BIJUR DELIMON
INTERNATIONAL

FARVAL®
A BIJUR DELIMON BRAND

DUALINE™ LUBRICATION SYSTEMS

Planning and Setup Guide

SECTION DB

SYSTEM PLANNING

TABLE OF CONTENTS

INTRODUCTION

This section contains a step by step procedure for selecting optimum combinations of the Farval dual line assemblies shown in Fig. 1.1. It starts with the selection of measuring valves and proceeds to the planning of distribution lines, selection of pumps and reservoirs, and finally the selection of timer controls.

A description of loop systems and end-of-line systems and how they operate in terms of "pump-on" periods is included in section DA (Manual DL100). Section DA also refers to other sections which describe the assemblies in detail.*

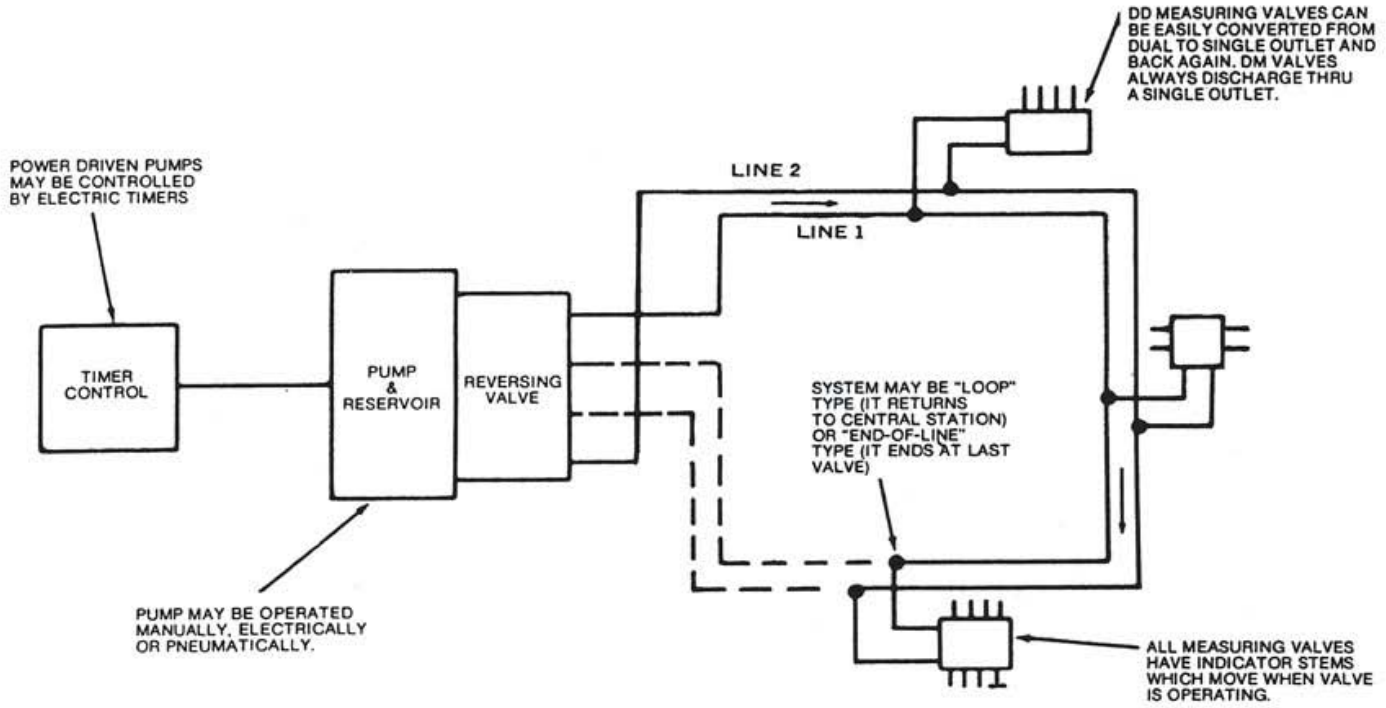

Fig. 1.1 — A typical Farval dual line system.

*It requires two consecutive "pump-on" periods to lubricate all bearings and thus complete one lube cycle in a dual line system. A reversing valve switches from one main distribution line to another between "pump-on" periods. Measuring valve pistons complete one stroke in one direction during one "pump-on" period and the return stroke during the second "pump-on" period, discharging lubricant each time.

SYSTEM PLANNING

SELECTING MEASURING VALVES

A. Prepare a bearing list similar to that shown in Fig. 1.2. Determine bearing make-up (thats the lube volume added at regular intervals) from page DB1-3. This type of bearing list is the starting point for developing **any** type of lubrication system.

