

Designing A System For Mobile Equipment

DESCRIPTION

The following procedure can be used to design a series progressive lubrication system for mobile equipment (off-the-road trucks, loaders and shovels). Before an accurate system can be designed, a machine survey should be made to determine the location and size of bearings. A copy of the lube chart usually found in the machine's operator's manual will be helpful in locating and identifying lube points. After making the survey, the following procedure should be used:

DESIGN PROCEDURE

1. Group bearings to minimize flex lines and simplify line routing.
2. Calculate the bearing lubrication requirements.
3. Select manual or automatic operation. If automatic, determine available power.
 - Pneumatic/ •Hydraulic/ •DC Voltage/ •AC Voltage
4. Design divider valve network (See Bulletin No. 20101).
5. Select pump, reservoir and indicators.
6. Select divider valve mounting locations and use protective metal guards to prevent damage from moving articles.

Note: Generally, MSP divider valves are used on mobile applications; however, on large drilling or shovel equipment MXP divider valves are required.

OPERATION OF SYSTEM

Each time the pump is actuated, lubricant is delivered to the system. Refer to Figure 1. The master divider valve or first divider valve in the system divides the lubricant into the amounts required by the secondary divider valve assemblies which in turn serves any number of lubrication points. The pump develops only the pressure required to lubricate the bearing points.

Since the system works on a progressive piston displacement basis, every piston must complete its stroke before the next piston can cycle. If any one piston in the system fails to complete its cycle, pressure will build up and warn the operator of the system malfunction. When high pressure occurs, blockage can be traced by checking the indicators located on the master and secondary divider valve assemblies. A protruding pin indicates malfunction in the outgoing line common with the indicator position.

Power supply source can be air, hydraulic, electric or manual.

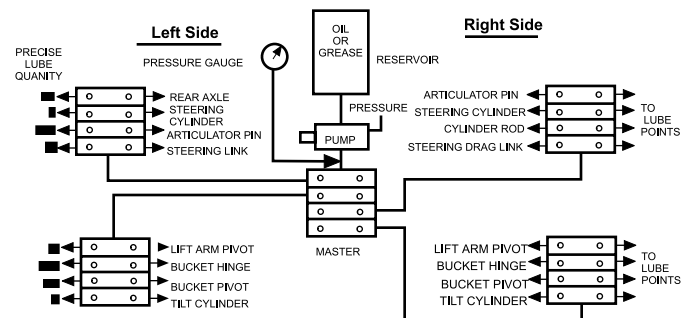


Figure 1. Typical Operational System

SYSTEM DESIGN

Film Replacement Calculations —

The quantity of lubricant required by the various lubrication points is determined by several factors. Construction equipment is designed to withstand high loads and severe operating conditions. The following factors must be considered when designing lubrication systems for mobile equipment:

1. Surface area of bearing.
2. Manufacturer's recommended lube interval.
3. Movement of wear surface.
4. Environment of lubrication points.

The total amount of lube required for a bearing point is determined through the formula:

$$V = A \times T \times I \times R \times E$$

Where:

- V = Lube Volume in cu. in./hr.
- A = Surface Area (sq. in.)
- T = Film Thickness (in. per hr.)
- R = Rotation Factor
- E = Environment of Lube Point

Surface Area —

Plain Bearings

- Area = πDL
- $\pi = 3.1416$
- D = Diameter (Inches)
- L = Length of Contact (Inches)

Anti-Friction Bearings

- A = D^2R
- D = Shaft Diameter
- R = No. of Rows

Film Thickness —

- t = Film thickness replacement in inches per hour
- t = .3 x clearance

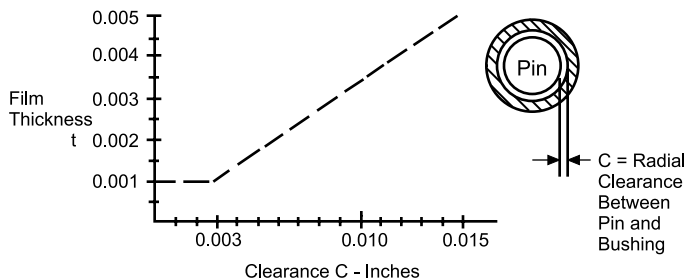


Figure II. Radial Clearance = C.

