tack Coat A coat of bituminous material applied to a surface to prepare the latter for subsequent applications of aggregate and bituminous materials.

Talus The accumulation of debris at the base of a cliff or slope chiefly as the result of gravitational roll or slide.

Vehicle
1) The liquid portion of paint.
2) Every device by which any person or property is transported or drawn upon a public highway, excepting devices used exclusively upon stationary rails or tracks.

Viscosity The resistance of a fluid to flow.

Voids The empty spaces between particles in a substance or mixture.

Volatile Evaporating readily.

Waterbound Bonded with the aid of water.

Xylene Equivalent The test to determine whether an asphalt has been cracked or injured by overheating during the refining process.

Section 02 Volume-Temperature Correction of Asphaltic Products

The temperature of 60º F is taken as the standard for volume measurement of asphalitic products. If the volume is actually measured at any temperature other than 60º F a correction factor must be applied. As volume-temperature relations vary somewhat with specific gravity, it is necessary that the connection factor be selected from the proper table group. The tables of reduction factors given herewith are intended for use in reducing oil volumes to the basis of 60º F when extreme accuracy is not required.

Section 02.01 Conversion Table I

The following table is to be used for converting volumes of liquid asphalt products, grades 250 to 3000 inclusive, and paving asphalts, grades AR-1000 to AR-16000 inclusive.

Legend:

t observed temperature in degrees Fahrenheit.
M multiplier for reducing volumes to the basis of 60º F.

t	M	t	M	t	M	t	M	t	M	t	M
0	1.0211	35	1.0088	70	0.9965	105	0.9844	140	0.9723	175	0.9604
1	1.0208	36	1.0084	71	0.9962	106	0.9840	141	0.9720	176	0.9601
2	1.0204	37	1.0081	72	0.9958	107	0.9837	142	0.9716	177	0.9597
3	1.0201	38	1.0077	73	0.9955	108	0.9833	143	0.9713	178	0.9594
4	1.0197	39	1.0074	74	0.9951	109	0.9830	144	0.9710	179	0.9590
5	1.0194	40	1.0070	75	0.9948	110	0.9826	145	0.9706	180	0.9587
6	1.0190	41	1.0067	76	0.9944	111	0.9823	146	0.9703	181	0.9584
7	1.0186	42	1.0063	77	0.9941	112	0.9819	147	0.9699	182	0.9580
8	1.0183	43	1.0060	78	0.9937	113	0.9816	148	0.9696	183	0.9577
9	1.0179	44	1.0056	79	0.9934	114	0.9813	149	0.9693	184	0.9574
10	1.0176	45	1.0053	80	0.9930	115	0.9809	150	0.9689	185	0.9570
11	1.0172	46	1.0049	81	0.9927	116	0.9806	151	0.9686	186	0.9567
12	1.0169	47	1.0046	82	0.9923	117	0.9802	152	0.9682	187	0.9563
13	1.0165	48	1.0042	83	0.9920	118	0.9799	153	0.9679	188	0.9560
14	1.0162	49	1.0038	84	0.9916	119	0.9795	154	0.9675	189	0.9557
15	1.0158	50	1.0035	85	0.9913	120	0.9792	155	0.9672	190	0.9553
16	1.0155	51	1.0031	86	0.9909	121	0.9788	156	0.9669	191	0.9550
17	1.0151	52	1.0028	87	0.9906	122	0.9785	157	0.9665	192	0.9547
18	1.0148	53	1.0024	88	0.9902	123	0.9782	158	0.9662	193	0.9543
19	1.0144	54	1.0021	89	0.9899	124	0.9778	159	0.9658	194	0.9540
20	1.0141	55	1.0017	90	0.9896	125	0.9775	160	0.9655	195	0.9536
21	1.0137	56	1.0014	91	0.9892	126	0.9771	161	0.9652	196	0.9533
22	1.0133	57	1.0010	92	0.9889	127	0.9768	162	0.9648	197	0.9530
23	1.0130	58	1.0007	93	0.9885	128	0.9764	163	0.9645	198	0.9526
24	1.0126	59	1.0003	94	0.9882	129	0.9761	164	0.9641	199	0.9523
25	1.0123	60	1.0000	95	0.9878	130	0.9758	165	0.9638	200	0.9520
26	1.0119	61	0.9997	96	0.9875	131	0.9754	166	0.9635	201	0.9516
27	1.0116	62	0.9993	97	0.9871	132	0.9751	167	0.9631	202	0.9513
28	1.0112	63	0.9990	98	0.9868	133	0.9747	168	0.9628	203	0.9509
29	1.0109	64	0.9986	99	0.9864	134	0.9744	169	0.9624	204	0.9505
30	1.0105	65	0.9983	100	0.9861	135	0.9740	170	0.9621	205	0.9503
31	1.0102	66	0.9979	101	0.9857	136	0.9737	171	0.9618	206	0.9499
32	1.0098	67	0.9976	102	0.9854	137	0.9734	172	0.9614	207	0.9496
33	1.0095	68	0.9972	103	0.9851	138	0.9730	173	0.9611	208	0.9493
34	1.0091	69	0.9969	104	0.9847	139	0.9727	174	0.9607	209	0.9489

Conversion Table I-Continued

t	M	t	M	t	M	t	M	t	M	t	M
210	0.9486	250	0.9352	290	0.9220	330	0.9089	370	0.8960	410	0.8832
211	0.9483	251	0.9349	291	0.9217	331	0.9086	371	0.8957	411	0.8829
212	0.9479	252	0.9346	292	0.9213	332	0.9083	372	0.8953	412	0.8826
213	0.9476	253	0.9342	293	0.9210	333	0.9079	373	0.8950	413	0.8822
214	0.9472	254	0.9339	294	0.9207	334	0.9076	374	0.8947	414	0.8819
215	0.9469	255	0.9336	295	0.9204	335	0.9073	375	0.8944	415	0.8816
216	0.9466	256	0.9332	296	0.9200	336	0.9070	376	0.8941	416	0.8813
217	0.9462	257	0.9329	297	0.9197	337	0.9066	377	0.8937	417	0.8810
218	0.9459	258	0.9326	298	0.9194	338	0.9063	378	0.8934	418	0.8806
219	0.9456	259	0.9322	299	0.9190	339	0.9060	379	0.8931	419	0.8803
220	0.9452	260	0.9319	300	0.9187	340	0.9057	380	0.8928	420	0.8800
221	0.9449	261	0.9316	301	0.9184	341	0.9053	381	0.8924	421	0.8797
222	0.9446	262	0.9312	302	0.9181	342	0.9050	382	0.8921	422	0.8794
223	0.9442	263	0.9309	303	0.9177	343	0.9047	383	0.8918	423	0.8791
224	0.9439	264	0.9306	304	0.9174	344	0.9044	384	0.8915	424	0.8989
225	0.9436	265	0.9302	305	0.9171	345	0.9040	385	0.8912	425	0.8984
226	0.9432	266	0.9299	306	0.9167	346	0.9037	386	0.8908	426	0.8781
227	0.9429	267	0.9296	307	0.9164	347	0.9034	387	0.8905	427	0.8778
228	0.9426	268	0.9293	308	0.9161	348	0.9031	388	0.8902	428	0.8775
229	0.9422	269	0.9289	309	0.9158	349	0.9028	389	0.8899	429	0.8772
230	0.9419	270	0.9286	310	0.9154	350	0.9024	390	0.8896	430	0.8768
231	0.9416	271	0.9283	311	0.9151	351	0.9021	391	0.8892	431	0.8765
232	0.9412	272	0.9279	312	0.9148	352	0.9018	392	0.8889	432	0.8762
233	0.9409	273	0.9276	313	0.9145	353	0.9015	393	0.8886	433	0.8759
234	0.9405	274	0.9273	314	0.9141	354	0.9011	394	0.8883	434	0.8756
235	0.9402	275	0.9269	315	0.9138	355	0.9008	395	0.8880	435	0.8753
236	0.9399	276	0.9266	316	0.9135	356	0.9005	396	0.8876	436	0.8749
237	0.9395	277	0.9263	317	0.9132	357	0.9002	397	0.8873	437	0.8746
238	0.9392	278	0.9259	318	0.9128	358	0.8998	398	0.8870	438	0.8743
239	0.9389	279	0.9256	319	0.9125	359	0.8995	399	0.8867	439	0.8740
240	0.9385	280	0.9253	320	0.9122	360	0.8992	400	0.8864	440	0.8737
241	0.9382	281	0.9250	321	0.9118	361	0.8989	401	0.8861	441	0.8734
242	0.9379	282	0.9246	322	0.9115	362	0.8986	402	0.8857	442	0.8731
243	0.9375	283	0.9243	323	0.9112	363	0.8982	403	0.8854	443	0.8727
244	0.9372	284	0.9240	324	0.9109	364	0.8979	404	0.8851	444	0.8724
245	0.9369	285	0.9236	325	0.9105	365	0.8976	405	0.8848	445	0.8721
246	0.9365	286	0.9233	326	0.9102	366	0.8973	406	0.8845	446	0.8718
247	0.9362	287	0.9230	327	0.9099	367	0.8969	407	0.8841	447	0.8715
248	0.9359	288	0.9227	328	0.9096	368	0.8966	408	0.8838	448	0.8712
249	0.9356	289	0.9223	329	0.9092	369	0.8963	409	0.8835	449	0.8709

Conversion Table I-Continued

450	0.8705	460	0.8674	470	0.8643	480	0.8611	490	0.8580
451	0.8702	461	0.8671	471	0.8640	481	0.8608	491	0.8577
452	0.8699	462	0.8668	472	0.8636	482	0.8605	492	0.8574
453	0.8696	463	0.8665	473.	0.8633	483	0.8602	493	0.8571
454	0.8693	464	0.8661	474	0.8630	484	0.8599	494	0.8568
455	0.8690	465	0.8658	475	0.8627	485	0.8596	495	0.8565
456	0.8687	466	0.8655	476	0.8624	486	0.8593	496	0.8562
457	0.8683	467	0.8652	477	0.8621	487	0.8590	497	0.8559
458	0.8680	468	0.8649	478	0.8618	488	0.8587	498	0.8556
459	0.8677	469	0.8646	479	0.8615	489	0.8583	499	0.8552

Section 02.02 Conversion Table II

The following table is to be used for converting volumes of liquid asphalt product, grade 70.

