DRILLING LINE CALCULATIONS

TITAN

Better Value
for oil field operations

DRILLING LINE CALCULATIONS

Design/Service factor

Oil ropes service factors

Service Factor results from dividing the minimum breaking load of the rope by the real load on it.

The Service Factor is characteristic of each operation and plays an important role in implementing the run and cutoff program.

Line	SF recommended	SF minimum allowed
Drilling line	5	3 in deep drilling 2 when setting casing
Sand line	5	3
Mast raising line	5	2.5
Auxiliary hoisting winch rope	5	3 (not recommended)
Winch truck rope	5	API does not specify. Experience indicates a minimum of 2.5 with extreme precautions.

Source: API RP 9b Standard

The Design/ Service factor should be determined by the following formula:

Equation (1)

Design/ Service Factor=B/W

where -
B is the nominal strength of the wire rope, lb;
W is the fast line tension

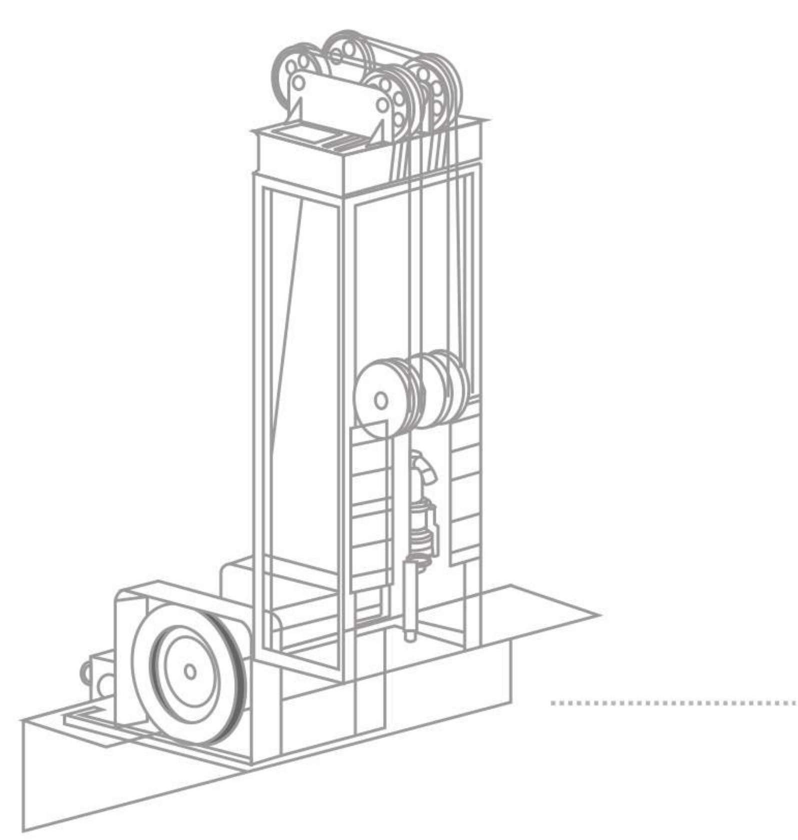
#When a wire rope is operated close to the minimum Design/ Service factor, care should be taken that the rope and related equipment are in good operating condition. At all times, the operating personnel should use diligent care to minimize shock, impact and acceleration or deceleration of loads. Successful field operations indicate that the Design/ Service factors in Table 1 should be regarded as minimum.

