

CHAPTER VI
MAINTENANCE

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A. PURPOSE

1. General

Every wastewater treatment plant must be recognized as a highly specialized and complex facility producing an acceptable effluent. It is the plant managements' responsibility to produce this effluent at the lowest unit cost and at the highest possible quality. A key to fulfilling this responsibility is a sound maintenance-management program.

Maintenance programs fall generally under one or two major categories:

- i. Preventive Maintenance and
- ii. Corrective Maintenance

Preventive maintenance is the maintenance performed on a routine basis or as sensed by observing, listening, feeling or smelling at or near the equipment. This type maintenance is performed to circumvent equipment failure or malfunction.

Corrective maintenance is the maintenance performed whenever there is an equipment failure or malfunction. Corrective maintenance often is of an emergency nature requiring immediate performance; hence, it is usually more costly than preventive maintenance and often times requires workmen of special skills and perhaps special tools.

Detecting a potential source of trouble before it happens or a failure soon after it occurs can often prevent damage to other parts of the equipment and also may lessen the danger of plant unbalance. Therefore a preventive maintenance program is of the utmost importance for the workmen at the wastewater treatment plant.

2. Scope

All moving parts of any type machinery must be kept clean, well lubricated and properly adjusted. If equipment is not maintained properly, wear will increase, efficiency will decrease and eventually the equipment will fail. A well planned and implemented preventive maintenance program will be effective in assuring maximum efficiency and long life from each item of equipment installed in the plant.

The equipment selected for use in this wastewater treatment plant was considered on the basis of initial cost and for its ability to provide long life and service under the working conditions to which it would be subjected. Most equipment is of the "heavy duty" type and with proper care should provide many years of service without requiring any

corrective maintenance. The life of any piece of machinery is dependent upon the care the machine receives. Properly maintained, the major equipment items of this wastewater treatment facility should provide approximately ten years of service.

A maintenance management system recommendation for this wastewater treatment plant is made later in this chapter of the Operation and Maintenance Manual. The system selected was chosen from a varied assortment of methods available, each of which might provide certain advantages. The system described herein is (if put into operation) an effective, easily understood means to provide all the maintenance requirements of this plant. Minor modifications to the system may be desired depending upon availability of materials suggested for use.

B. PREVENTIVE MAINTENANCE

As previously mentioned, the preventive maintenance program is perhaps the most important of all maintenance procedures. Manufacturers' catalogs and literature furnished with the equipment generally furnish the preventive maintenance requirements of the equipment. This type maintenance generally consists of lubrication, cleaning, adjusting, replacement of worn parts, winterizing, housekeeping and work directed by this manual, equipment service requirements, and sensual (including visual, audio, feel and smell) observations which can be accomplished with the tools provided at the plant and by workmen having an average understanding of the workings of the machinery and total plant operation.

Preventive maintenance will not require specially skilled or factory trained workmen nor sophisticated tools and machinery. Each workman responsible for this type maintenance will be required to be familiar with the purpose, scope, advantages, safety precautions, economics, and necessity of the performance of the work.

C. CORRECTIVE MAINTENANCE

Some items of equipment located in the plant may have corrective maintenance performed by the operator or unskilled workmen at the plant site. Some items of equipment may require corrective maintenance performed by highly skilled or factory trained personnel at the plant site. Additionally there are some items of equipment which cannot be repaired at the plant site and will require corrective maintenance performed at the manufacturing plant or a plant equipped for this type repair work.

Whenever an item of equipment requires repair the operator should, except for minor items, always acquire additional assistance from such persons as:

- i. Supervisor
- ii. Engineer
- iii. Manufacturer
- iv. Skilled Repairmen

This assistance is to determine the cause and result of the failure or malfunction. The operator must then evaluate the knowledge of his workmen, the instructions provided with the equipment, the tools at hand, and the availability of repair parts in order to ascertain whether the corrective maintenance should be undertaken by employees of the plant owner or whether the repair should be made by contract maintenance.

D. CONTRACT MAINTENANCE

Contract maintenance is that portion of corrective maintenance which cannot be done by plant employees (either regular, part time or temporary). This type maintenance is that which is conducted in its entirety by the hiring of workmen skilled and regularly engaged in the type work involved whether it be a factory which builds the equipment, a service agency of the factory, which installs, services and repairs equipment manufactured by the factory, or whether it be a privately owned independent firm skilled in the nature of work required.

E. SCHEDULING

1. Maintenance Guidelines

The wastewater treatment facilities do not observe holidays, vacations or weekend shutdowns. The facilities do experience variations in flows and maintenance work loads. Under these conditions, it is imperative that maintenance be planned and scheduled so that there is no idle time or peak work load period.