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Bearing List — Sheet 1
Sheet No. _____
Record No. _____
Job No. _____

Firm _____ Date _____
Machine or Equipment _____ Reference Dwg. _____
Builder _____ Lubricant Used ☐ Oil ☑ Grease
System Required _____ ☐ Hand Gun ☑ Duoline ☐ Single Line ☑ Manual ☐ Automatic Total Points 24

REF NO	NAME OR LOCATION OF BEARING	NO BRGS.	BEARING SIZE (NOTE 1)	BEARING TYPE (NOTE 2)	BEARING SPEED (NOTE 3)	TAP SIZE	NOTE 4 TAPS PER BRG.	NOTE 4 I or R	AMOUNT OF MOVEMENT OR FLEX. LENGTH	TOTAL NO. POINTS	BEARING MAKE-UP FL. OZ.	BEARING MAKE-UP CU. IN.	VALVE SIZE	VALVE ADJ.	VALVE MANIFOLD
1	Drive Shaft Bearings	2	3-½"	AF	200	1/8	1	F		2		.013	DD20	.013	1-DD22
2-3	Roll Bearings–Top	8	3-½"x 3"	PL	40	1/8	1	F		8		.026	DD20	.026	2-DD24
4-5	Roll Bearings–Bottom	8	5"x 4"	PL	40	1/8	1	F		8		.056	DD50	.056	2-DD54
6	Header Pin	1	2"x 4"	PL	20	1/8	1	F		1		.012	DD20	.006	1-DD22
7	Eccentric Connection	1	4"x 1"	PL	20	1/8	1	F		1		.010	DD20	.005	1-DD22
8	Eccentric Connecting Pin	1	3"x 2"	PL	20	1/8	1	F		1		.012	DD20	.006	1-DD22
9	Guide Roll	1	*7-½"	AF	400	1/8	1	F		1		.176	DD50	.088	1-DD52
10	Pick-up Slide	2	3"x 6"	Slide	5 osc.	1/8	1	M	2'-3'	2		.018	DD20	.018	1-DD22
										24					
	*Double row ball bearings–multiply chart make-up volume by 2.														

NOTE 1 — Advise diameter and length of cylindrical bearings; width and length of slides; inside diameter of anti-friction bearings.
NOTE 2 — Advise whether plain (cylindrical rotating), or sliding bearing surface, or make of anti-friction bearing.
NOTE 3 — Advise number of R.P.M. if rotating bearing, or indicate if oscillating and number of oscillations per minute. (Example 10 osc.)
NOTE 4 — Indicate number of inlets to each bearing and condition of bearing tap as fixed (F), movable (M), requiring flex, or rotating (R) requiring swivel connection.
NOTE 5 — See reverse side for additional data.

To facilitate planning installation and grouping valves into manifolds, this bearing list should be accompanied with assembly drawings or sketches on which the points to be lubricated are numbered to agree with the reference numbers of the bearing list above.

Form 52-625A (Rev. 12/72)

BY _____

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Fig. 1.2 - Farval Bearing List Form 52-625A

B. Select measuring valves from Fig. 1.3. It lists the lube volume discharged from each active port of individual valves during the two "pump-on" periods needed to extend and retract the valve pistons and thus to complete one lube cycle. Each port serves a single bearing. The following examples refer to Fig. 1.2.

Example 1: A single two-port DD22 valve can be adjusted to discharge .013 cu. in. of lube to each drive shaft bearing (BRG Ref. No. 1) during two "pump-on" periods.

Example 2: A single one-port DD52 valve can be adjusted to discharge .176 cu. in. of lube to the guide roll (Ref. 9) during two "pump-on" periods.

Fig. 1.3 lists only the basic measuring valve number. The exact number depends on the type of valve selected (whether with or without an indicator stem or with or without adjustment) and on the type of connecting line (whether pipe or tube). The "X" must be replaced by a number indicating the number of discharge ports per valve block. Also, check valves must be placed in discharge ports under certain conditions. For details see section DE (Manual DL600).

C. Valve blocks of from two to four individual valves are useful when bearing of similar size are in the same vicinity, but be sure pressure drop between valves and bearings is not excessive. See page DB2-1 for details.

SELECTING MEASURING VALVES

Measuring Valve Part No.	Lube Discharged from Each Active Port in Cu.In. During Two "Pump-On" Periods			
	One Port Valves		Two Port Valves	
	Min.	Max.	Min.	Max.
DD2X	.012	.072	.006	.036
DD5X	.022	.578	.011	.289
DM3X	.024	.144	DOES NOT APPLY TO DM VALVES (THEY ALWAYS HAVE ONE ACTIVE PORT ONLY).	
DM4X	.072	.270		
DM5X	.150	.578		
DM6X	.360	1.600		
DM62-101	.720	3.200		

Fig. 1.3 — Measuring valve selection chart.