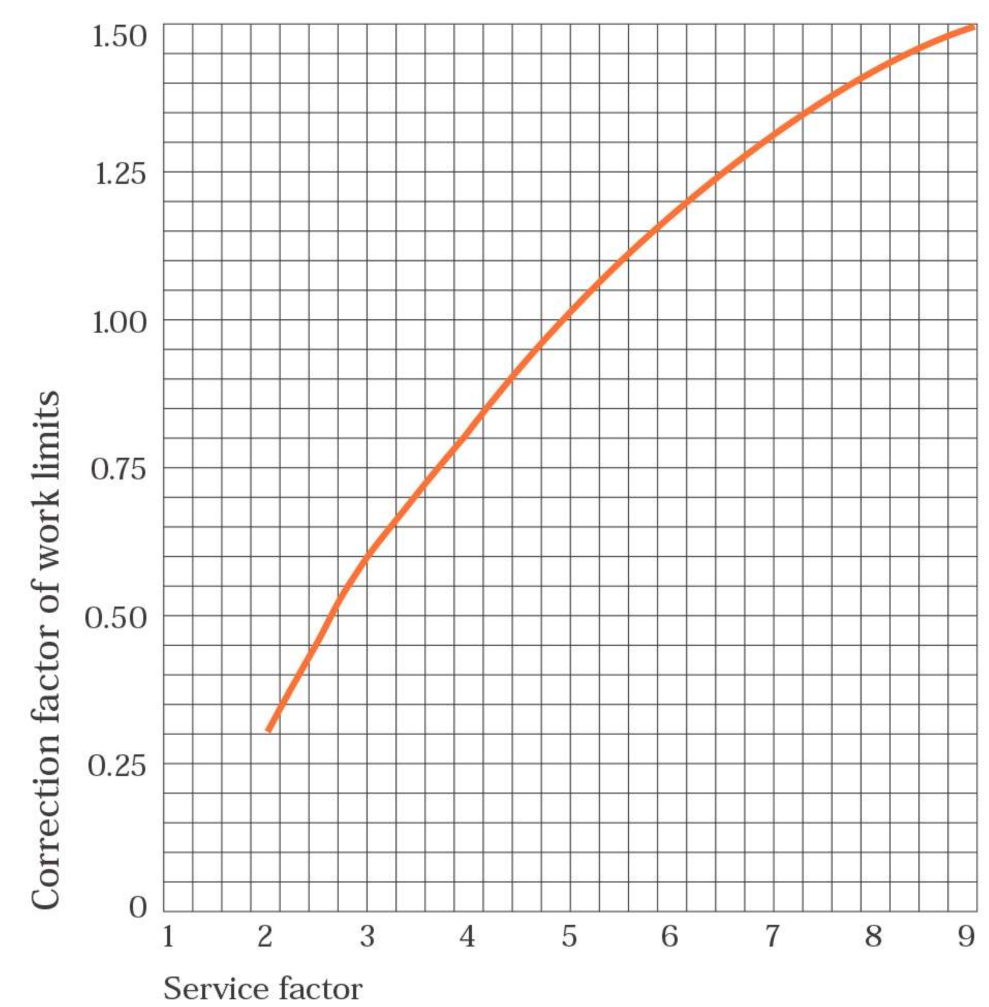
Table 1 - Minimum Design Factors

Operation	Minimum Design Factor
Sand line	3
Rotary drilling line	3
Hoisting service other than rotary drilling	3
Mast raising and lowering line	2.5
Rotary drilling line when setting casing	2
Pulling on stuck pipe and similar infrequent operations	2

Correction factor for T- mile at different Design/Service factor

Wire rope life varies with the Design/ Service factor; therefore, longer rope life can generally be expected when relatively high Design/ Service factors are maintained.





Calculation of Design/Service factor

To calculate the Design/ Service factor for multipart string-ups, use Chart 1 and 2 (on next page) to determine the value of W.

W is the fast line tension and equals the fast line factor times the hook load or weight indicator reading.

Note: The fast line factor is calculated considering the tensions needed to overcome sheave-bearing friction.

EXAMPLE

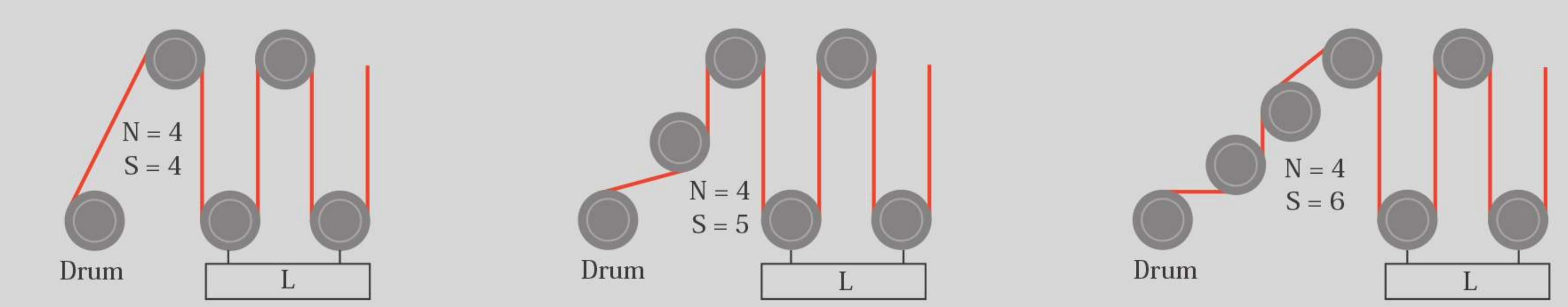
Drilling Line = 1 3/8 in. (35 mm) EIPS

Number of Lines = 10

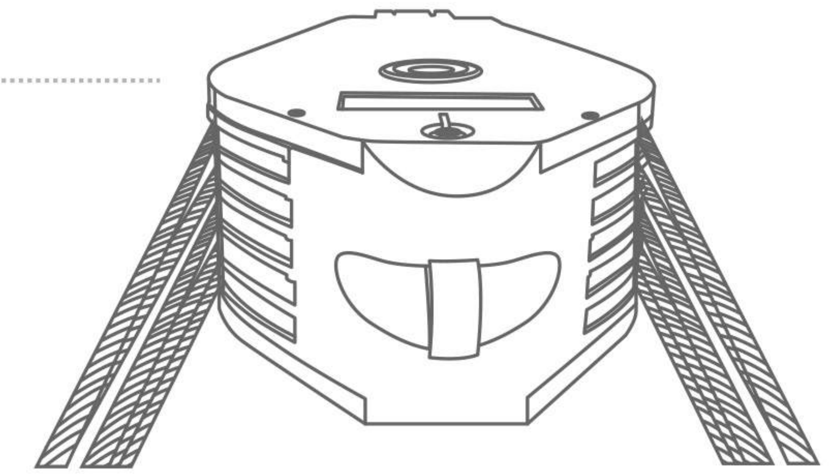
Hook Load = 400,000 lb (181.4t)

Sheaves are roller bearing type. From Chart 2, Case A, the fast line factor is 0.123. The fast line tension is then 400,000 lb (181.4t) 0.123 = 49,200 lb (22.3t) W. Following the formula in Equation 1, the Design/ Service factor is then the nominal strength of 1-3/8 inch (35 mm) EIPS drilling line divided by the fast line tension or 192,000 lb (87.1t) ÷ 49,200 lb (22.3t) = 3.9.