Preventive maintenance must be performed on a periodic basis. For plant equipment, the manufacturers maintenance manuals must be consulted and a schedule of maintenance required listed. For plant facilities other than equipment, inspections of items and/or plant history will provide information for putting together a schedule.

Corrective maintenance must be scheduled immediately upon occurrence. A history of corrective maintenance problems will greatly contribute to scheduling future work of similar nature.

Indoor and outdoor maintenance should be scheduled to take advantage of open or inclement weather, low load or flow periods and other variable conditions beyond the control of the operating staff.

All maintenance work should be scheduled just as the operating routine has to be scheduled. Preventive maintenance should not be a haphazard procedure to be done if time permits..

Some type of maintenance must be scheduled for the once a year opportunity when the plant load normally is at its lowest. This may be the time to drain, check, repair, and paint the aeration tanks, settling tanks, chlorine contact tank and certain underwater items of equipment.

There are seasonal items to be scheduled such as:

- i. Lawn and landscaping work
- ii. Snow removal
- iii. Exterior painting

There are items which may occur annually or others with as much as 4 or 5 year intervals. The items include:

- i. Painting
- ii. Roofing
- iii. Paving and road repairs
- iv. Fencing
- v. Insulating
- vi. Electrical system upgrading
- vii. Plumbing revisions

The manufacturer's maintenance manual is generally the best guide for preventive maintenance instructions for any item of equipment. Most equipment is mass produced on a competitive basis and the cost of its maintenance should be consistent with its value, life expectancy and replacement costs. Equipment should be rated as to its critical position in the plant operating system and its maintenance priority. Unnecessary or too frequent preventive maintenance can be as wasteful as improper maintenance procedures.

2. Schedule Chart

A schedule chart with priorities of subjects, personnel and time is a convenient aid to reduce impulse searches for work, for idle personnel. The schedule chart may be divided into daily, weekly, monthly, quarterly, semiannually, and yearly sections so that the entire range of maintenance functions can be observed. Color tabs and labels can be coded to account for all personnel and their duties at a specific point in time. The removal of the tag from the schedule chart indicates the work is underway or has been completed. The chart provides a graphic indication of progress and manpower usage. The chart also provides a graphic indication of tasks that are running behind. Charts are available from most office supply companies. The size, method of use, and detail of the schedule chart depends upon the facility management.

A schedule chart becomes more advantageous as the size of the wastewater treatment facility increases. This facility is of a size where a schedule chart may not be desired. Even though it is a useful tool, this plant does not have sufficient operating personnel nor quantity of maintenance tasks to warrant the keeping of such a chart.

3. Work Order System

A work order system should be established to initiate all corrective maintenance tasks. The work order system will aid in identifying work to be accomplished, procedure priority, and information on any special

aspects of the job. A log of the work orders will provide a record of when the work order was initiated and completed. The work order forms should be numbered to provide a means of maintaining accountability.

a. Work Order Form

A sample work order form is shown on the following page. The operator is requested to complete a work order format which is convenient explicit and cost effective.

b. Work Order Log

Each form is to be numbered consecutively and dated at the time the work order is initiated. A brief description of the work to be performed is to be listed. An anticipated list of materials to be purchased must also be tallied. Whenever the work is done a listing of personnel, title and hours are to be ledgered. The date the work is done should be noted. The person making out the work order form should sign whenever the form is initiated. The date of completion is to be entered any unusual or exceptional conditions noted under comments.

F. INVENTORY

A central storeroom for spare parts, equipment and supplies should be maintained. The room designated control room on the construction drawings may be used for this purpose. The storeroom should be kept neat and orderly at all times to facilitate finding inventory items.

1. Spare Parts/Components Inventory

it is recommended that adequate quantities of spare parts and equipment components be kept on hand to permit maintenance schedules to be met. Too many parts is many times as bad as too few parts.

2. Inventory Quantities

Following is a list of inventory item quantities recommended for this wastewater treatment facility:

<u>Description</u>	<u>Maximum</u>	<u>Minimum</u>
Pump Bearings	2 Sets (each size)	1 Set (each size)
Pump Packing	6 Sets (each size)	1 Set (each size)
Pump Shaft Sleeves	2 Sets (each size)	1 Set (each size)
Pump Flexible Couplings	2 Sets (each size)	1 Set (each size)
Pressure Gauges	3 (each range)	1 (each range)
Adjustable Sheaves	2 Sets (each size)	1 Set (each size)
Drive Belts	2 Sets (each size)	1 Set (each size)
Electrical Fuses	10 (each size)	1 (each size)

WORK ORDER

WORK ORDER NO. _____ DATE: _____

WORK TO BE PERFORMED:

MATERIALS TO BE PURCHASED:

WORK PERFORMED BY:

- | | | |
|----|-------|-------------|
| 1. | _____ | _____ HOURS |
| 2. | _____ | _____ HOURS |
| 3. | _____ | _____ HOURS |
| 4. | _____ | _____ HOURS |

WORK COMPLETED:

SIGNED: _____

DATE: _____

COMMENTS:

SAMPLE WORK ORDER

Items not specifically used for processing mine water have been purposely omitted from the list. Some of these items include: Paper, pencils, file folders, forms, laboratory chemicals, oils, greases, fuses, light bulbs, cleansers, etc.