HOW TO USE GRAPH (Fig. 1.4)

For a given bearing, determine the nominal diameter of the shaft on which the bearing is mounted. Locate the shaft diameter on the horizontal axis of the graph (Fig. 1.4). From the point on the graph representing the shaft diameter, draw a line vertically upward to the diagonal line representing the speed closest to the speed of the shaft. If the shaft is rotating at 100 rpm, or less, use the 100 rpm line. If the shaft is rotating at 400 rpm, or more, use the 400 rpm line. From the point where the vertical line and the diagonal line intersect, draw a horizontal line to the left intersecting the vertical axis of the graph. The point of intersection on the vertical axis represents the bearing make-up factor (F).

To determine the make-up volume (F) in cubic inches let:

A = the surface area (actual bearing area, not sliding area) to be lubricated for slides and for flat surfaces, in square inches.
I = number of lubrication inlets in bearing.
L = bearing length for plain bearings and bearing width for roller bearings.

Multiply F, as determined from Fig. 1.4, by the following:

BEARING TYPE	MULTIPLIER
Plain	L / I
Anti-friction ball and short roller	1.0 / I
Anti-friction double row ball and double short roller	2.0 / I
Anti-friction needle, tapered, or long roller (where "L" is greater than or equal to 1 inch)	0.5L / I
Slides and flat surfaces	0.001A / I

A suggested frequency of application of bearing make-up volume as derived above is once every two hours for oil or once every four hours for grease, but both volume and frequency can be altered in extenuating circumstances. Bearings need more lubricant if subjected to excessive heat, dust, water, scale, etc. and less if subjected to extremely light loads.

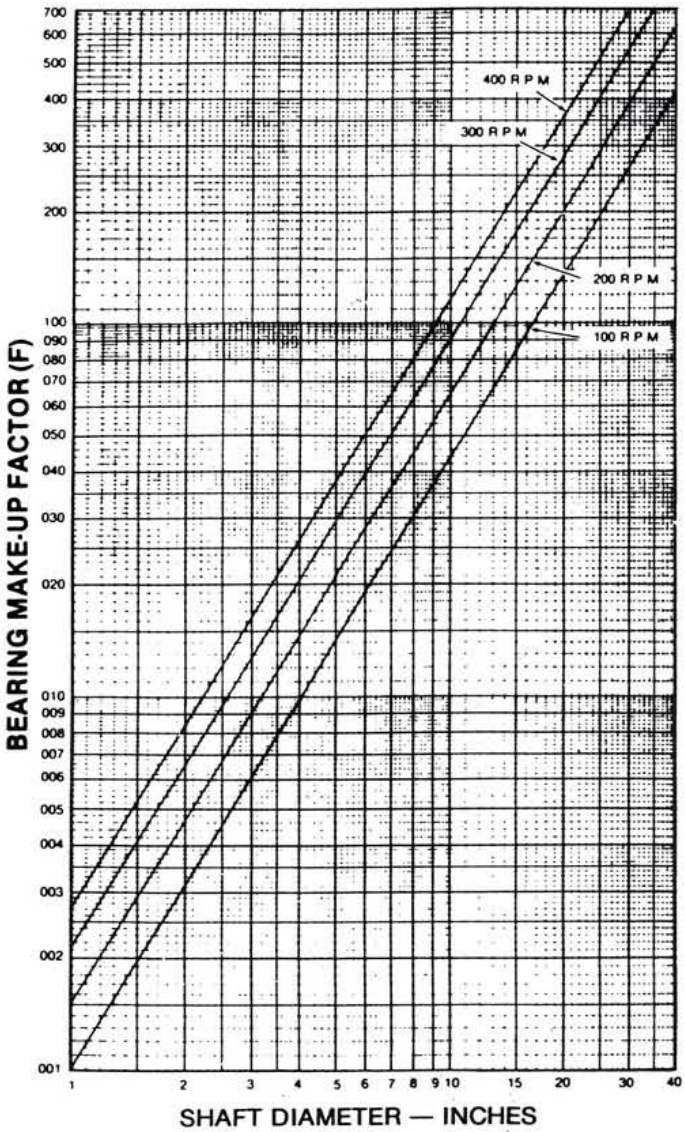


FIG. 1.4 — BEARING MAKE-UP VOLUME CHART

SYSTEM PLANNING

PLANNING SYSTEM DISTRIBUTION LINES

A. Pressure drop thru the main supply lines "L" in Fig. 2.1 or a-b-c-d-e in Fig. 2.2 should be less than 1500 psi. For oil, this condition can be met with ¼" pipe or tube throughout, but for grease or for oils which approach grease in consistency, such as on power shovels in cold climates, select line sizes from the data given in Fig. 2.3 or 2.4. The data is for greases having an ASTM penetration number at 77°F of 325-340 for No. 1 NLGI grease and 275 for No. 2 grease. Flow rate was 18 cubic inches (10 fluid ounces) per minute at 60°F.