When working near the minimum Design/Service factor, consideration should be given to the efficiencies of wire rope bent around sheaves, fittings or drums. Chart 1 shows how rope can be affected by bending.



L = Load S = No. of sheaves N = No. of rope parts supporting load



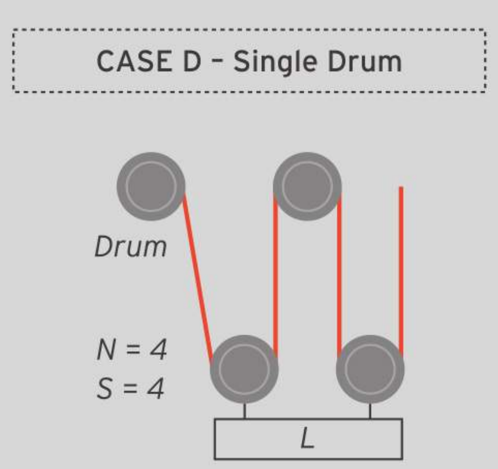
DRILLING LINE CALCULATIONS

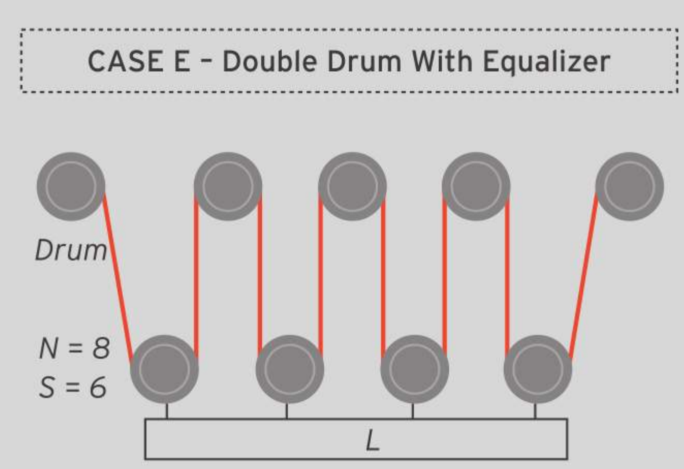
	Plain Bearing Sheaves K = 1.09*						Roller Bearing Sheaves K = 1.04*					
N	Efficiency			Fast Line Factor			Efficiency			Fast Line Factor		
	Case A	Case B	Case C	Case A	Case B	Case C	Case A	Case B	Case C	Case A	Case B	Case C
2	0.880	0.807	0.740	0.568	0.620	0.675	0.943	0.907	0.872	0.530	0.551	0.573
3	0.844	0.774	0.710	0.395	0.431	0.469	0.925	0.889	0.855	0.360	0.375	0.390
4	0.810	0.743	0.682	0.309	0.336	0.367	0.907	0.873	0.839	0.275	0.287	0.298
5	0.778	0.714	0.655	0.257	0.280	0.305	0.890	0.856	0.823	0.225	0.234	0.243
6	0.748	0.686	0.629	0.223	0.243	0.265	0.874	0.840	0.808	0.191	0.198	0.206
7	0.719	0.660	0.605	0.199	0.217	0.236	0.857	0.824	0.793	0.167	0.173	0.180
8	0.692	0.635	0.582	0.181	0.197	0.215	0.842	0.809	0.778	0.149	0.154	0.161
9	0.666	0.611	0.561	0.167	0.182	0.198	0.826	0.794	0.764	0.134	0.140	0.145
10	0.642	0.589	0.540	0.156	0.170	0.185	0.811	0.780	0.750	0.123	0.128	0.133
11	0.619	0.568	0.521	0.147	0.160	0.175	0.796	0.766	0.736	0.114	0.119	0.123
12	0.597	0.547	0.502	0.140	0.152	0.166	0.782	0.752	0.723	0.107	0.111	0.115
13	0.576	0.528	0.485	0.134	0.146	0.159	0.768	0.739	0.710	0.100	0.104	0.108
14	0.556	0.510	0.468	0.128	0.140	0.153	0.755	0.725	0.698	0.095	0.098	0.102
15	0.537	0.493	0.452	0.124	0.135	0.147	0.741	0.713	0.685	0.090	0.094	0.097
16	0.520	0.477	0.437	0.120	0.131	0.143	0.728	0.700	0.673	0.086	0.089	0.093
17	0.503	0.461	0.423	0.117	0.128	0.139	0.716	0.688	0.662	0.082	0.085	0.089
18	0.486	0.446	0.409	0.114	0.124	0.136	0.703	0.676	0.650	0.079	0.082	0.085
19	0.471	0.432	0.396	0.112	0.122	0.133	0.691	0.665	0.039	0.076	0.079	0.082
20	0.456	0.419	0.384	0.110	0.119	0.130	0.680	0.653	0.628	0.074	0.077	0.080

Chart 1 – Efficiency of Wire Rope Reeving for Multiple Sheave Blocks Cases A, B and C (Fast Line and Efficiency Factors for Derricks, Booms etc.)

Note: These cases apply also where the rope is dead ended at the lower or travelling block or derrick floor after passing over a dead sheave in the crown.

(*) In these tables, the K-factor for seave friction is 1.09 for plain bearings and 1.04 for roller bearings. Other K-factors can be used if recommended by the equipment manufacturer.