Legend:

t observed temperature in degrees Fahrenheit.
M multiplier for reducing volumes to the basis of 60º F.

t	M	t	M	t	M	t	M	t	M	t	M
0	1.0241	35	1.0100	70	0.9960	105	0.9822	140	0.9686	175	0.9551
1	1.0237	36	1.0096	71	0.9956	106	0.9818	141	0.9682	176	0.9547
2	1.0233	37	1.0092	72	0.9952	107	0.9814	142	0.9678	177	0.9543
3	1.0229	38	1.0088	73	0.9948	108	0.9810	143	0.9674	178	0.9539
4	1.0225	39	1.0084	74	0.9944	109	0.9806	144	0.9670	179	0.9536
5	1.0221	40	1.0080	75	0.9940	110	0.9803	145	0.9666	180	0.9532
6	1.0217	41	1.0076	76	0.9936	111	0.9799	146	0.9662	181	0.9528
7	1.0213	42	1.0072	77	0.9932	112	0.9795	147	0.9659	182	0.9524
8	1.0209	43	1.0068	78	0.9929	113	0.9791	148	0.9655	183	0.9520
9	1.0205	44	1.0064	79	0.9925	114	0.9787	149	0.9651	184	0.9517
10	1.0201	45	1.0060	80	0.9921	115	0.9783	150	0.9647	185	0.9513
11	1.0197	46	1.0056	81	0.9917	116	0.9779	151	0.9643	186	0.9509
12	1.0193	47	1.0052	82	0.9913	117	0.9775	152	0.9639	187	0.9505
13	1.0189	48	1.0048	83	0.9909	118	0.9771	153	0.9635	188	0.9501
14	1.0185	49	1.0044	84	0.9905	119	0.9767	154	0.9632	189	0.9498
15	1.0181	50	1.0040	85	0.9901	120	0.9763	155	0.9628	190	0.9494
16	1.0177	51	1.0036	86	0.9897	121	0.9760	156	0.9624	191	0.9490
17	1.0173	52	1.0032	87	0.9893	122	0.9756	157	0.9620	192	0.9486
18	1.0168	53	1.0028	88	0.9889	123	0.9752	158	0.9616	193	0.9482
19	1.0164	54	1.0024	89	0.9885	124	0.9748	159	0.9612	194	0.9478
20	1.0160	55	1.0020	90	0.9881	125	0.9744	160	0.9609	195	0.9475
21	1.0156	56	1.0016	91	0.9877	126	0.9740	161	0.9605	196	0.9471
22	1.0152	57	1.0012	92	0.9873	127	0.9736	162	0.9601	197	0.9467
23	1.0148	58	1.0008	93	0.9869	128	0.9732	163	0.9597	198	0.9463
24	1.0144	59	1.0004	94	0.9865	129	0.9728	164	0.9593	199	0.9460
25	1.0140	60	1.0000	95	0.9861	130	0.9725	165	0.9589	200	0.9456
26	1.0136	61	0.9996	96	0.9857	131	0.9721	166	0.9585	201	0.9452
27	1.0132	62	0.9992	97	0.9854	132	0.9717	167	0.9582	202	0.9448
28	1.0128	63	0.9988	98	0.9850	133	0.9713	168	0.9578	203	0.9444
29	1.0124	64	0.9984	99	0.9846	134	0.9709	169	0.9574	204	0.9441
30	1.0120	65	0.9980	100	0.9842	135	0.9705	170	0.9570	205	0.9437
31	1.0116	66	0.9976	101	0.9838	136	0.9701	171	0.9566	206	0.9433
32	1.0112	67	0.9972	102	0.9834	137	0.9697	172	0.9562	207	0.9429
33	1.0108	68	0.9968	103	0.9830	138	0.9693	173	0.9559	208	0.9425
34	1.0104	69	0.9964	104	0.9826	139	0.9690	174	0.9555	209	0.9422

Conversion Table II-Continued

210	0.9418	220	0.9380	230	0.9343	240	0.9305
211	0.9414	221	0.9376	231	0.9339	241	0.9301
212	0.9410	222	0.9373	232	0.9335	242	0.9298
213	0.9407	223	0.9369	233	0.9331	243	0.9294
214	0.9403	224	0.9365	234	0.9328	244	0.9290
215	0.9399	225	0.9361	235	0.9324	245	0.9286
216	0.9395	226	0.9358	236	0.9320	246	0.9283
217	0.9391	227	0.9354	237	0.9316	247	0.9279
218	0.9388	228	0.9350	238	0.9313	248	0.9275
219	0.9384	229	0.9346	239	0.9309	249	0.9272

Section 02.03 Conversion Table III

The following table is to be used for converting volumes of all types of asphaltic emulsion specified in this section.

Legend:

t observed temperature in degrees Fahrenheit.
M multiplier for reducing volumes to the basis of 60º F.

t	M	t	M	t	M	t	M	t	M
60	1.00000	78	.99550	96	.99100	115	.98625	133	.98175
61	.99975	79	.99525	97	.99075	116	.98600	134	.98150
62	.99950	80	.99500	98	.99050	117	.98575	135	.98125
63	.99925	81	.99475	99	.99025	118	.98550	136	.98100
64	.99900	82	.99450	100	.99000	119	.98525	137	.98075
65	.99875	83	.99425	101	.98975	120	.98500	138	.98050
66	.99850	84	.99400	102	.98950	121	.98475	139	.98025
67	.99825	85	.99375	103	.98925	122	.98450	140	.98000
68	.99800	86	.99350	104	.98900	123	.98425	141	.97975
69	.99775	87	.99325	105	.98875	124	.98400	142	.97950
70	.99750	88	.99300	106	.98850	125	.98375	143	.97925
71	.99725	89	.99275	107	.98825	126	.98350	144	.97900
72	.99700	90	.99250	108	.98800	127	.98325	145	.97875
73	.99675	91	.99225	109	.98775	128	.98300	146	.97850
74	.99650	92	.99200	110	.98750	129	.98275	147	.97825
75	.99625	93	.99175	111	.98725	130	.98250	148	.97800
76	.99600	94	.99150	112	.98700	131	.98225	149	.97775
77	.99575	95	.99125	113	.98675	132	.98200	150	.97750
				114	.98650				

Section 03 Application Temperature of Liquid Asphalts

Grade of Liquid Asphalt	Pug Mill Mixing Temperature of Aggregate Maximum °F.	Distributor Application Temperature	
		Minimum °F.	Maximum °F.
SC-70.....	.....	105	175
SC-250.....	200	140	225
SC-800.....	225	175	255
SC-3000.....	260	215	290
MC-70.....	.....	105	175
MC-250.....	200	140	225
MC-800.....	225	175	255
MC-3000.....	260	215	290
RC-70.....	.....	105	175
RC-250.....	.....	140	225
RC-800.....	.....	175	255
RC-3000.....	.....	215	290
ROMC-3.....	200	175	255

Section 04 Weights and Volumes of Asphaltic Road Materials

Volumetric measurements of liquid asphalt at any temperature shall be reduced to the volume the material would occupy a 60º F before converting the volumetric measurements to weight. The following tables shall be used to convert the volumes from gallons to weight.

All types SC, MC, ROMC and RC, of the same grade shall be considered to have equal weights per volume.

Average Weights and Volumes of Liquid Asphalt

Grade	Gallons per Ton at 60°F.	Barrels per Ton at 60°F. (42 U.S. Gals.)	Pounds per Gal. at 60°F.
.....	253	6.03	7.90
.....	249	5.93	8.03
.....	245	5.83	8.16
.....	241	5.74	8.30
-3.....	245	5.83	8.16

Average Weights and Volumes of Paving Asphalt

Grade	Gallons per Ton at 60°F.	Barrels per Ton at 60°F. (42 U.S. Gals.)	Pounds per Gal. at 60°F.
AR-1000.....	239	5.70	8.36
AR-2000.....	237	5.64	8.44
AR-4000.....	235	5.60	8.51
AR-8000.....	235	5.60	8.51
AR-16000.....	235	5.60	8.51

Average Weights and Volumes of Asphaltic Emulsion

Type of Emulsion	Gallons per Ton at 60°F.	Barrels per Ton at 60°F. (42 U.S. Gals.)	Pounds per Gal. at 60°F.
Penetration.....	240	5.71	8.33
Mixing.....	240	5.71	8.33
High Viscosity....	240	5.71	8.33

Refer to Standard Specifications for additional data on liquid asphalts and asphaltic emulsions.