B. Pressure drop thru branch lines can be provided for by following the recommendations of Fig. 2.2 for loop systems and by locating the pressure switches at the point of greatest pressure drop in end-of-line systems. If pressure switches are located at other points (such as at the central station), they must be set to allow for line losses.

Branch lines are installed for several reasons—to keep the main line of loop systems within the allowable pressure drop; to match the layout of the machine; or to control, by manual or powered shutoff valves, lubrication to groups of machines which are operated intermittently.

PRESSURE SWITCHES CAN BE LOCATED ANYWHERE BUT SHOULD BE AT POINT OF GREATEST PRESSURE DROP (USUALLY THE POINT WHICH IS THE GREATEST DISTANCE FROM THE STATION), TO ASSURE THAT ALL MEASURING VALVES OPERATE.

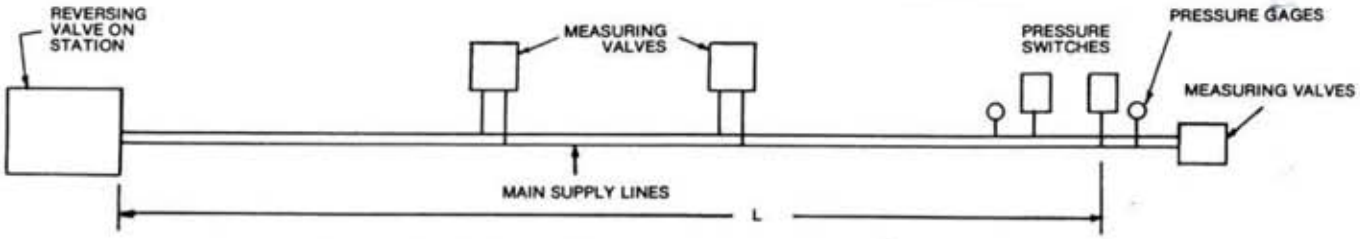
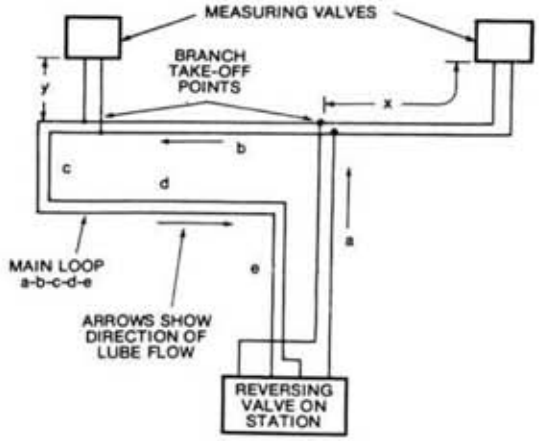


Fig. 2.1 — A typical end-of-line system (it ends at the last measuring valve.)



1. Keep branch line pressure drop to less than half that in main loop return lines. The return lines here are from the branch take-off point back to station in direction of lube flow. Thus, pressure drop in length "X" must be less than half that in length b-c-d-e and in length "Y" less than half that in length c-d-e.
2. When both main loop and branch pipe lines are the same size, the above can be stated in terms of lengths. Thus, length "X" must not exceed half of length b-c-d-e.

Fig. 2.2 — A typical loop system (it ends where it starts—at the central station).

C. Pressure drop between measuring valves and bearings can be minimized by selecting tubing as follows: For No. 1 NLGI grease use 1/4" minimum O.D. tubing and limit length to 5' at 32°F, 10' at 60°F. These lengths can be increased 50 percent if 3/8" O.D. tubing is installed. For oil, 3/16" tubing will not cause excessive pressure drop. A good rule of thumb is not to exceed 10 feet from the measuring valve to the farthest bearing point.