L = Load

S = No. of sheaves (not counting equalizer)

N = No. of rope parts supporting load

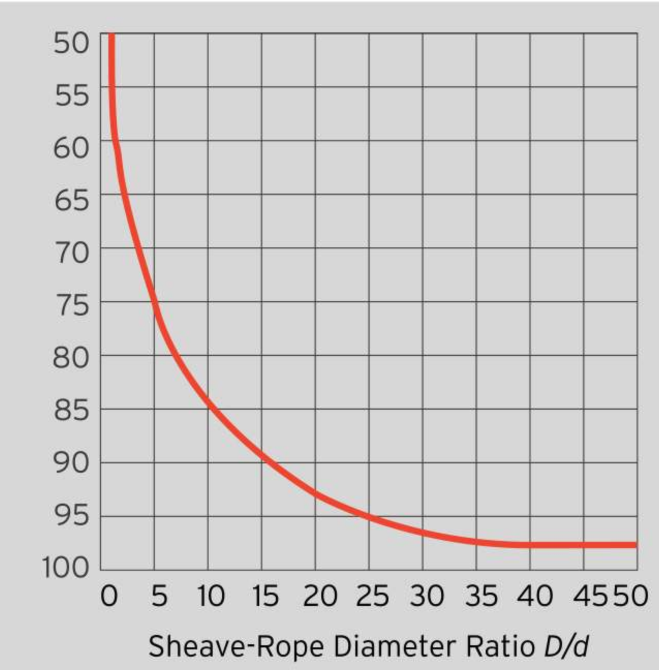
	Plain Bearing Sheaves K = 1.09*				Roller Bearing Sheaves K = 1.04*			
N	Efficiency		Fast Line Factor		Efficiency		Fast Line Factor	
	Case D	Case E	Case D	Case E	Case D	Case E	Case D	Case E
2	0.959	1.000	0.522	0.500	0.981	1.000	0.510	0.500
3	0.920		0.362		0.962		0.346	
4	0.883	0.959	0.283	0.261	0.944	0.981	0.265	0.255
5	0.848		0.236		0.926		0.216	
6	0.815	0.920	0.205	0.181	0.909	0.962	0.183	0.173
7	0.784		0.182		0.892		0.160	
8	0.754	0.883	0.166	0.142	0.875	0.944	0.143	0.132
9	0.726		0.153		0.859		0.129	
10	0.700	0.848	0.143	0.118	0.844	0.926	0.119	0.108
11	0.674		0.135		0.828		0.110	
12	0.650	0.815	0.128	0.102	0.813	0.909	0.102	0.092
13	0.628		0.123		0.799		0.096	
14	0.606	0.784	0.118	0.091	0.785	0.892	0.091	0.080
15	0.586		0.114		0.771		0.086	
16	0.566	0.754	0.110	0.083	0.757	0.875	0.083	0.071
17	0.548		0.107		0.744		0.079	
18	0.530	0.726	0.105	0.077	0.731	0.859	0.076	0.065
19	0.513		0.103		0.719		0.073	
20	0.498	0.700	0.101	0.071	0.707	0.844	0.071	0.059

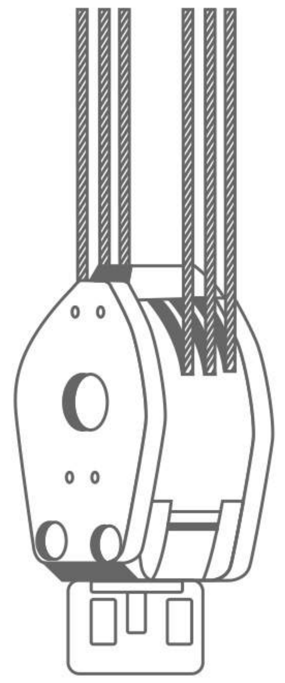
Chart 2 – Efficiency of Wire Rope Reeving for Multiple Sheave Blocks Cases D and E (Fast Line and Efficiency Factors for Derricks, Booms, Etc.)

Note: These above cases apply also where the rope is dead ended at the lower or travelling block or derrick floor after passing over a dead sheave in the crown.

(*) In these tables, the K-factor for seave friction is 1.09 for plain bearings and 1.04 for roller bearings. Other K-factors can be used if recommended by the equipment manufacturer.

Chart 3 – Efficiencies of Wire Ropes Bent Around Stationary Sheaves (Static Stresses Only)





Evaluation of Rotary Drilling Line

Total Service Performed

The total service performed by a rotary drilling line can be evaluated by taking into account the amount of work done by the line in the various drilling operations (drilling, coring, fishing, setting casing etc.), and by evaluating such factors as the stresses imposed by acceleration and deceleration loadings, vibration stresses, stresses imposed by friction forces of the line in contact with drum and sheave surfaces and other even more indeterminate loads. However, for comparative purposes, an approximate evaluation can be obtained by computing only the work done by the line in raising and lowering the applied loads in making round trips and in the operations of drilling, coring, setting casing, and short trips.

Round-trip Operations

Most of the work done by a drilling line is that performed in making round trips (or half-trips) involving running the string of drill pipe into the hole and pulling the string out of the hole. The amount of work performed per round trip should be determined by use of the following formula:

Equation (2)

$$T_r = \frac{D(L_s + D)W_m}{10{,}560{,}000} + \frac{D\left(M + \frac{1}{2}C\right)}{2{,}640{,}000}$$

where
Tr is the ton-miles [weight in tons (2,000 lb) times distance moved in miles]
D is the depth of hole, in ft
L_s is the length of drill-pipe stand, in ft
N is the number of stands of drill-pipe
W_m is the effective (buoyed) weight per foot of drill-pipe in drilling fluid, in lb/ft
M is the total weight of traveling block-elevator assembly and top drive (if used), in lb
C is the effective (buoyed) weight of drill collar assembly in drilling fluid minus the effective (buoyed) weight of the same length of drill-pipe in drilling fluid, in lb/ft.