Note: When bearing clearances are not known, an average film thickness (t) of 0.003-inch can be used.

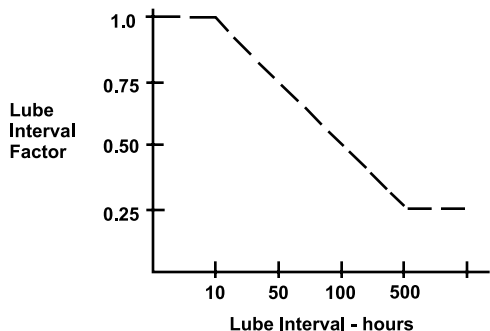


Figure III. Manufacturer's Recommended Lube Interval.

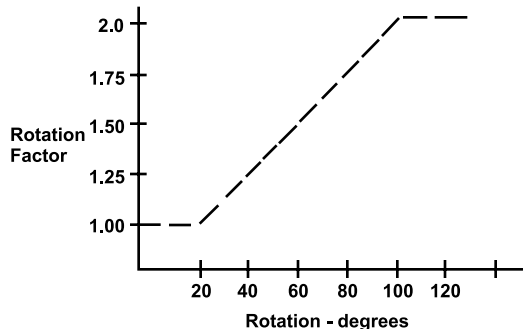


Figure IV. Rotation Factor (For Oscillating Bearings) Degrees.

Environment of Lube Point —

Lube Point Contamination, Protected & Poor Environment, Poor Environment Normal Loads or High Load and High Load

F	
A	
C	
T	1.0 ————— 2.0 ————— 3.0
O	
R	

Other Considerations —

- Location of lube inlet to bearing.
- Number of taps per bearing.
- Minimize flex lines by proper grouping.
- Use anchor blocks and swivels when necessary.
- Critical bearings can be lubricated directly from the master divider valve to increase frequency and amount to these points.

(Example: Bucket hinge pins on a front end loader).

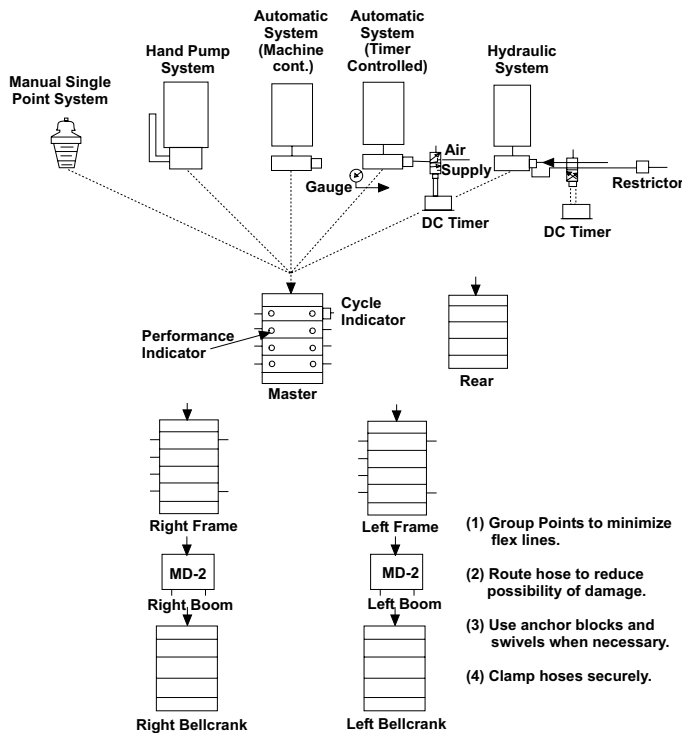
The pump and reservoir should be mounted in a convenient and protected area. Reservoir fill line should be accessible and a strainer mounted before the fill stud. If required, a pressure gauge can be mounted in the cab for system monitoring. A timer should be used whenever practical to accurately control lubricant usage. All lubricant lines must be adequately supported with clamps and anchored to the machine. Any line or component which is vulnerable to damage should be guarded.