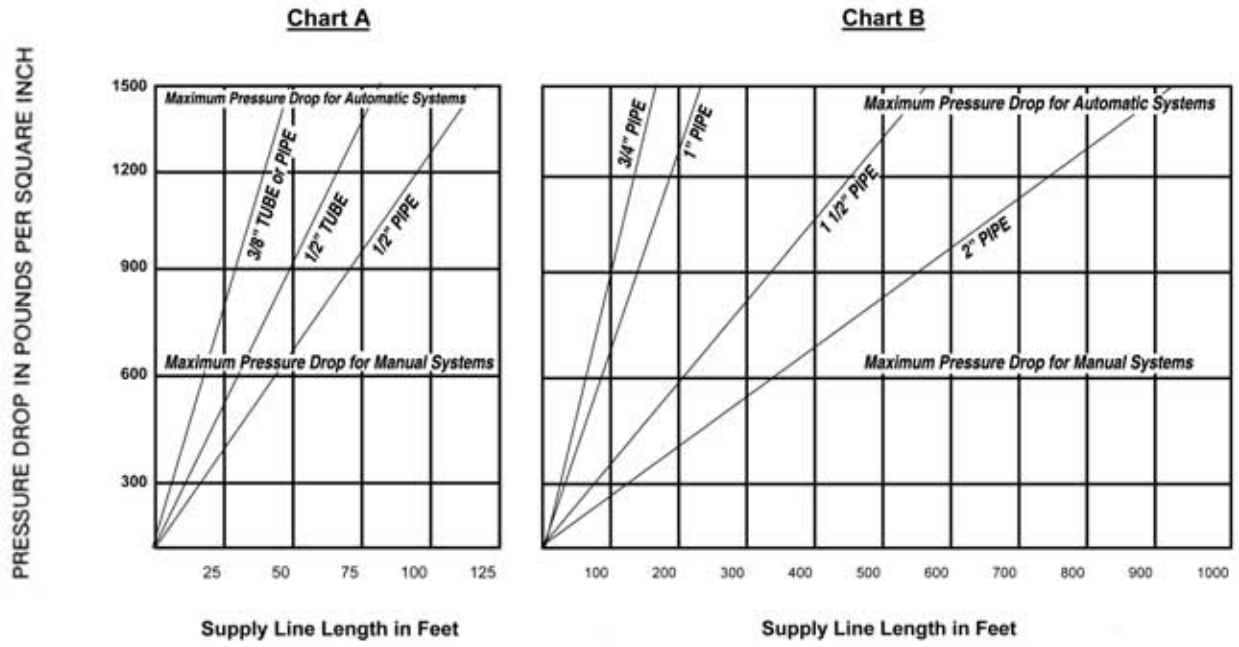
SYSTEM PLANNING

PLANNING SYSTEM DISTRIBUTION LINES

Pipe Size	Tube Size		Capacity		Pressure Drop • (Pounds/Foot)		Maximum Main Line Length-#1NLGI Grease			
							Manual Systems+		Automatic Systems	
	Nom. O.D.	Wall	Ft.Per Lb. Of Grease	Vd-Cu.In. Per Foot	#1NLGI	#2NLGI	Above 32°F	Below 32°F	Above 32°F	Below 32°F
¼"			25.0	1.25	25.7	51.4	50'	20'		
⅜"			13.5	2.29	14.4	28.8	100'	40'		
½"			11.0	2.82	6.5	13.0	150'	75'		
¾"			6.0	5.19	4.7	9.4	200'	100'	120'	
1"			3.6	8.63	3.2	6.4	250'	125'	200'	120'
*1-¼"			2.0	15.39					300'	160'
1-½"			1.45	21.20	1.36	2.7			400'	200'
2"			0.87	35.43	0.8	1.6			600'	300'
	¼"	.032			30.0	60.0				
	⅜"	.032			15.0	30.0				
	½"	.049			9.3	18.6				

*Consult factory before using—this is a non-standard size.
+ Applies to systems with DA (end-of-line) manual pumps only.
•Above pressure drops based on flow rate of 18 cu. in. per/min. (10 fluid ounces) at 60°F.

Fig. 2.3 — Table for determining line capacities and sizes.



For No. 2 NLGI Grease

HOW TO USE THE CHARTS

1. Refer to chart A for tubing and small diameter pipe and chart B for large diameter pipe.
2. For No. 2 NLGI grease, project a vertical line from LINE LENGTH IN FEET to MAXIMUM PRESSURE DROP line. Select pipe or tube indicated by the diagonal line closest to the intersecting point.
   Example: Select 1" pipe if line length is 100'.
3. For No. 1 NLGI grease, proceed as above except use half the anticipated pipe run. Example: Select ¾" pipe if length of run is 100'.
4. For operating temperatures below 32°F., select the next larger pipe size.
   Example: For item 2 above, select a 1½" diameter pipe.

Fig. 2.4 — Charts for determining line sizes.

PLANNING SYSTEM DISTRIBUTION LINES

D. The volume of lubricant in the distribution lines can be estimated from Fig. 2.3. This is useful for calculating lube needed for initial filling or for calculating grease compressibility from: $V_C = .005 \times V_d \times L$. Where V_C = volume in cu. in. which the pump must compress grease before building system pressure (V_C does not apply to oil) consider oil compression negligible for lubrication systems. V_d = lube capacity of pipe in cu. in. per foot (Fig. 2.3); and L = length of one main distribution line and its branches. V_d in Fig. 2.3 is based on use of schedule 40 or schedule 80 pipe as described below in section G.