The formula for ton-miles per round trip as earlier is based on the following derivation:

In making a round trip, work is done in raising and lowering the traveling block assembly and in running and pulling the drill stem, including the drill collar assembly and bit. The calculations are simplified by considering the drill pipe as extending to the bottom of the hole and making separate calculations for the excess weight of the drill collar-bit assembly over that of the same length of drill pipe.

In running the string, the traveling block assembly, which includes the traveling block, hook, links, and elevator (weight M), moves a distance equal (approximately) to twice the length of the stand (2Ls), for each stand. The amount of work done is equal to 2MLsN. In pulling the string, a similar amount of work is done; therefore, the total amount of work done in moving the traveling block assembly, during one complete round trip is equal to 4MLsN. Because the drill pipe is assumed to extend to the bottom of the hole, making LsN equal to D, the total work can be expressed as 4DM in pound-feet or

Equation (3)

$$\frac{4DM}{5280 \times 2000}\text{, In ton-miles}$$

In lowering the drill pipe into the hole, the amount of work done is equal to the average of the weights lowered times the distance (D). The average weight is equal to one-half the sum of one stand of drill pipe (the initial load) plus the weight of N stands (the final load). Since the weight of the drill pipe is decreased by the buoyant effect of the drilling fluid, an allowance must be made for buoyancy. The work done in pound-feet is therefore equal to 1/2 (Wm Ls + Wm Ls N)D, or 1/2 (Wm Ls + Wm Ls D)D

Assuming the friction loss is the same in going into the hole as in coming out, the work done in raising the drill pipe is the same as in lowering, so for a round trip, the work done in ton-miles is equal to Equation (4).

Equation (4)

$$\frac{DW_s(L_s + D)}{5280 \times 2000}$$

Because the drill collars and bit weigh more per foot than drill pipe, a correction factor must be introduced for the added work done in lowering and lifting this assembly. This amount is equal to the excess weight of the drill collar assembly, including subs and bits (C), times and distance moved (D). For a round trip the work done (in ton-miles) would be

Equation (5)

$$\frac{2 \times C \times D}{5280 \times 2000}$$

The total work done in making a round trip would be equal to the sum of the amounts expressed in Equations (3), (4), and (5); namely

Equation (6)

$$T_r = \frac{4DM}{5280 \times 2000} + \frac{DW_m(L_s + D)}{5280 \times 2000} + \frac{2CD}{5280 \times 2000}$$

This can be rewritten as

or

Equation (7)

$$T_r = \frac{D(L_s + D)W_m}{5280 \times 2000} + \frac{4D\left(M + \frac{1}{2}C\right)}{5280 \times 2000}$$

Drilling Operations

The ton-miles of work performed in drilling operations is expressed in terms of work performed in making round trips, since there is a direct relationship as illustrated in the following cycle of drilling operations:

a. drill ahead length of the kelly
b. pull up length of the kelly
c. ream ahead length of the kelly
d. pull up length of the kelly to add single or double
e. put kelly in rat hole
f. pick up single or double
g. lower drill stem in hole
h. pick up kelly

Analysis of the cycle of operations shows that for any one hole, the sum of all operations (a) and (b) is equal to one round trip; the sum of all operations (c) and (d) is equal to another round trip; the sum of all operations (g) is equal to one-half a round trip; and the sum of all operations (e), (f), and (h) may, and in this case does, equal another one-half round trip, thereby making the work of drilling the hole equivalent to three round trips to bottom. This relationship can be expressed as follows:

Equation (8)

$$T_d = 3(T_2 - T_1)$$

where
T_d is the ton-miles drilling
T_1 is the ton-miles for one round trip at depth D1 (depth where drilling started after going in hole, in ft)
T_2 is the ton-miles for one round trip at depth D2 (depth where drilling stopped before coming out of hole, in ft)

If operations c and d are omitted, then formula 8 becomes:

Equation (9)

$$T_d = 2(T_2 - T_1)$$

If a top drive is used, formula 8 becomes:

Equation (10)

$$T_d = T_2 - T_1$$

If reaming is done between connections with a top drive then formula 8 becomes:

Equation (11)

$$T_d = 2(T_2 - T_1)$$

Coring Operations

The ton-miles of work performed in coring operations, as for drilling operations, is expressed in terms of work performed in making round trips, since there is a direct relationship that is illustrated in the following cycle of coring operations:

a. core ahead length of core barrel
b. pull up length of kelly
c. put kelly in rat hole
d. pick up single
e. lower drill stem in hole
f. pick up kelly

Analysis of the cycle of operation shows that for any one hole the sum of all operations (a) and (b) is equal to one round trip; the sum of all operations (e) is equal to one-half a round trip; and the sum of all operations (c), (d), and (f) may, and in this case does, equal another one-half round trip, thereby making the work of drilling the hole equivalent to two round trips to bottom. This relationship can be expressed as follows:

Equation (12)

$$T_c = 2(T_4 - T_3)$$

where
T_c is the ton-miles coring
T_3 is the ton-miles for one round trip at depth, D3 (depth where coring started after going in hole, in ft)
T_4 is the ton-miles for one round trip at depth D4 (depth where coring stopped before coming out of hole, in ft)

Note: Extended coring operations are ordinarily not encountered.