To accommodate the various temperature conditions encountered with construction equipment, the following lubricant guide can be used:

Ambient Temperature	Lubricant NLGI No.
- 30°F(- 34°C) to + 30°F(-1°C)	00
+30°F (-1°C) and above	0 or 1

Either 1/4 or 3/16 I.D. pressure hose (SAE 100 R1 rating or equivalent) is used as lube lines.

Figure V. Typical Mobile System Design Guide.



- (1) Group Points to minimize flex lines.
- (2) Route hose to reduce possibility of damage.
- (3) Use anchor blocks and swivels when necessary.
- (4) Clamp hoses securely.

Figure VI. Major system components used on a mobile installation.



A. MSP Divider valve, used to proportion and distribute lubricant.



B. Modu-Flo Pump Package, complete with reservoir pump manifold and pump.

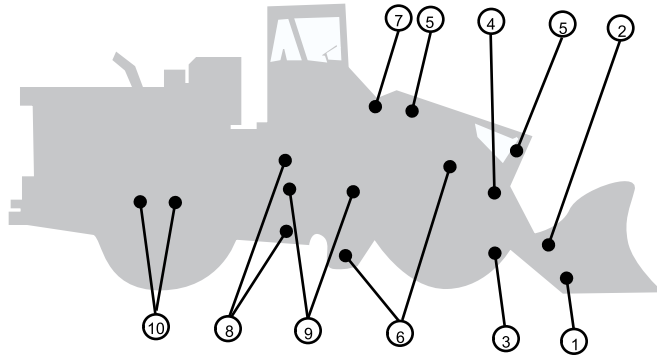


C. WMP III 24 VDC Maxi-Monitor used to initiate lube cycles and monitor lube system.

MOBILE EQUIPMENT ORDERING INFORMATION		
Description	Part No.	Old Part No.
Reservoirs (Modu-Flo)		
12 lb Plastic, Grease	562884	185-100-000
20 lb Plastic, Grease	562885	185-100-010
12 lb Metal, Grease	562886	185-100-020
20 lb Metal, Grease	562887	185-100-030
40 lb Plastic, Grease	564267	185-100-970
Pump-Reservoir Manifolds		
W/Gauge, Fill Check, Outlet Check & Blowout Assembly	563324	521-001-180
W/Gauge, Fill Check, Outlet Check & Tubed Blowout Assembly	563331	521-001-790
Pumps (Modu-Flo)		
AL-25 Air Actuated Pump	563306	521-000-021
HL-25 Hydraulic Actuated Pump	563307	521-000-031
HL-5X High Pressure Hydraulic Actuated Pump	563345	521-005-900
Additional Pumps		
Electric	Bulletin 12011, 12250, 12255	
Drum	Bulletin 12216	
Manual	Bulletin 12415	
Timers and Controllers		
12-32 VDC Timer (Bulletin 14511)	557925	550-200-040
24 VDC Controller (Bulletin 14750)	556025	163-310-020
Strainers		
100 Mesh Res. Fill Port, Grease	563102	473-020-468
325 Mesh Res. Fill Port, Oil	563103	473-020-469
100 Mesh Lube Line, Grease	563507	527-100-380
325 Mesh Lube Line, Oil	563508	527-100-390
Pump Inlet Restrictor		
Air and Hydraulic	563072	463-410-080
MSP Divider Valves		
Per Lube System Print	Bulletin 10102	
Other Accessories		
Performance Indicators	Bulletin 15401	
Mounting Anchor Blocks	Bulletin 15121	
Tube and Pipe Fittings	Bulletin 15101	
Divider Valve Mtg Bars, Brackets, Plates	Bulletin 15126	

SAMPLE DESIGN PROBLEM

Note: The following example is a guide to be used in the design of a system for a front end loader.