E. End-of-line systems with electro-hydraulic reversing valves must include pressure switches and should include pressure gauges as shown in Fig. 2.1.

Both pipe and tube are installed in system distribution lines. Final choice depends on such factors as type of machine service, ambient temperature conditions, type of lubricant, length of supply lines, and installation cost.

All tube: For small systems where the longest supply line from pump to bearing is less than 50', where temperatures are normal, where grease is soft, and where it is not subject to abuse or extreme vibration.

All pipe: Where temperatures are low or grease is heavy and where supply lines are subject to extreme abuse such as in steel mills.

Pipe for Main Lines and Tubing for Risers and Discharge Lines: For large systems where main line runs are long and where temperatures are low or grease is stiff. Tube risers must be relatively short and not subject to severe abuse or vibration.

Pipe for Main Line and Risers and Tube for Discharge Lines: Where main line runs are long and where temperatures are low or grease is stiff. The pipe risers permit measuring valves to be located some distance from main supply line.

All or Part Hose: Where vibration is extreme and where clearance and space limitations require exceptional flexibility for installation. Recommended for underground mining equipment, some cranes, shovels, etc.

Nylon Tubing: For discharge lines where temperatures do not exceed 180°F. or go below -40°F., and where vibration or flexing is a problem. Its working pressure rating does not permit its connection to the supply line. Do not use where tubing will be continuously exposed to sunlight.

G. The pipe specifications listed below permit direct purchases from a steel supplier:

For ⅜ inch and smaller

Pipe — Use Schedule #40, standard wall seamless or welded black steel pipe — **All black pipe to be inside scale-free and oiled.**

Unions — 3000# forged steel ground joint steel-to-steel seat.

Pipe Nipples — Use Schedule 80, extra heavy wall seamless or welded black steel.

Couplings — 3000# forged steel.

Reducing Bushings — 3000# steel with hexagonal head.

Pipe Plugs — 3000# steel with square head.

All other fittings — 3000# forged steel.

For ½ inch or larger

PIPE — Use Schedule #80, extra heavy wall seamless or welded black steel pipe — **All black pipe to be inside scale-free and oiled.**

Unions — 3000# forged steel ground joint steel-to-steel seat.

Pipe Nipples — Specs same as for pipe.

Couplings — 3000# forged steel.

All other fittings — 3000# forged steel fittings.

SYSTEM PLANNING

SELECTING PUMPS AND RESERVOIRS

Pumps and reservoirs must be able to supply lube to one main distribution line when all of its measuring valves are adjusted to maximum discharge. Selection should be based on the equations and tables below:

Duration T_p of one "pump-on" period is: $T_p = \frac{D_t + V_c}{Q}$

T_p = number of pump handle cycles of manual pumps or time in minutes of power driven pumps. For power driven pumps, T_p should be less than half of the lube time cycle (Fig. 3.1); D_t = TOTAL maximum displacement in cu. in. of all measuring valve pistons (both discharge and pilot) during one "pump-on" period in one distribution line (see table below). V_c - grease compression volume from page DB2-3 para. D; and Q = pump discharge rate in cu. in.

Time T_r in hours between reservoir refills is: $T_r = \frac{N \times V_r}{2 \times D_m}$

N = number of hours between lube cycles*; V_r = reservoir capacity in cu. in.; and D_m = same as D_t above except discharge piston only.

Electric Motor Driven Pumps with Reservoirs①

Station	Pump	Type Lube	Discharge Rate Cu.In./Min.	Reservoir Capacity													
				Grease						Oil							
				Small		Med.		Large		Very Sm.		Small		Med.		Large	
				Lbs.	Cu. In.	Lbs.	Cu. In.	Lbs.	Cu. In.	Qts.	Cu. In.	Qts.	Cu. In.	Qts.	Cu. In.	Qts.	Cu. In.
CS1000	DJ1000	Oil or Grease	3.0	10	290					6	347						
CS2000	DJ2000	Oil or Grease	6.0	10	290	24	694	100	2893	6	347	24	694	48	1388	120	6930
DC41,42	DJ4	Oil or Grease	33.6	100	2893			200	5786					120	6930	120	6930
DC36	U-985-5W	Oil	34.5									60	3465			200	11550

Air Driven Pumps and Reservoirs②

Pump Models	Type Lube	Discharge Rate (Cu.In. Per Min.)	Reservoir Capacity
9120/9400	Oil or Grease	40	120 or 400# Drums
F622/F624		348	120 or 400# Drums