Application Temperatures - Degrees F

	TYPE	MIN TEMP	MAX TEMP
Emulsified Asphalt	Penetration	75	130
Emulsified Asphalt	Mixing	75	130
Paving Asphalts	all grades	250	375

Section 05 Liquid Asphalt Tons per Mile

	¼ gallon application, tons per mile				½ gallon application, tons per mile				1 gallon application, tons per mile			
Width	SC-70	SC-250	SC-800	Emul.	SC-70	SC-250	SC-800	Emul.	SC-70	SC-250	SC-800	Emul.
2.0.....	1.1594	1.1780	1.1973	1.2222	2.3188	2.3561	2.3946	2.4444	4.6377	4.7122	4.7891	4.8889
3.5.....	2.0290	2.0616	2.0952	2.1389	4.0580	4.1232	4.1905	4.2778	8.1159	8.2463	8.3810	8.5556
4.0.....	2.3188	2.3561	2.3946	2.4444	4.6277	4.7122	4.7891	4.8889	9.2754	9.4244	9.5782	9.7778
5.0.....	2.8986	2.9451	2.9932	3.0556	5.7971	5.8902	5.9864	6.1111	11.5942	11.7904	11.9728	12.2222
6.0.....	3.4783	3.5341	3.5918	3.6667	6.9565	7.0683	7.1837	7.3333	13.9130	14.1365	14.3673	14.6667
7.0.....	4.0580	4.1232	4.1905	4.2778	8.1159	8.2463	8.3810	8.5556	16.2319	16.4926	16.7619	17.1111
8.0.....	4.6377	4.7122	4.7891	4.8889	9.2754	9.4244	9.5782	9.7778	18.5507	18.8487	19.1565	19.5556
9.0.....	5.2174	5.3012	5.3878	5.5000	10.4348	10.6024	10.7755	11.0000	20.8696	21.2048	21.5510	22.0000
10.0.....	5.7971	5.8902	5.9864	6.1111	11.5942	11.7804	11.9728	12.2222	23.1884	23.5609	23.9456	24.4444
11.0.....	6.3768	6.4792	6.5850	6.7222	12.7536	12.9585	13.1701	13.4444	25.5072	25.9170	26.3401	26.8889
12.0.....	6.9565	7.0683	7.1837	7.3333	13.9130	14.1365	14.3673	14.6667	27.8261	28.2731	28.7347	29.3333
13.0.....	7.5362	7.6573	7.7823	7.9444	15.0725	15.3146	15.5646	15.8889	30.1449	30.6292	31.1292	31.7778
14.0.....	8.1159	8.2463	8.3810	8.5556	16.2319	16.4926	16.7619	17.1111	32.4638	32.9853	33.5238	34.2222
15.0.....	8.6956	8.8353	8.9796	9.1667	17.3913	17.6707	17.9592	18.3333	34.7826	35.3414	35.9184	36.6667
16.0.....	9.2754	9.4244	9.5782	9.7778	18.5507	18.8487	19.1565	19.5556	37.1014	37.6974	38.3129	39.1111
17.0.....	9.8551	10.0134	10.1769	10.3889	19.7101	20.0268	20.3537	20.7778	39.4203	40.0535	40.7075	41.5555
18.0.....	10.4348	10.6024	10.7755	11.0000	20.8696	21.2048	21.5510	22.0000	41.7391	42.4096	43.1020	44.0000
19.0.....	11.0145	11.1914	11.3741	11.6111	22.0290	22.3829	22.7483	23.2222	44.0580	44.7657	45.4966	46.4444
20.0.....	11.5942	11.7804	11.9728	12.2222	23.1884	23.5609	23.9456	24.4444	46.3768	47.1218	47.8912	48.8889

Quantities used--SC-70--253 gallons per ton
SC-250--249 gallons per ton
SC-800--245 gallons per ton
Emulsion--240 gallons per ton

Example--One-fifth gallon SC-800 to be applied 20 feet wide for 2.2 miles.
Figure tons and gallons of oil required.

From table--One gallon SC-800--20 feet wide requires 47.8912 tons per mile. For 2.2 miles--47.8912 X 2.2 = 105.6306 tons for one-fifth gallon application:

$$\frac{105.3606}{5} = 21.07 \text{ tons}$$

or 21.07 X 245 = 5162.15 gallons required

Section 06 Area of Pavement Surfaces

Width in Feet	Square Feet per Mile	Square Yards per Mile	Square Yards per Lineal Foot	Width in Feet	Square Feet per Mile	Square Yards per Mile	Square Yards per Lineal Foot
1.....	5,280	587	0.1111	18.....	95,040	10,560	2.0000
8.....	42,240	4,693	0.8889	20.....	105,600	11,733	2.2222
9.....	47,520	5,280	1.0000	22.....	116,160	12,907	2.4444
10.....	52,800	5,867	1.1111	24.....	126,720	14,080	2.6667
11.....	58,080	6,453	1.2222	26.....	137,280	15,253	2.8889
12.....	63,360	7,040	1.3333	28.....	147,840	16,427	3.1111
15.....	79,200	8,800	1.6667	30.....	158,400	17,600	3.3333
16.....	84,480	9,387	1.7778				

Section 07 Tons Asphalt per Mile of Paving

Based on 240 Gals. /Ton, 5 Percent Asphalt by Wt. and 111.15 # Mix Per Sq. Yd.

Width in feet	Square yards per mile	Tons per mile	Tons asphalt per mile				
		1.0 gal./sq. yd.	1" thick	1 1/2 " thick	2" thick	2 1/2 " thick	3" thick
1.....	587	2.44	1.63020	2.44530	3.26040	4.07550	4.89060
18.....	10,560	44.00	29.34	44.02	58.69	73.36	88.03
19.....	11,147	46.44	30.97	46.46	61.95	77.43	92.92
20.....	11,733	48.89	32.60	48.91	65.21	81.51	97.81
21.....	12,320	51.33	34.23	51.35	68.47	85.59	102.70
22.....	12,907	53.78	35.86	53.80	71.73	89.66	107.59
23.....	13,493	56.22	37.49	56.24	74.99	93.74	112.48
24.....	14,080	58.67	39.12	58.69	78.25	97.81	117.37
25.....	14,667	61.11	40.76	61.13	81.51	101.89	122.27
26.....	15,253	63.55	42.39	63.58	84.77	105.96	127.16
27.....	15,840	66.00	44.02	66.02	88.03	110.04	132.05
28.....	16,427	68.44	45.65	68.47	91.29	114.11	136.94
29.....	17,013	70.89	47.28	70.91	94.55	118.19	141.83
30.....	17,600	73.33	48.91	73.36	97.81	122.27	146.72

Example: 1 1/2" surfacing is to be placed 22' wide on 3.2 miles. How much asphalt should be ordered for the mix?

From table: 53.80 tons asphalt per mile. For 3.2 miles:
3.2 X 53.80 = 172.160 tons.
172 tons X 240 = 41,318 gallons required.

Section 08 Emulsions--Gallons per Mile

Rates of application		Width in feet								
Gallons per square yard		8	9	10	12	16	18	20	22	24
1/10	0.10	469	528	587	704	939	1,056	1,173	1,291	1,408
1/8	0.125	587	660	733	880	1,173	1,320	1,467	1,613	1,760
1/6	0.167	782	880	978	1,178	1,564	1,760	1,956	2,151	2,347
1/5	0.20	939	1,056	1,173	1,408	1,876	2,112	2,347	2,581	2,816
1/4	0.25	1,173	1,320	1,467	1,760	2,347	2,640	2,933	3,227	3,520
1/3	0.333	1,564	1,760	1,956	2,347	3,129	3,520	3,911	4,302	4,693
1/2	0.50	2,347	2,640	2,933	3,520	4,693	5,280	5,867	6,453	7,040
2/3	0.667	3,129	3,520	3,911	4,693	6,258	7,040	7,822	8,604	9,387
3/4	0.75	3,520	3,960	4,400	5,280	7,040	7,920	8,800	9,680	10,560
1	1.00	4,693	5,280	5,867	7,040	9,387	10,560	11,733	12,907	14,080
1 1/4	1.25	5,867	6,600	7,333	8,800	11,733	13,200	14,667	16,133	17,600
1 1/2	1.50	7,040	7,920	8,800	10,560	14,080	15,840	17,600	19,360	21,120
1 3/4	1.75	8,213	9,240	10,267	12,320	16,427	18,480	20,533	22,587	24,640
2	2.00	9,387	10,560	11,733	14,080	18,773	21,120	23,467	25,813	28,160