Setting Casing Operations

The calculation of the ton-miles for the operation of setting casing should be determined as in 4.2, as for drill pipe, but with the effective weight of the casing being used, and with the result being multiplied by one-half, since setting casing is a one-way (1/2 round-trip) operation. Ton-miles for setting casing can be determined from the following formula:

Equation (13)

Since no excess weight for drill collars need be considered, this formula becomes:

Equation (14)

where

Ts is the ton-miles setting casing

Lcs is the length of joint of casing, in ft

Wcm is the effective weight per foot of casing, in lb.

The effective weight per foot of casing, Wcm, may be calculated as

Wcm = Wca (1 - 0.015B)

where
Wca is the weight per foot of casing in air, in lb;
B is the weight of drilling fluid, in lb/gal.

Short Trip Operations

The ton-miles of work performed in short trip operations, as for drilling and coring operations, is also expressed in terms of round trips. Analysis shows that the ton-miles of work done in making a short trip is equal to the difference in round trip ton-miles for the two depths in question. This can be expressed as follows:

Equation (15)

TST = T6 -T5

where
TST is the ton-miles for short trip
T5 is the ton-miles for one round trip at depth D5 (shallower depth)
T6 is the ton-miles for one round trip at depth D6 (deeper depth)

Other Operations

There are other operations that work the drilling line that need to be accounted for in the ton-mile accumulation. They include operations such as: motion compensation devices, working casing, setting casing with landing string, jarring, pulling on stuck pipe and running riser.

Evaluation of Service

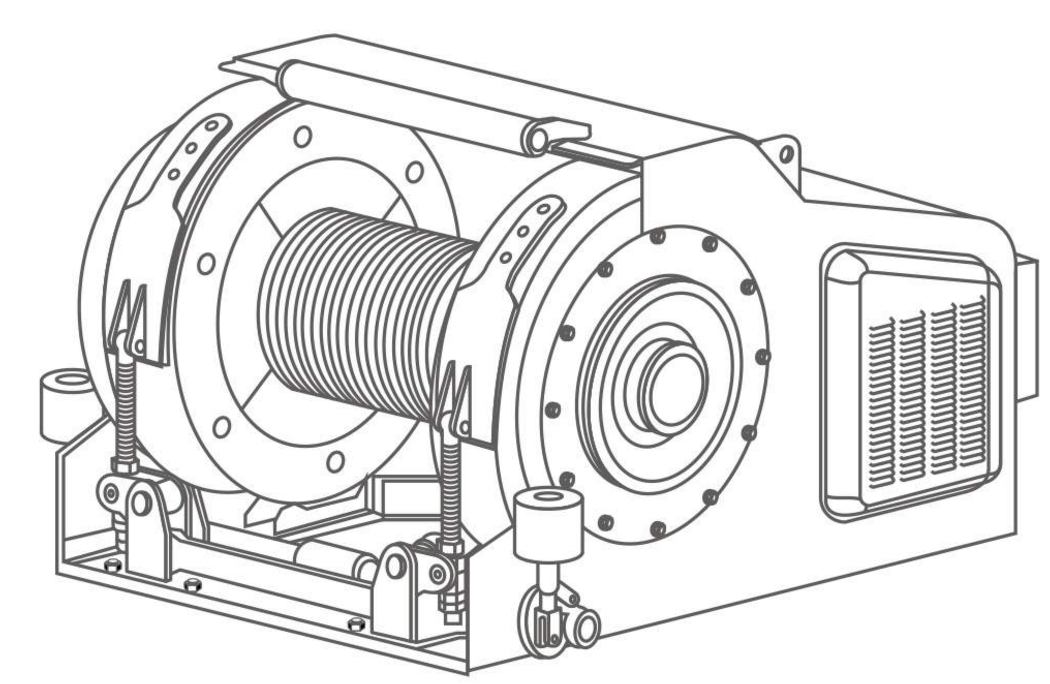
For comparative evaluation of service from rotary drill lines, the ton miles for all operations should be totalled. Divide the total ton miles by the length of drill line purchased minus the string-up length.

Rotary Drilling Line Ton-Mile Calculators

Drilling contractors and wire rope manufactures use or supply different calculators that utilize the API formulas to calculate ton-miles for the different rig operations

Rotary Drilling Line Service Record Form

Chart next is an example of a drilling line service record form. The form should be modified to conform to the needs of the drilling contractor.



ROTARY DRILLING LINE SERVICE RECORD

Sheet .... of .... Sheets

Company .... Well and No. .... Rig No. .... Make and Type DWKS

Drum Diam............ Plain or Grooved Drum .... | Crown Block Sheave Diam .... | Travelling Block Sheave Diam .... | Wt. of Travelling Block Assembly (Factor "M") .... | Size and Weight Drill Pipe

Make of Line .... Size and Length .... Construction .... Grade .... Reel No. ....