Pt	Description	No. Pts.	Da.	Length	II DL	Lube Interval (In ³)
1	Bucket Hinge Pin	2	3	4	38	10
2	Pushrod to Bucket	2	3	4	38	10
3	Crank to Pushrod	2	3	4	38	10
4	Crank Pivot	2	3-1/2	3	33	10
5	Tilt Cylinder	2	3	2	19	10
6	Lift Cylinder	2	3	2	19	10
7	Boom Pivot	2	5	4	63	10
8	Articulating Pin	2	4	4	50	10
9	Steering Cylinder	4	3	4	38	10
10	Axle Cradle	2	3	3	28	50

USE t 0.003 AND DESIGN VALVE NETWORK

Pt.	0.003 DL	Lube Interval Factor	Rotation Factor	Environ. Factor	Vo. Req'd. Per Hour (In ³)
1	0.114	1	2	3	0.684
2	0.114	1	1	2	0.228
3	0.114	1	1	1	0.114
4	0.100	1	1	1	0.100
5	0.057	1	1	1	0.057
6	0.057	1	1	1	0.057
7	0.189	1	1.25	1	0.235
8	0.150	1	1.25	1	0.187
9	0.114	1	1	1	0.114
10	0.084	0.5	1	1	0.042

Figure VII. Example Problem

Note: Group the Bearings as Shown Below (Refer to Figure VII.)

PL	Vol/Hr.	Basic Ratio	x 10	Secondary Divider	Total Vol. Req'd to Group	Basic Ratio	x 20	Master Divider Design
1	0.684	From Master			0.684	1.23	25	
2	0.228	4	40	A	0.556	1	20	1 25T A B C D
3	0.004	2	20	20S				
4	0.100	2	20	20T				
5	0.057	1	10	10T				
6	0.057	1	10	MSP-3				
7	0.235	2	20	B	0.650	1.17	25	MSP-3
8	0.187	1.6	16	7-10S				
9	0.114	1	10	8-10S				
9	0.114	1	10	9-10T				
1	0.684	From Master			0.684	1.23	25	
2	0.228	4	40	C	0.556	1	20	
3	0.114	2	20	20S				
4	0.100	2	20	20T				
5	0.057	1	10	10T				
6	0.057	1	10	MSP-3				
7	0.235	6	60	D	0.734	1.3	25	
8	0.187	4	40	30S				
9	0.114	3	30	20S				
9	0.114	3	30	30T				
9	0.114	3	30	10S				
10	0.042	1	10	MSP-4				
10	0.042	1	10	Flex line				

3,864 in³/hr to system

ALS-25 Set at Maximum .120 in³/cycle
3,864 = 32 Pump Cycles Per Hour
0,120

Set DC Timer @ 30 Cycles Per hour

Note: The following form indicates the information required to complete application data for mobile equipment.

Customer _____ Address _____
 Individual Contacted _____ Phone _____
 Vehicle Model No. & Mfg. _____ No. Vehicles Owned _____
 S/N _____ Hr. Meter Reading _____
 No. Lube Points _____
 Mfg. Lube Chart Available _____

Pump Power Available
 Air (PSI) Min. _____ Max. _____ Intermittent (Cycles) _____
 Hydraulic (PSI) Min. _____ Max. _____ Intermittent (Cycles) _____
 Electrical DC Volts _____
 Manual _____
 Other _____

Operating Ambient Temp: Min. _____ Max. _____
 Lubricant Grease (Type) _____ Oil (Type) _____

Lube Points:

Item	Description	No. Points	Lube Interval	Brg. Size

Performance Indicators Required _____
 Monitoring _____
 Filters Req'd _____
 Flow Control Required _____

Pump and Reservoir to be Mounted _____
 Guard Required _____
 Guarding Required for Lube Line to Points _____
 Guarding Required for Lube Fittings at Points _____
 Hose Power Source to Pump _____
 (Type) Pump to Master _____
 Master to Secondary _____
 Secondary to Lube Point _____
 Special Pts. (Describe) _____
 Installation Time Estimate _____

Use Reverse Side for System Layout, Complete Parts List, Quotation Worksheet

Figure VIII. Typical Mobile Application Data Sheet.

All written and visual data contained in this document are based on the latest product information available at the time of publication. Graco reserves the right to make changes at any time without notice.

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