Section 09 Volume in C.Y. Pavement per Mile

Depth, inches	Width in feet								
	8	9	10	12	16	18	20	22	24
1	130	147	163	196	261	293	326	358	391
2	261	293	326	391	521	587	652	717	782
3	391	440	489	587	782	880	978	1,076	1,173
4	521	587	652	782	1,043	1,173	1,304	1,434	1,564
5	652	733	815	978	1,304	1,467	1,630	1,793	1,956
6	782	880	978	1,173	1,564	1,760	1,956	2,151	2,347
7	913	1,027	1,141	1,369	1,825	2,053	2,281	2,510	2,738
8	1,043	1,173	1,304	1,564	2,086	2,347	2,607	2,868	3,129
9	1,173	1,320	1,467	1,760	2,347	2,607	2,933	3,227	3,520
10	1,304	1,467	1,630	1,956	2,607	2,933	3,259	3,585	3,911
11	1,434	1,613	1,793	2,151	2,868	3,227	3,585	3,944	4,302
12	1,564	1,760	1,956	2,347	3,129	3,520	3,911	4,302	4,693

Section 10 Lineal Feet of Spread for Liquid Asphalt

1.0 Gallon Spread per Square Yard of Finished Road Surface

Gallons of oil	Width of spread, in feet												Gallons of oil
	1	2	3	4	5	6	7	8	9	10	11	12	
	Length of spread, in lineal feet												
5	45	23	15	11	9	8	6	6	5	5	4	4	5
10	90	45	30	23	18	15	13	11	10	9	8	7	10
15	135	68	45	34	27	23	19	17	15	14	12	11	15
20	180	90	60	45	36	30	26	22	20	18	16	15	20
25	225	113	75	56	45	38	32	28	25	23	21	19	25
30	270	135	90	68	54	45	38	34	30	27	25	23	30
35	315	158	105	79	63	53	45	39	35	31	29	26	35
40	360	180	120	90	72	60	51	45	40	36	33	30	40
45	405	203	135	101	81	68	58	50	45	40	37	34	45
50	450	225	150	113	90	75	64	56	50	45	41	38	50
55	495	248	165	124	99	83	70	62	55	50	45	41	55
60	540	270	180	135	108	90	77	67	60	54	49	45	60
65	585	293	195	146	117	98	83	73	65	59	53	49	65
70	630	315	210	158	126	105	90	79	70	63	57	53	70
75	675	338	225	169	130	113	96	84	75	68	62	56	75
80	720	360	240	180	144	120	102	90	80	72	66	60	80
85	765	383	255	191	153	127	109	95	85	77	70	64	85
90	810	405	270	203	162	135	115	101	90	81	74	68	90
95	855	428	285	214	171	143	122	107	95	85	78	71	95
100	900	450	300	225	180	150	128	112	100	90	82	75	100
200	1,800	900	600	450	360	300	256	225	200	180	164	150	200
300	2,700	1,350	900	675	540	450	386	338	300	270	246	225	300
400	3,600	1,800	1,200	900	720	600	514	450	400	360	327	300	400
500	4,500	2,250	1,500	1,125	900	750	643	563	500	450	409	375	500
600	5,400	2,700	1,800	1,350	1,080	900	772	675	600	540	491	450	600
700	6,300	3,150	2,100	1,575	1,260	1,050	900	788	700	630	573	525	700
800	7,200	3,600	2,400	1,800	1,440	1,200	1,029	900	800	720	655	600	800
900	8,100	4,050	2,700	2,025	1,620	1,350	1,157	1,013	900	810	736	675	900
1,000	9,000	4,500	3,000	2,250	1,800	1,500	1,286	1,125	1,000	900	818	750	1,000
1,100	9,900	4,950	3,300	2,475	1,980	1,650	1,415	1,237	1,100	990	910	825	1,100
1,200	10,800	5,400	3,600	2,700	2,160	1,800	1,543	1,350	1,200	1,080	982	900	1,200
1,300	11,700	5,850	3,900	2,925	2,340	1,950	1,671	1,462	1,300	1,170	1,064	975	1,300
1,400	12,600	6,300	4,200	3,150	2,520	2,100	1,800	1,575	1,400	1,260	1,146	1,050	1,400
1,500	13,500	6,750	4,500	3,375	2,700	2,250	1,929	1,688	1,500	1,350	1,228	1,125	1,500

Example: Use 1-gallon application for 1,000-gallon truck. Spread 10 feet wide.
As the table is based on a 1.0-gallon spread per square yard, a 1,000-gallon truck will spread 900 lineal feet 10 feet wide.
For a 1/2-gallon application, etc., 900 X 2 = 1,800 lineal feet.

Section 11 Liquid Asphalt Surface Treatments for Aggregate Base Roads

(Quantities per Square Yard)

Prime Coat to Be Omitted if Surface Has Been Previously Treated

Treatment	Materials	Type of liquid asphalt	Method of application
1. Penetration	Light oil	SC-70 or SC-250	Sweep, penetrate with 1/4 to 1/2 gallon SC-70 or SC-250, blot with roadside cover.
2. Penetration and seal	Oils and sand	SC-70 to SC-800	Sweep, prime base with 1/4 gallon SC-70 to SC-800, cover with sand.
3. Penetration and seal	Cutbacks and sand	MC	Sweep, prime base with 1/4 gallon SC-70; allow to dry; apply 1/7 to 1/4 gallon MC; cover with 10 to 15 lbs. sand.
4. Penetration and seal	Hot asphalt and screenings	200-300 or 85-100 penetration asphalt	Sweep, prime base with 1/4 gallon SC-70, allow to dry; apply 1/6 gallon 200-300 or 85-100 penetration asphalt; cover with 15 lbs. meduim or fine screenings, roll.
5. Penetration and seal	Hot asphalt and screenings	200-300 or 85-100 penetration asphalt	Sweep, prime base with 1/4 gallon SC-70, allow to dry; apply 1/5 gallon 200-300 or 85-100penetration asphalt; cover with 20-25 lbs.medium screenings, roll.
6. Penetration and seal	Emulstion and sand	P types	Sweep, prime base with 1/4 gallon SC-70, allow to dry; apply 1/8 to 1/6 gallon P type emulsified asphalt; cover with 5 to 10 lbs. sand.
7. Penetration and seal	Emulsion and screenings	P types	Sweep, prime base with 1/4 gallon SC-70, allow to dry; apply 1/6 to 1/5 gallon P type emulsified asphalt; cover with 15 lbs. medium or fine screenings, roll.
8. Penetration and seal	Emulsion and screenings	P types	Sweep, prime base with 1/4 gallon SC-70, allow to dry; apply 1/5 to 1/4 gallon P type emulsified asphalt; cover with 20 to 25 lbs. medium screenings, roll.
9. Armor Coat	Hot asphalt and screenings	200-300	Sweep, prime base with 1/4 gallon SC-70, allow to dry; apply 1/8 gallon 200-300; apply 60 lbs. 1/2" X 3/8" screenings; roll, then 3/8 gallon 200-300; cover with 25 lbs. medium screenings, roll.
10. Armor Coat	Emulsion and screenings	P types	Sweep, prime base with 1/4 gallon SC-70, allow to dry; apply 1/8 gallon P type emulsified asphalt; apply 60 lbs.1/2" X 3/8" screenings; roll, apply 3/8 gallon P type emulsified asphalt;cover with 25 lbs. medium screenings; roll, then 1/4 to 3/8 gallon P type emulsified asphalt; cover with 15 lbs. fine screenings, roll.
11. Armor Coat (Light)	Emulsion and screenings	P types	Sweep, prime base with 1/4 gallon SC-70, allow to dry; apply 1/8 gallon P type emulsified asphalt; apply 25 bls. coarse screenings; roll, then 3/8 gallon P type emulsified asphalt; cover with 15 lbs. medium screenings, roll.
12. Road Mix, present base.	1 1/2" thick	SC-800, MC	Scarify approximately 1 1/2" deep, apply 1 gallon SC-800, or MC liquid asphalt in one or two applications; mix thoroughly, spread, then finish to cross section during compaction.

NOTE--Road mix application will vary according to various gradients of materials for treatment. See Standard Specifications for Armor Coat, Seal Coats, and Road Mix surface treatment. Types of oil will vary as to conditions, as well as results desired.

Section 12 Contents of Cylindrical Tanks (Horizontal)

Full Capacity in Gallons=[.7854 x Dia.^{2} (inches) x Length (Inches)] /231

Percent of depth		Percent of capacity		Percent of depth		Percent of capacity	
1 filled	2 unfilled	1a filled	2a unfilled	1 filled	2 unfilled	1a filled	2a unfilled
1	99	0.20	99.80	26	74	20.73	79.27
2	98	0.50	99.50	27	73	21.86	78.14
3	97	0.90	99.10	28	72	23.00	77.00
4	96	1.34	98.66	29	71	24.07	75.93
5	95	1.87	98.13	30	70	25.31	74.69
6	94	2.45	97.55	31	69	26.48	73.52
7	93	3.07	96.93	32	68	27.66	72.34
8	92	3.74	96.26	33	67	28.84	71.16
9	91	4.45	95.55	34	66	30.03	69.97
10	90	5.20	94.80	35	65	31.19	68.81
11	89	5.98	94.02	36	64	32.44	67.56
12	88	6.80	93.20	37	63	33.66	66.34
13	87	7.64	92.36	38	62	34.90	65.10
14	86	8.50	91.50	39	61	36.14	63.86
15	85	9.40	90.60	40	60	37.39	62.61
16	84	10.32	89.68	41	59	38.64	61.36
17	83	11.27	88.73	42	58	39.89	60.11
18	82	12.24	87.76	43	57	41.14	58.86
19	81	13.23	86.77	44	56	42.40	57.60
20	80	14.23	85.77	45	55	43.66	56.34
21	79	15.26	84.74	46	54	44.92	55.08
22	78	16.32	83.68	47	53	46.19	53.81
23	77	17.40	82.60	48	52	47.45	52.55
24	76	18.50	81.50	49	51	48.73	51.27
25	75	19.61	80.39	50	50	50.00	50.00

Columns No. 1 and No. 1a should be used together to ascertain percentage of capacity filled when less than 50%.