Manual Pumps and Reservoirs③

Pump Model	Type Lube	Discharge Rate	Reservoir Capacity	
			Lbs., Qts.	Cu. In.
DA4-101A	Grease	.45	4.5 lbs.	130
DA4-101B	Oil	.45	2.5 qts.	144
DA5-101A	Grease	.45	8.25 lbs.	239
DA5-101B	Oil	.45	4.5 qts.	260
DA6-101A	Grease	.45	12.5 lbs.	362
DA6-101B	Oil	.45	6.5 qts.	375

Piston Displacements Per Valve④

Measuring Valve Part No.	Max. Displ. Per Valve-Cu.In.	
	Discharge & Pilot Piston	Discharge Piston Only
DD2X 2X	.048	.036
DM3X	.088	.072
DM4X	.168	.135
DD5X DM5X	.331	.289
DM6X	.844	.800

NOTES:

1. Pump U-985-9W is gear type - DJ2000 pumps are double piston type and DJ1000 pumps are single piston type.
2. Air driven pumps listed in pump chart above, have a 50:1 ratio (other ratios available-consult factory.) Discharge rate is at 80 psi line pressure and 1000 psi back pressure.
3. Manual pump discharge rate is the number of cu. in. discharged in one pump handle cycle (e.g., a DA pump would discharge .45 cu. in. of lube if its handle were pushed back and forth once). At 50 strokes per/min. the discharge rate is 22.5 cu. in.
4. Piston displacements are INDIVIDUAL measuring valves, (e.g., a line with two DD22 valves must provide 2 x .048 = .096 cu. in. for both main and pilot piston or 2 x .036 = .072 cu. in. for the main pistons.

BEARING DESCRIPTION	TIME (Minutes)	BEARING DESCRIPTION	TIME* (Minutes)
PLAIN NECK BEARINGS		ANTI-FRICTION BEARINGS	
Blooming, billet, bar, rod, structural, rail mills	5-15	Hot continuous mills — neck bearings	15-30
		Tandem or reversing cold mills — neck bearings	30-60
PLAIN TABLE ROLL BEARINGS		Cold temper pass mills — neck bearings	60-120
Reversing tables	15-30	Mill tables	60-120
Approach and delivery tables	30-60	Run-out tables	120-240
Machine tool and presses	30-60	Hot strip coilers	20-40
		Hot bloom shears, plain or anti-friction — automatic oil	15-30
		Machine tool presses	30-60

Fig. 3.1 — Approximate time to complete one lube cycle.*

*See footnote on page DB1-1 for definition of lube cycle.

AN EXAMPLE

PLANNING A MANUAL LUBE SYSTEM

First bearing data was determined from a field survey, a bearing list was prepared, and from that information bearing make-up was calculated and measuring valves selected. The results were tabulated on page 1 of Form 52-625 as shown in Fig. 1.2 Ambient temperature range (60 to 80°F.), maximum machine temperature (100°F.), and the type of grease (NLGI#1) were included on Form 52-625B, see last page of this bulletin.

The longest distribution line was found to be 70'. This requires ⅜" pipe (fig. 2.3).

Pump-reservoir assemblies were selected as described on page DB3-1. Values D_t and D_m were calculated for one main line and its branches (see table). Grease compression in one main distribution line V_c is:

$V_c = .005 \times 2.29 \times 144 = 1.65$ cu. in.