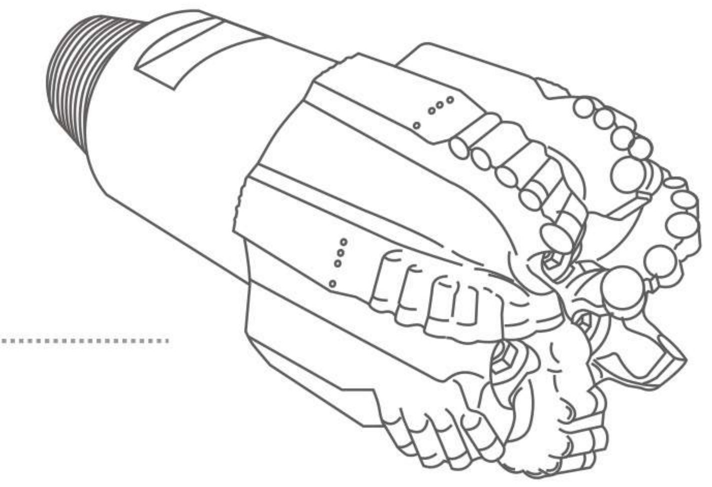
Date Line Put Into Service .... | Date Line Retired from Service .... | No. of Lines Strung .... Initial 1st Change 2nd Change | Well Depth When String-Up Increased .... Initial 1st Change 2nd Change

1 Date	2 Trip No.	3 Depth of Trip	4 Orientation to be Performed & Remarks	5 Mud Weight ib/gal	6 Effective Wt. of Pipe Fig. 13	7 Drill Collars O.D. and Bore	8 Drill Collars Effective Wt., E Flf.14	9 Drill Collars Excessive Wt. (Col.8 Minus Col.6)	10 Drill Collars No. of Feet	11 Factor C (Col. 9-Co.10)	12 Factor M +1/2 C	13 Ton-Mile Service This Operation Fig.12	14 Cumulative Ton-Miles Since Last Slip	15 Length of Line Slipped, ft.	16 cumulative Ton-Miles Since Last Cutoff	17 Length Line Cutoff ft.	18 Length Line Remaining ft.

Ton-Miles service Previous Wells .... | Ton-Miles Service on Trips.....This Well .... | Ton-Miles Service Drilling .... This well .... | Ton-Miles Service Coring .... This Well .... | Ton-Miles Service Setting Casing .... This Well

Total Ton Miles Service-All Wells............ | Ton Miles per ft of Initial Length

Directions for filling out this form, including use of charts, are given in the instruction sheets included with each pad, and are



Cutoff Practice for Rotary Drilling Lines

Service Life

The service life of drilling lines can be greatly increased by the use of a planned cutoff program. A cutoff program removes the most heavily worn wire rope from the string-up by introducing new rope from the storage reel into the system. Using only visual inspection to determine when to cutoff will result in uneven wear, trouble with spooling (line "cutting in" on the drum), and long cuts - thus decreasing the wire rope's service life. A cutoff program, based on accumulated ton-miles, should be used.

Initial Length of Line

The relationship between initial lengths of rotary lines and their normal service life expectancies is shown in chart. Possible savings by the use of a longer line may be offset by an increased cost of handling for a longer line.

Service Goal

The most accurate goal is based on past records of a rig or from similar rigs using the same size drill line and having the same diameter drawworks drum. The goal should be selected by agreement between the drilling contractor and the drill line manufacturer. The goal can be adjusted after each drill line is replaced.

An initial T-Mile goal for different drill line sizes based on drum diameter (T-Mile table given). The diameter of the sheaves may be taken into considerations to slightly adjust the goal.

Variations in Line Services

The T-Mile goals are for normal operations when the drill line is operated around a Design/ Service factor of 5. Continued operations with Design/ Service factors higher than 7.0 or lower than 4.0 will affect the service life of the drill line. The T-Mile goal may have to be lowered to prevent a long cut.

Cutoff Length

The following factors should be considered in determining a cutoff length.

- Load pick up points from reeving diagram
- Drum diameter and crossover point on the drum
- Maximum ton miles accumulated between cuts

Care should be taken to prevent the duplication of crossover points of the drum. This can be accomplished by adding 1/8 of a drum circumference. Cut off lengths should be based on the service goal. The ton-miles accumulated since the last cut divided by the service goal equals the length of the rope to cut. Do not cut the same length each time or make cuts that are multiples of the distance between sheave pick-up points.

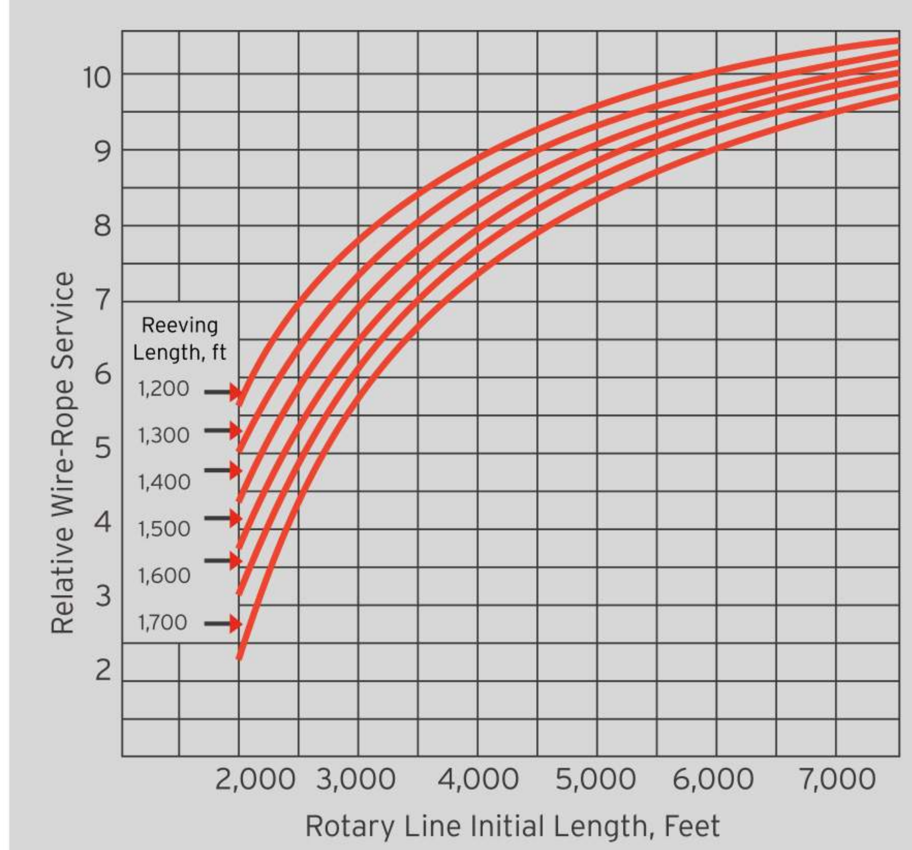
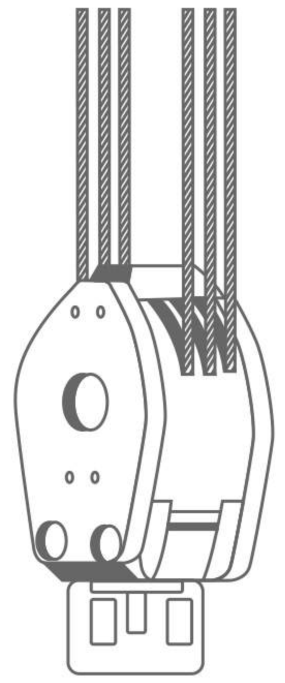