Columns No. 2 and No. 2a should be used together to ascertain percentage of capacity filled when greater than 50%.

Example: A 1,000-gallon tank 6' 8" diameter has 20" fluid left. How many gallons in tank?

6' 8" = 80" depth tank.

$\frac{20}{80}$ = 25% filled.

From table: 19.61 X 1,000 gallons = 196.1 gallons in tank.

Section 13 Sizes of Sieves

U.S. Standard Sieves	Tyler Standard Sieves	Size of opening in inches	U.S. Standard Sieves	Tyler Standard Sieves	Size of opening in inches
4".....	.....	4	No. 3	.....	0.250
3".....	.....	3	No. 4	4 Mesh	0.187
2 1/2"...	.....	2 1/2	No. 8	8 Mesh	0.0937
2".....	.....	2	No. 16	14 Mesh	0.0469
1 1/2"...	.....	1 1/2	No. 30	28 Mesh	0.0232
1 1/4"...	.....	1 1/4	No. 50	48 Mesh	0.0117
1".....	.....	1	No. 100	100 Mesh	0.0059
3/4"....	.....	3/4	No. 200	200 Mesh	0.0029
1/4"....	.....	1/4	No. 270	270 Mesh	0.0021
3/8"....	.....	3/8			

Section 14 Grading Requirements for Asphalt Concrete Aggregate or Grading Requirements for Road-mix Surfacing Aggregate

	Percentage Passing Sieves			
	3/4" Maximum	1/2" Maximum	3/8" Maximum	No. 4 Maximum
Sieve sizes				
1".....	100	.....	.....	.....
3/4".....	95-100	100	.....	.....
1/2".....	.....	95-100	100	.....
3/8".....	65- 80	80- 95	95-100	100
No. 4.....	45- 60	55- 75	65- 85	95-100
No. 8.....	30- 45	38- 55	50- 70	70- 80
No. 30.....	15- 25	18- 33	28- 40	35- 70
No. 200.....	3- 7	4- 8	7- 14	7- 60
Approximate amount of liquid asphalt*				
+Lower limit...	3.9	3.9	4.2	4.5
+Upper limit...	4.6	4.7	5.0	5.3

* The amount of liquid asphalt will vary from quantity shown for porous rock or different fines. The amounts shown are satisfactory for commercial plants. For ordinary conditions, SC-250, SC-800, MC-250, and MC-800 grades of liquid asphalt should be used.

\+ The amount of asphalt required in the mix for either plant-mix surfacing or road-mix surfacing is to be determined from tests obtained from district laboratory.

The above gradings are satisfactory for patching material.

Section 15 Grading Requirements for Sand for Slurry Seal

Sieve Size	Percent Passing
4.....	100
8.....	95-100
16.....	60- 90
30.....	40- 65
200.....	8- 15

Section 16 Grading Requirements for Seal Coat Screenings

Sieve Sizes	Percentage Passing Sieves			
	Coarse 1/2 " x No. 4	Medium 3/8 " x No. 6	Med. Fine 5/16" x No. 8	Fine 1/4 " x No. 10
3/4 "	100	.....	.....	.....
1/2 "	90-100	100	.....	.....
3/8 "	50- 80	90-100	100	100
No. 3.....	10- 45	45- 70	70- 90	90-100
No. 4.....	0- 15	5- 30	30- 60	60- 85
No. 8.....	0- 5	0- 10	0- 15	0- 25
No. 16.....	.....	0- 5	0- 5	0- 5
No. 30.....	.....	.....	0- 3	0- 3
No. 200.....	0- 2	0- 2	0- 2	0- 2

Section 17 Grading Requirements for Class 2 Aggregate

Sieve Sizes	Percentage Passing Sieves	
	1 ½" Maximum	¾" Maximum
2"	100	.....
1 ½"	90-100	.....
1"	.....	100
¾"	50- 85	90-100
No. 4	25- 45	35- 55
No. 30	10- 25	10- 30
No. 200	2- 9	2- 9

Section 18 Sand or Screenings per Mile

For Estimating Applications on Seal Coats
Quantity of Screenings in Tons per Mile for Various Rates of Application
(Tons Per Mile)

Pounds per square yard	Width in feet										
	9	10	12	14	15	16	18	20	22	24	30
10.....	27	30	35	41	44	47	53	59	65	71	89
15.....	40	44	53	61	66	70	79	88	97	106	132
18.....	48	53	63	74	79	85	95	106	116	127	159
20.....	53	59	70	82	88	94	106	118	129	141	177
22.....	58	65	77	90	97	103	116	129	142	155	194
24.....	63	71	84	98	105	112	126	141	155	168	212
25.....	66	74	88	103	110	117	132	147	161	176	221
30.....	79	88	106	123	132	141	158	176	194	211	264
35.....	93	103	123	144	154	164	185	205	226	246	308
40.....	106	118	141	164	176	188	212	236	258	282	354
45.....	118	132	159	184	198	211	237	264	291	317	396
50.....	132	147	176	206	220	234	264	294	323	352	441
60.....	158	176	211	246	264	282	316	352	388	422	528

Section 19 Lineal Feet Truck Spread

Sand or Screenings
Lineal Feet Spread for Various Sized Trucks and Rates of Applications
(Lineal Feet Spread)

Application in pounds per square yard	Cubic yard trucks				
	1.0	1.5	2.0	3.0	4.0
	Pounds per load				
	2,700	4,050	5,400	8,100	10,800
1	3,240.0	4,860.0	6,480.0	9,720.0	12,960.0
7	462.9	694.3	925.7	1,388.6	1,851.4
10 Spread 7.5 feet wide.....	324.0	486.0	648.0	972.0	1,296.0
12	270.0	405.0	540.0	810.0	1,080.0
15	216.0	324.0	432.0	648.0	864.0
25	129.6	194.4	259.2	388.8	518.4
1	3,037.5	4,556.2	6,075.0	9,112.5	12,150.0
7	433.9	650.9	867.9	1,301.8	1,735.7
10 Spread 8.0 feet wide.....	303.8	455.6	607.5	911.2	1,215.0
12	253.1	379.7	506.2	759.4	1,012.5
15	202.5	303.7	405.0	607.5	810.0
25	121.5	182.2	243.0	364.5	486.0
1	2,700.0	4,050.0	5,400.0	8,100.0	10,800.0
7	385.7	578.6	771.4	1,157.1	1,542.9
10 Spread 9.0 feet wide.....	270.0	405.0	540.0	810.0	1,080.0
12	225.0	337.5	450.0	675.0	900.0
15	180.0	270.0	360.0	540.0	720.0
25	108.0	162.0	216.0	324.0	432.0
1	2,430.0	3,645.0	4,860.0	7,290.0	9,720.0
7	347.1	520.7	694.3	1,041.4	1,388.6
10 Spread 10.0 feet wide.....	243.0	364.5	486.0	729.0	972.0
12	202.5	303.7	405.0	607.5	810.0
15	162.0	243.0	324.0	486.0	648.0
25	97.2	145.8	194.4	291.6	388.8

Section 20 Aggregate per Mile

Aggregate for One Mile Surfacing
For Estimating Shoulder, Base or Surface Material

Thickness, inches	18' wide				20' wide				22' wide			
	Loose		Compact		Loose		Compact		Loose		Compact	
	Tons	Cu. yds.	Tons	Cu. yds.	Tons	Cu. yds.	Tons	Cu. yds.	Tons	Cu. yds.	Tons	Cu. yds.
1.....	439	293	586	439	489	326	652	489	537	358	717	537
2.....	880	587	1,174	880	978	652	1,304	978	1,076	717	1,434	1,076
3.....	1,320	880	1,760	1,320	1,467	978	1,956	1,467	1,613	1,075	2,150	1,613
4.....	1,760	1,173	2,346	1,760	1,956	1,304	2,608	1,956	2,151	1,434	2,868	2,151
5.....	2,199	1,466	2,932	2,199	2,445	1,630	3,260	2,445	2,688	1,792	3,584	2,688
6.....	2,640	1,760	3,520	2,640	2,934	1,956	3,912	2,934	3,225	2,150	4,300	3,225
7.....	3,080	2,053	4,106	3,080	3,423	2,282	4,564	3,423	3,764	2,509	5,018	3,764
8.....	3,520	2,347	4,694	3,520	3,912	2,608	5,216	3,912	4,300	2,867	5,732	4,300
9.....	3,960	2,640	5,280	3,960	4,400	2,933	5,866	4,400	4,838	3,225	6,450	4,838
10.....	4,400	2,933	5,866	4,400	4,888	3,259	6,518	4,888	5,376	3,584	7,168	5,376

Quantities based on--
1.5 tons = 1 cu. yd.
Loose cu. yds. = Actual yardage per mile.
Loose tons = 1.5 X actual yardage.
Compact tons = 2.0 X actual yardage.
Compact cu. yds. = 1.5 X actual yardage.