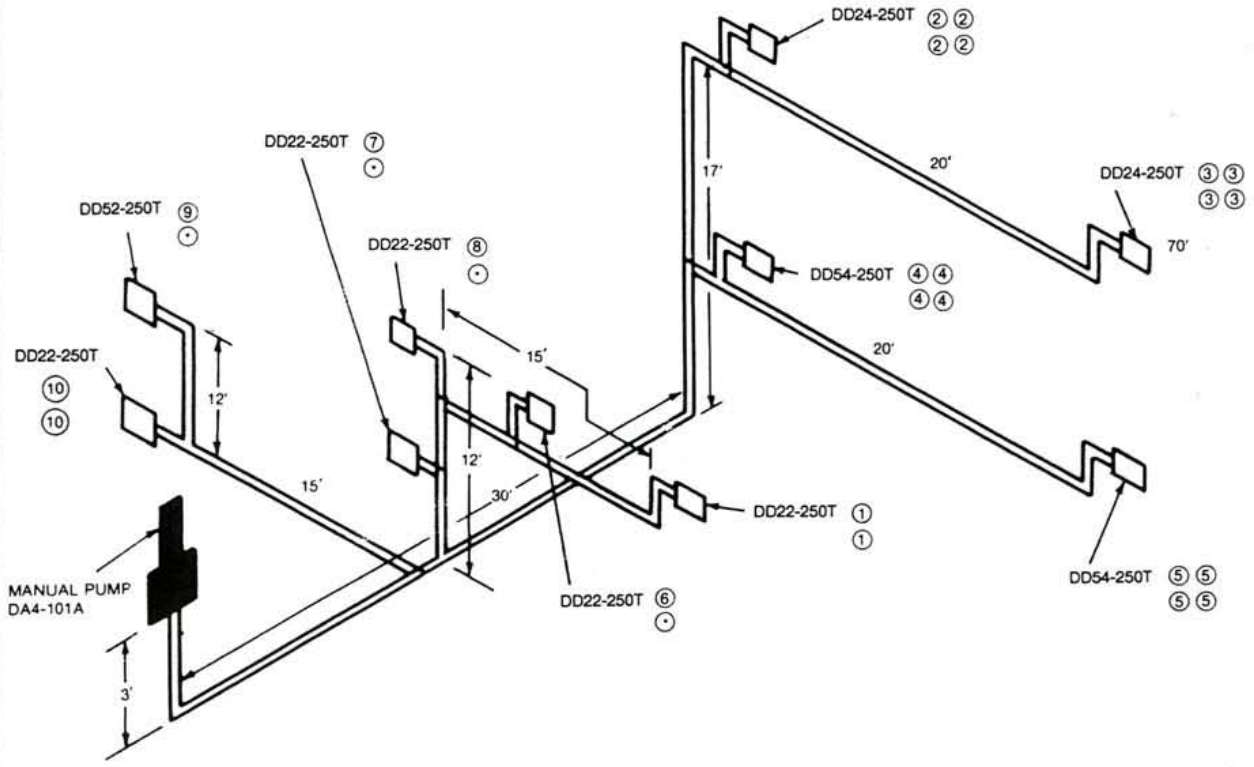
Measuring Valve No.	Dt		Dm	
	Per Valve	Total	Per Valve	Total
5 DD22	.048	.240	.036	.180
2 DD24	.048	.192	.036	.144
2 DD54	.331	1.324	.289	1.156
1 DD52	.331	.331	.289	.289
	TOTAL:	2.087		1.769

The bearings could be lubricated twice during an 8-hour period with a DA4-101A pump-reservoir assembly:

$$T_p = \frac{2.087 + 1.65}{.45} = 8.3 \text{ cycles of the pump handle}$$

$$T_r = \frac{4 \times 130}{2 \times 1.769} = 147 \text{ hours between reservoir refills}$$

During a typical lubricating period, the pump handle is cycled back and forth 8 to 9 times discharging .45 cu. in. of grease each time to one main line. Then the position of the slide valve handle is changed and the pump handle cycled again, forcing the same amount of grease into the other main line.



NOTES:
REFERENCE NUMBER IN CIRCLE CORRESPONDS WITH "REF. NO." IN FARVAL BEARING LIST. (Fig. 1.2)
*INDICATES "DD" VALVE TO BE CROSS PORTED DURING INSTALLATION BY USING A "DD" SINGLE DISCHARGE KIT.
ANY TWO BEARINGS SERVED BY A COMMON "DD" VALVE SECTION WILL RECEIVE THE SAME QUALITY OF LUBRICANT.

Fig. 4.1 — Schematic drawing of a manual dual line system.

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Bearing List

Sheet No. _____

Record No. _____

Job No. _____

Firm _____ Date _____

Machine or Equipment _____ Reference Dwg. _____

Builder _____ Lubricant Used ☐ Oil ☐ Grease

System Required _____ ☐ Hand Gun ☐ Dual Line ☐ Single Line ☐ Manual ☐ Automatic Total Points _____

REF. NO.	NAME OR LOCATION OF BEARING	NO. BRGS.	BEARING			TAP SIZE	NOTE 4		AMOUNT OF MOVEMENT OR FLEX. LENGTH	TOTAL NO. POINTS	BEARING MAKE-UP		VALVE SIZE	VALVE ADJ.	VALVE MANIFOLD
			SIZE (NOTE 1)	TYPE (NOTE 2)	SPEED (NOTE 3)		TAPS PER BRG.	F M R			FL. OZ.	CU. IN.			

NOTE 1—Advise diameter and length of cylindrical bearings; width and length of slides; inside diameter of anti-friction bearings.
NOTE 2—Advise whether plain (cylindrical rotating), or sliding bearing surface, or make of anti-friction bearing.
NOTE 3—Advise number of R.P.M. if rotating bearing, or indicate if oscillating and number of oscillations per minute. (Example 10 osc.)
NOTE 4—Indicate number of inlets to each bearing and condition of bearing tap as fixed (F), movable (M), requiring flex, or rotating (R) requiring swivel connection.
NOTE 5—See reverse side for additional data.

To facilitate planning installation and grouping valves into manifolds, this bearing list should be accompanied with assembly drawings or sketches on which the points to be lubricated are numbered to agree with the reference numbers of the bearing list above.

DB4-2

BY _____