Chart – Relationship between Rotary-line Initial Length and Service Life



Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 2

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 2

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	2	4							18
483	2	4							19
508	3	4							20
533	3	4							21
559	3	4							22
584	3	4	5						23
610	3	4	5	7					24
635	3	4	6	7					25
660	4	4	6	7					26
686	4	5	6	7					27
711		5	6	7					28
737		5	6	7					29
762		5	6	8	8				30
787			6	8	8				31
813			7	8	9				32
838			7	8	9				33
864			7	8	10				34
889				8	10				35
914				9	10	11	12		36
1067						12	14	14	42
1219							15	16	48
1524								18	60
1829								20	72

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 3

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	4	5							18
483	4	5							19
508	4	5							20
533	4	6							21
559	4	6							22
584	5	6	8						23
610	5	6	8	10					24
635	5	6	8	10					25
660	5	7	8	10					26
686	5	7	9	11					27
711		7	9	11					28
737		7	9	11					29
762		8	10	11	12				30
787			10	11	13				31
813			10	12	13				32
838			10	12	14				33
864			11	13	14				34
889				13	15				35
914				13	15	17	18		36
1067						17	20	22	42
1219							22	23	48
1524								27	60
1829								30	72

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 4

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	5	7							18
483	5	7							19
508	6	7							20
533	6	8							21
559	6	8							22
584	6	8	10						23
610	6	8	10	14					24
635	6	8	11	14					25
660	7	9	11	14					26
686	7	10	12	14					27
711		10	12	14					28
737		10	12	14					29
762		10	13	15	16				30
787			13	15	17				31
813			14	16	18				32
838			14	16	18				33
864			14	17	19				34
889				17	20				35
914				18	20	22	24		36
1067						23	27	29	42
1219							30	31	48
1524								36	60
1829								40	72

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 5

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	6	9							18
483	6	9							19
508	7	9							20
533	7	10							21
559	7	10							22
584	8	10	13						23
610	8	10	13	17					24
635	8	10	14	17					25
660	9	11	14	17					26
686	9	12	15	18					27
711		12	15	18					28
737		12	15	18					29
762		13	16	19	20				30
787			16	19	21				31
813			17	20	22				32
838			17	20	23				33
864			18	21	24				34
889				21	25				35
914				22	25	28	30		36
1067						29	34	36	42
1219							37	39	48
1524								45	60
1829								50	72

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 6

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	7	11							18
483	7	11							19
508	8	11							20
533	8	12							21
559	8	12							22
584	10	12	16						23
610	10	12	16	20					24
635	10	12	17	20					25
660	11	13	17	20					26
686	11	14	18	22					27
711		14	18	22					28
737		14	18	22					29
762		16	19	23	24				30
787			19	23	25				31
813			20	24	26				32
838			20	24	28				33
864			22	25	29				34
889				25	30				35
914				26	30	34	36		36
1067						35	41	43	42
1219							44	47	48
1524								54	60
1829								60	72

Ton -MILE GOAL per meter of rope as per API-9B at service/design factor 7

Drum dia	ROPE DIA								Drum dia
	1"/ 25 mm	1.1/8"/28 mm	1.1/4"/32 mm	1.3/8"/35 mm	1.1/2"/38 mm	1.5/8"/42 mm	1.3/4"	2"	
mm									inch
457	8	13							18
483	8	13							19
508	10	13							20
533	10	14							21
559	10	14							22
584	11	14	18						23
610	11	14	18	24					24
635	11	14	20	24					25
660	13	15	20	24					26
686	13	17	21	25					27
711		17	21	25					28
737		17	21	25					29
762		18	22	27	28				30
787			22	27	29				31
813			24	28	31				32
838			24	28	32				33
864			25	29	34				34
889				29	35				35
914				31	35	39	42		36
1067						41	48	50	42
1219							52	55	48
1524								63	60
1829								70	72