Section 21 Spacing of One-ton Piles of Covering Material for Various Widths and Rates of Application

Application pounds per square yard	Spacing of 1-ton piles, in feet							
	Width for cover							
	7.5'	8.0'	9.0'	10.0'	15.0'	16.0'	18.0'	20.0'
5.....	480	452	400	360	240	226	200	180
7.....	342	322	286	257	171	161	143	129
10.....	240	226	200	180	120	113	100	90
12.....	200	188	166	150	100	94	83	75
15.....	160	151	133	120	80	75	66	60
20.....	120	113	100	90	60	56	50	45
25.....	96	90	80	72	48	45	40	36
30.....	80	75	66	60	40	38	33	30

Section 22 Cost of Aggregate per Square Yard at Various Rates of Spread and Unit Prices

Pounds square yard	Prices per ton of aggregate, spread in place									
	$1.00	$1.50	$2.00	$2.50	$3.00	$3.50	$4.00	$4.50	$5.00	$6.00
5	.002	.004	.005	.006	.007	.009	.010	.011	.013	.015
10	.005	.007	.010	.012	.015	.017	.020	.022	.025	.030
15	.007	.011	.015	.019	.022	.026	.030	.034	.038	.045
20	.010	.015	.020	.025	.030	.035	.040	.045	.050	.060
25	.012	.019	.025	.031	.037	.044	.050	.056	.063	.075
30	.015	.022	.030	.037	.045	.052	.060	.067	.075	.090
35	.017	.026	.035	.044	.052	.061	.070	.079	.088	.105
40	.020	.030	.040	.050	.060	.070	.080	.090	.100	.120
45	.022	.034	.045	.056	.067	.079	.090	.101	.113	.135
50	.025	.037	.050	.062	.075	.087	.100	.112	.125	.150
60	.030	.045	.060	.075	.090	.105	.120	.135	.150	.180
75	.037	.056	.075	.094	.112	.131	.150	.169	.188	.225
100	.050	.075	.100	.125	.150	.175	.200	.225	.250	.300
150	.075	.112	.150	.187	.225	.262	.300	.337	.375	.450
200	.100	.150	.200	.250	.300	.350	.400	.450	.500	.600
250	.125	.187	.250	.312	.375	.437	.500	.562	.625	.750
300	.150	.225	.300	.375	.450	.525	.600	.675	.750	.900
400	.200	.300	.400	.500	.600	.700	.800	.900	1.000	1.200
500	.250	.375	.500	.625	.750	.875	1.000	1.125	1.250	1.500
600	.300	.450	.600	.750	.900	1.050	1.200	1.350	1.500	1.800

Section 23 Square Yards of Surface per Mile for Various Widths of Roadway

Width, feet	Surface, square yards	Width, feet	Surface, square yards
1	586.67		
10	5,867	18	10,560
12	7,040	20	11,733
14	8,213	22	12,907
15	8,800	24	14,080
16	9,387	30	17,600

Section 24 Weights and Volumes of Construction Materials

Portland Cement

1 bag (net) = 1 cu. ft. ……	94 pounds
1 barrel = 4 bags ……	376 pounds
A minimum car (in bags) ……	173 barrels
A medium car (in bags) ……	231 barrels
A large car (in bags) ……	289 barrels
Minimum shipment bulk cement by truck and trailer…	100 barrels

Example: Concrete wall will require 12 cu. yds. Cl. "B" concrete to be mixed in a 1 1/2-sack mixer.
How many sacks cement will be required and how many batches necessary?
Cl. "B" concrete has 5 sacks cement per cu. yd.

12 cu. yd. X 5 = 60 sacks cement.

$$\frac{60}{1.5} = 40 \text{ batches concrete required.}$$

Lumber

	Pounds per thousand feet, B.M.	
	Green	Dry
Timbers, rough.....	3,250	2,500
Lumber, rough.....	3,000	2,400
Lumber, dressed.....	2,500	2,000
Oak.....	5,500	4,000
Yellow pine.....	4,300	3,200
Redwood, rough.....	.....	2,500
Cedar.....	.....	2,300

Example: To figure FBM (Foot board measure)
1 FBM = 1" X 12" X 12" or 1 sq. ft. 1" thick.
How many FBM in 60 pieces 2" X 4" X 16'?

$$\frac{60 \text{ X } 2 \text{ X } 4 \text{ X } 16}{12} = 640 \text{ FBM.}$$

Broken Stone

1" to dust	Loose measure
Crushed gravel	2,700 pounds per cu. yd.
Crushed limestone	2,550 pounds per cu. yd.
Crushed granite.	2,600 pounds per cu. yd.
Screenings.	2,400 pounds per cu. yd.
Limestone dust (approx.).	75-85 pounds per cu. ft.

Sand

Cubic foot	90-95 pounds
Cubic yard	2,400-2,600 pounds

Soil

Clay bearing. Dry loose	2,160 pounds per cu. yd.
Clay bearing. Dry compact.	3,600 pounds per cu. yd.

Water

Water (fresh)=62.40 pounds per cu. ft. (approx.)
Water (salt)=64.00 pounds per cu. ft. (approx.)
=1.026 cu. ft. of pure water
C.F.S. =Cubic feet per second, or second-feet.
G.P.M. =Gallons per minute.

1-C.F.S. =60 cu. ft. per min.
= 86,400 cu. ft. per 24 hrs.
= 1.9835 acre feet per 24 hrs. (usually taken as 2).
= 40 Miners inches, Ariz., Calif., Mont. and Oregon.

Ice and Snow

1-C.F. of ice at 32^{o}F. weighs 57.50 pounds.
1-C.F. of fresh snow, according to humidity of atmosphere, weighs 5 pounds to 12 pounds.
1-C.F. of snow moistened and compacted by rain weighs 15 pounds to 50 pounds.

Section 25 Paint Coverage per Gallon

Type	Sq. ft. per gallon
Wood preservative	100 one coat
Outside lead and oil	Approximately 300 two coats
Flat white paint	Approximately 300 two coats
Floor oil stain.	Approximately 600 one coat
Enamel, floor	250 two coats
Wallhide for wall board	300 one coat
Aluminum	500 one coat
Varnish	600 one coat
Exterior paint--wood	450 one coat
Exterior paint--metal.	350 one coat
Interior paint.	450 one coat

Section 26 Lineal Feet to Decimal of a Mile

Lineal feet	Mile	Lineal feet	Mile	Lineal feet	Mile
5.....	0.001	60.....	0.011	600.....	0.114
10.....	0.002	70.....	0.013	700.....	0.133
15.....	0.003	80.....	0.015	800.....	0.152
20.....	0.004	90.....	0.017	900.....	0.170
25.....	0.005	100.....	0.019	1,000.....	0.189
30.....	0.006	200.....	0.038	2,000.....	0.379
35.....	0.007	300.....	0.057	3,000.....	0.568
40.....	0.008	400.....	0.076	4,000.....	0.758
50.....	0.009	500.....	0.095	5,000.....	0.947
				5,280.....	1.000

Section 27 Inches to Decimal of a Foot

Inches	Foot	Inches	Foot	Inches	Foot
1/4.....	.021	2 3/4.....	.229	5 1/4.....	.438
1/2.....	.042	3.....	.250	5 1/2.....	.458
3/4.....	.062	3 1/4.....	.271	5 3/4.....	.478
1.....	.083	3 1/2.....	.292	6.....	.500
1 1/4.....	.104	3 3/4.....	.313	.....	.....
1 1/2.....	.125	4.....	.333	.....	.....
1 3/4.....	.146	4 1/4.....	.354	.....	.....
2.....	.166	4 1/2.....	.375	.....	.....
2 1/4.....	.187	4 3/4.....	.396	.....	.....
2 1/2.....	.208	5.....	.417	.....	.....

Section 28 Plane Figures, Areas

SQUARE

Diagonal = d = $s\sqrt{2}$
Area = $s^2 = 4b^2 = 0.5d^2$.
Example. $s = 6$, $b = 3$. Area = $(6)^2 = 36$ Ans.
$d = 6 \times 1.414 = 8.484$ Ans.

RECTANGLE AND PARALLELOGRAM

Area = ab or $b\sqrt{}$
Example. $a = 6$, $b = 3$.
Area = 3 X 6 = 18 Ans.

CIRCLE

r = radius
d = diameter
c = circumference
A = area
$\pi = 3.14159$
$A = \pi r^2 = 0.7854 \times d^2$
$c = 2\pi r = \pi d$
Volume of a cylindrical tank
= Area of base X height

Section 29 Miscellaneous, Conversion of Measures

The metric system is a system of measures and weights, with the meter and gram as bases.

The Greek prefix	Before a unit means	The Latin prefix	Before a unit means
Deca	ten	deci	one tenth
Hecto	one hundred	centi	one hundredth
Kilo	one thousand	milli	one thousandth
Myria	ten thousand	micro	one millionth
Mega	one million		

CONVERSION OF MEASURES

Liquid Measure

2 pints	= 1 quart	= 0.9463 liter
4 quarts	= 1 gallon	= 3.7853 liters
31 1/2 U.S. gallons	= 1 bbl. (ordinary)	= 1.1924 hectoliters
42 U.S. gallons	= 1 bbl. (petroleum)	= 1.5895 hectoliters
1 U.S. gallon	= 231 cubic inches	= 0.1337 cubic foot
1.201 U.S. gallons	= 277.3 cubic inches	= 1 Imperial gallon
7.48 U.S. gallons	= 1 cubic foot	

Avoirdupois Weight

1 grain	= 0.0648 gram	
27 11/32 grains	= 1 dram	= 1.7718 grams
16 drams	= 1 ounce	= 28.3495 grams
16 ounces	= 1 pound	= 0.4537 kilogram
2.204 pounds		= 1.0 kilogram
2,000 pounds	= 1 short ton	= 907.1849 kilograms
2,204 pounds	= 1 metric ton	= 1,000 kilograms
2,240 pounds	= 1 long ton	= 1,016.33 kilograms

Troy Weight

1 grain		= 0.0648 gram
24 grains	= 1 pennyweight	= 1.5552 grams
20 pennyweight	= 1 dram	= 21.1035 grams
12 ounces	= 1 pound	= 0.3732 kilogram

Linear Measure

1 inch	= 1/12 foot	= 2.54 centimeters
12 inches	= 1 foot	= 0.3048 meter
36 inches (3 feet)	= 1 yard	= 0.9144 meter
39.37 inches (3.28 feet)	= 1.0935 yards	= 1 meter
5 1/2 yards	= 1 rod	= 5.0298 meters
40 rods	= 1 furlong	= 201.1684 meters
8 furlongs (5,280 feet)	= 1 mile	= 1.6093 kilometers
3 miles (15,840 feet)	= 1 league	= 4.8280 kilometers
6, 080.27 feet	= 1 nautical mile	

Square Measure

1 square inch		= 6.4516 sq. centimeters
144 square inches	= 1 square foot	= 0.0929 square meter
9 square feet	= 1 square yard	= 0.8361 square meter
30 1/4 square yards	= 1 square rod	= 25.29 square meters
160 square rods	= 1 acre (43,560 square feet)	= 0.4047 hectare
640 acres	= 1 square mile	= 258.9998 hectares

Cubic Measure

1 cubic inch		= 16.3872 cubic centimeters
231 cubic inches	= 1 gallon	= 4.5459 liters
1,728 cubic inches	= 1 cubic foot	= 0.0283 cubic meter
27 cubic feet	= 1 cubic yard	= 0.7645 cubic meter

1 acre-foot ..... = ...12 acre-inches ..... = ...43,560 cubic feet ..... = 325,829 gallons

Doubling the diameter of a pipe increases its flow approximately six times

Water boils at 212^{o}F. (100^{o}C.) at sea level

Sea water freezes at 27^{o}F.

Water freezes at 32^{o}F. (0^{o}C.)

1 cubic foot of ice at 32^{o}F. =57.5 pounds

Section 30 Strength Requirements for Metal Culverts

(A) Corrugated Metal Pipes--The required thickness of steel corrugated pipes with 2 2/3" X 1/2" corrugation under a given overfill is determined from Table 33-1. The given gage thickness shall be regarded as minimum values.

(B) Structural Plate Pipes--The required thickness for structural steel plate circular pipes under a given overfill is determined from Table 7-851.5 F. The given gage thickness shall be regarded as minimum values.

TABLE A

Maximum Height of Cover for Corrugated Steel Pipe With 2 2/3" x 1/2" Corrugations (Annular or Helical)

Diameter (inches)	Maximum Height of Cover (Feet)				
	5/16" Rivets		3/8" Rivets		
	METAL THICKNESS IN INCHES				
	0.064	0.079	0.109	0.138	0.168
	Single Riveted				
12	63	83			
15	50	66			
18	42	55	84		
21	36	47	72		
24	32	42	61	75	
30	25	33	49	60	
36	21	28	41	50	
	Double Riveted				
42	40	43	72	76	80
48	35	38	63	67	70
54	--	34	56	59	63
60	--		50	53	56
66	--		46	49	51
72	--			45	47
78	--			43	44
84	--			40	40

NOTES:

(1) Annular and longitudinal seams may be riveted or welded. Helical seams may be continuous lock seam or continuous welded. Pipes with lock seams limited to 48 inch maximum diameter.

(2) When flow velocity with a full culvert at entrance exceeds 5 fps under abrasive conditions, thicker metal shall be provided.

Table B
Maximum Height of Cover for Structural Steel Plate Circular Pipe with 6" X 2" Corrugations

Diameter inches	Maximum Height of Cover (feet)							
	4-bolt seams							6-bolt seam
	METAL THICKNESS IN INCHES							
	0.109	0.138	0.168	0.188	0.218	0.249	0.280	0.280
60	42	62	80	93				
68	39	57	73	85				
72	35	52	67	78	94			
78	33	48	62	72	87			
84	30	45	57	67	80	95		
90	28	42	54	62	75	88	96	
96	27	39	50	58	70	83	90	
102	25	37	47	55	66	78	85	
108	24	35	45	51	63	74	80	
114	22	33	42	49	59	70	76	98
120	21	31	40	47	56	66	72	92
126	20	30	38	45	54	63	69	83
132	19	28	37	43	51	60	66	84
138	18	27	35	41	49	58	63	80
144	18	26	34	39	47	55	60	77
150	17	25	32	38	45	53	58	74
156	16	24	31	36	44	51	56	71
162	16	23	30	35	42	49	54	68
168	15	22	29	34	40	47	52	66
174	15	22	28	32	39	46	50	64
180	14	21	27	31	38	44	48	62
186	14	20	26	30	36	43	47	60
192		20	25	29	35	42	45	58
198		19	25	29	34	40	44	56
204		19	24	28	33	39	43	54
210		18	23	27	32	38	42	53
216		18	23	26	31	37	40	51
222			22	26	31	36	39	50
228			21	25	30	35	38	49
234			21	24	29	34	37	47
240				24	28	33	36	46
246				23	28	33	35	45
252				22	27	32	34	44

NOTES;

1) When flow velocities with full culvert at entrance exceeds 5 fps, thicker metal invert plates shall be provided for values left of heavy broken line.

2) For fill heights over 100', special design required.

Section 31 Strength Requirements for Reinforced Concrete Pipe

(A) D-Load Criterion. For purposes of this manual, the cracking D-load shall be the measure of strength of reinforced concrete pipe. It is the actual test load (in pounds per linear foot of pipe per foot of inside pipe diameter) under the 3-edge bearing method which produces a 0.01-inch crack throughout a length of 1 foot. Any reference to D-load will henceforth mean the cracking D-load.

(B) Specifications and Special Requirements. Specifications for reinforced concrete pipe are based on ASTM Designation: M-170. Pipe shall be ordered or specified by strength class as shown in Table A. Neither D-load nor wall thickness shall be specified except when unusual conditions clearly call for special pipe. Unusual conditions which would dictate additional cover over the reinforcing steel include: (a) wear from abrasion or high velocities, and (b) corrosive environments. In these cases, 2 inches of cover shall be specified; to call for a thick wall does not ensure the required cover.

For uses of the various classes of pipe, see Table A.

(C) Height of Overfill. Table B gives the safe overfills for commercial sizes of concrete pipe relative to Method "A" and Method "B" backfill. This table has been computed on the premise that a certain amount of yielding will occur in the foundation as anticipated in the installation methods prescribed in the Standard Specifications. Before selecting the appropriate pipe class from the table, the method of backfill and foundation conditions must be appraised from available data.

Section 32.01 Backfill Considerations Regarding Metal and Concrete Pipes

The height of overfill a culvert will safely sustain depends upon the structural strength and rigidity of the culvert barrel, foundation conditions and methods of installation. Only the methods of backfill prescribed in the Standard Specifications are discussed here. For further information the way earth loads affect culverts, current literature including California Culvert Practice should be consulted.

(A) Method "A" Backfill. This method requires that all the backfill material be compacted and applies to both rigid and flexible culverts. An installation using Method "A" is usually more economical than one by Method "B".

(B) Method "B" Backfill. Method "B" backfill shall apply only to rigid pipes and box culverts. Method "B" calls for placing the pipe or box in a trench with vertical sides. This involves placing compacted backfill (Method "A") below a horizontal plane 1/2 foot above the top of the culvert and loose backfill above that to a depth equal to the exterior vertical dimension (structure depth) of the culvert barrel.

TABLE A. Strengths and Uses of Reinforced Concrete Pipe

*Class	Diameters (Inches)	Cracking D-Load	Principal highway uses
I	60-108	800D	Not adequate for highway uses
II	12-108	1000D	Use outside the roadbed under moderately low depths of cover (See Table B). This class is required for pipe shaft manholes and drop inlets.
III	12-108	1350D	Intended for normal culvert and storm drain uses.
IV	12-84	2000D	Same as Class III but will sustain higher overfills.
V	12-72	3000D	High strength pipe for severe loading conditions.

* ASTM Designation: M-170

TABLE B. Safe Overfills for Reinforced Concrete Pipe

Inside Diameter (Inclusive) Inches	Safe Heights of Overfill in Feet			
	Class II 1000D	Class III 1350D	Class IV 2000D	Class V 3000D
	Method "A" Backfill			
12-18	18	23	32	47
21-27	19	24	33	47
30-39	19	25	34	49
42-48	19	25	35	50
51-63	20	25	35	51
66-72	20	25	36	52
75-84	20	25	36	Not listed
87-108	20	26	Not listed	Not listed
	Method "B" Backfill			
48 or less	See Note 2	No limit	No limit	No limit
51		70		
54-72		See Note 2		
75-81				
84			117	Not listed

NOTES: 1. All pipe conforms to current ASTM designation: M-170
2. Use method "A" and stronger pipe up to the limit of overfill shown under Method "A".

Method "B" backfill offers no benefits for flexible pipes because distortion by strutting accomplishes the same results as the loose backfill above the structure. The loose material induces arch action in the overlying fill somewhat in the manner of a tunnel and results in less pressure on the culvert than backfill by Method "A." Method "B" thus permits higher safe overfills for the same strength of culvert than would be allowable under Method "A."

Method "B" backfill shall not be used for concrete pipes of box culverts where the depth of cover over the culvert is less than three times the structure depth.

In the culvert placed under a fill by Method "B," the loose backfill should terminate at a point on the side slope where the limiting height of loose cover is reached (one structure depth plus 1/2 foot above the top of the culvert). Method "A" is used below this level to the end of the fill slope.

Method "B" shall be used only when it yields savings over other alternatives.

Section 32 Culvert Shipment Data

Culverts take a fifth-class rating with a minimum of 20,000 pounds in either carload lots or truckload lots, and second-class rating in less than carload or truckload lots. In submitting requisitions for shipment for culverts, the necessary band couplers should be included.

Section 33 Gages Corrugated Metal Pipe

Nominal diameter (inches)	End area (sq. ft.)	Gage of culvert sheets	Minimum gage of connecting bands	Plain galvanized weight per lin. ft. (pounds)
8.....	.349	16	16	7
8.....	.349	14	16	9
10.....	.545	16	16	9
10.....	.545	14	16	11
12.....	.785	16	16	10
12.....	.785	14	16	13
15.....	1.227	16	16	13
15.....	1.227	14	16	16
15.....	1.227	12	14	22
18.....	1.767	16	16	15
18.....	1.767	14	16	19
18.....	1.767	12	14	26
21.....	2.405	16	16	18
21.....	2.405	14	16	22
21.....	2.405	12	14	31
21.....	2.405	10	12	39
24.....	3.142	14	16	25
24.....	3.142	12	14	35
24.....	3.142	10	12	44
30.....	4.909	14	16	31
30.....	4.909	12	14	43
30.....	4.909	10	12	55
30.....	4.909	8	12	66
36.....	7.069	12	14	51
36.....	7.069	10	12	65
36.....	7.069	8	12	79
42.....	9.621	12	14	60
42.....	9.621	10	12	77
42.....	9.621	8	12	93
48.....	12.566	12	14	68
48.....	12.566	10	12	87
48.....	12.566	8	12	106
54.....	15.904	12	14	78
54.....	15.904	10	12	100
54.....	15.904	8	12	121
60.....	19.635	10	12	110
60.....	19.635	8	12	134
66.....	23.758	10	12	121
66.....	23.758	8	12	146
72.....	28.274	10	12	130
72.....	28.274	8	12	159
78.....	33.183	8	12	176
84.....	38.485	8	12	190

Section 34 Sacked Portland Cement Concrete Riprap

For location where rock or riprap protection of fill slopes is not available at reasonable cost, sacked portland cement concrete riprap may be used to advantage. Experience indicates that various coverages and thicknesses can be controlled by the degree of bulking of the sacks, which in turn is controlled by the sack tie. The sacks shall be placed so that the face coverage per cubic yard of concrete riprap measured on the slope shall not be more than 27 square feet nor less than 26 square feet exclusive of foundations, cut-off stubs and end returns. Further details covering sacked portland cement concrete riprap will be found under Section 72 of the Standard Specifications.

Section 35 Blocks and Tackle

Block and tackle arrangements are one of the common tools employed by construction personnel. With the proper combination of rope and blocks, many heavy jobs can be easily done.

Use blocks as large as the job requires, too small a block bends the rope too sharply and too large a rope causes excessive friction on the sheaves and blocks. The proper size rope for different blocks is:

Size of block (inches)	*Rope diameter (inches)*	*Size of block (inches)*	*Rope diameter (inches)*
3	3/8	9	1
4	1/2	10	1 1/8
5	9/16 - 5/8	12	1 1/4
6	3/4	14	1 3/8
7	3/16 - 7/8	15	1 1/2
8	7/8 - 1	16	1 5/8

LINE PARTS AND HOOK PULL

LINE PARTS- Number of lines strung through or supporting the moving block.

HOOKPULL- Theoretically the pull at the hook is equal to "head line" pull multiplied by the number of line parts. Actually the friction of the sheave bearings and the work of bending the rope around the sheaves reduces the effective pull. The more parts the greater the loss from friction.

Example: Load to be lifted, 200 pounds. Tackle: One single and one double block.

$$\frac{200 \text{ lbs.}}{3 \text{ X } 0.90 \text{ X } 0.90 \text{ X } 0.90} = 91.44 \text{ lbs. pull}$$

(Number of sheaves) (Efficiency of each sheave)

Minimum Breaking Strength of Rope

Rope diameter (inches)	*Manila 100 percent pounds*	*Rope diameter (inches*	*Manila 100 percent pounds*
3/8	1,350	1	9,000
1/2	2,650	1 1/2	26,500
3/4	5,400	2	31,000

Section 36 Metric Conversion Charts

Common Conversion Factors to Metric

Class	Multiply:	By:	To Get:
Area *	ft^2	0.0929	m^2
	yd^2	0.8361	m^2
	mi^2	2.590	km^2
Length *	ft	0.3048	m
	in	25.4	mm
	mi	1.6093	km
	yd	0.9144	m
Volume	ft^3	0.0283	m^3
	gal	3.785	L **
	fl oz	29.574	mL **
	yd^3	0.7646	m^3
	acre ft	1233.49	m^3
Mass	oz	28.35	g
	lb	0.4536	kg
	kip (1,000 lb)	0.4536	tonne (1000 kg)
	short ton (2,000 lb)	907.2	kg
	short ton	0.9072	tonne (1000 kg)
Density	lb/yd^3	0.5933	kg/m^3
	lb/ft^3	16.0185	kg/m^3
Pressure	psi	6894.8	Pa
	ksi	6.8948	MPa (N/mm^2)
	lb_f/ft^2	47.88	Pa
Velocity	ft/s	0.3048	m/s
	mph	0.4470	m/s
	mph	1.6093	km/h
Light	footcandle (or) lumen/ft^2	10.764	lux (lx) (or) lumen/m^2
Temperature	°F	$t°_C=(t°_f-32)/1.8$	°C

* For land surveying, see "Land Surveying Conversion Factors" table.

** Use Capital "L" for liter to eliminate confusion with the numeral "1".

Less Common Conversion Factors

Class	Multiply:	By:	To Get:
Density:Gravity Force	lb_f/ft^3	157.0	N/m^3
	lb_f/in^3	271.0	kN/m^3
	kg_f/m^3	9.81	N/m^3
Density: Mass	lb_m/in^3	27.68	Mg/m^3
	lb_m/gal (US)	119.8	kg/m^3
Force (including gravity force)	dyne	0.01	mN
	kg_f	9.81	N
	oz_f	0.278	N
	lb_f	4.45	N
	ton_f (2000 lb_f)	8.90	kN
Mass	carat (metric)	0.2	g
	oz_m (avoirdupois)	28.35	g
	oz_m (troy)	31.10	g
	lb_m	0.454	kg
	slug	14.6	kg
	ton_m(short)	0.907	Mg

Note: The Metric System eliminates the confusion in US terminology about "weight" by separating it into two definitions: "mass", and "gravity force". Mass refers to the inertia of an object, or the force required to accelerate or decelerate it in a gravity-free environment. Gravity force is the net downward force acting on a stationary object to attract it to another, always proportional to the strength of the gravitational field and the object's mass.

Land Surveying Conversion Factors

Class	Multiply:	By:	To Get
Area	acre	4046.872 61	m^2
	acre	0.404 69	ha (10 000 $m^{2)}$
Length	ft	1200/3937*	m

* Exact, By definition of the US Survey foot, Section 8810, State of California Public Resources Code

Speed Conversion Table

Current (mph)	Metric (km/h)
25	**40**
35	**60**
45	**70**
55	**90**
65	**110**
75	**120**