3. Record System

A record system to facilitate storeroom inventory items is recommended for use at this plant. The record system must not be complex; yet, it must be inclusive sufficiently to enable personnel to readily determine the storeroom stock with a minimum of paperwork and time.

A separate file folder should be maintained by the plant operator titled "Inventory Items."

Each item of inventory should be assigned a number and a description of the item which shall be placed on a card entitled "INVENTORY ITEM". The cards shall be placed in the file folder in Chronological order numerically with a subsequent placing alphabetically according to description of the item.

G. HOUSEKEEPING

Housekeeping of buildings, tanks, equipment and grounds must be performed to produce a neat appearance in order to promote public support for the facility and have sanitary and safe working conditions for employees.

1. Yard Work

Housekeeping of yard work is further broken down into winter work and summer work.

a. Winter

Work to be performed in the winter cannot be placed on a regular schedule basis. Weather conditions will dictate the quantity of work, the work timetable and the type of work required. It will be necessary to keep the driveways, walkways and service areas free of snow and ice not only for employee access but also for delivery of necessary supplies and removal of waste materials. Walkways must be cleared for plant safety and icy conditions must be kept at a minimum. Care must be exercised in the spreading of chemicals and materials to correct icing conditions. Ashes used for walks could become a problem of removal in the spring if too heavily applied. Chemicals, in addition to wasting money, if applied too heavily, may cause damage to plantings and walkway surfaces. It is extremely important that the plant structures be considered whenever materials are purchased and used.

Cleanliness of the site must be maintained throughout the winter months. During the short times of thaw and workable exterior weather, the operator should assure that any debris or materials that have accumulated are removed. This would be a good time to hose the tanks above the water level to remove scum and foreign materials clinging to the tank walls. Also the walkways ought, to be hosed down. Scum accumulations which are left go during severe weather should be taken care of during these times.

b. Summer

Summer work can normally be scheduled with reasonable assurance that the schedule can be kept. Heavy rain and strong winds are generally the only deterrent to summer yard work. The following schedule of exterior summer housekeeping activities is recommended:

- | | | |
|------|-----------------|-----------|
| i. | Hosing Tanks | Bi-weekly |
| ii. | Hosing Walkways | Bi-weekly |
| iii. | Mowing Grass | Bi-weekly |
| iv. | Debris Cleanup | Monthly |

2. Painting

Touch up painting must be scheduled as the need arises. Whenever equipment undergoes corrective maintenance touch-up painting will be required to restore the equipment to its original condition. Weathering and normal wear will also deteriorate painting such that touching up will be required. It is recommended that five (5) days be scheduled each summer for touch-up painting work. This will be in addition to major painting work which will be required periodically.

Painting of buildings, equipment, tanks, etc should be performed on a regular basis. It is recommended that the building piping, equipment tanks, etc. be completely repainted each five (5) years. This work may be done under supervision by the plant operator. Major painting labor operations are definitely not to be considered a part of the work requirements of the treatment plant operator.

3. General Cleaning

Good housekeeping techniques include general cleaning of the building and interior facilities. The interior work is not affected by weather conditions and may be planned, scheduled and performed on a regular routine schedule filled into the total plant maintenance program. The following cleaning schedule is recommended:

- | | | | |
|-----|--------|-------------|---------|
| i. | Floors | (sweeping) | Weekly |
| ii. | Floors | (scrubbing) | Monthly |

<u>iii.</u>	Walls	(washing)	Annually
<u>iv.</u>	Furniture	(dusting)	Weekly
<u>v.</u>	Furniture	(washing)	Bi-weekly
<u>vi.</u>	Equipment	(dusting)	Monthly
<u>vii.</u>	Equipment	(washing)	Semi-annually
<u>viii.</u>	Piping	(dusting)	Monthly
<u>ix.</u>	Piping	(washing)	Semi-annually
<u>x.</u>	Toilet	(washing)	Weekly
<u>xi.</u>	Workbench	(Washing)	Monthly

4. Other Housekeeping Tasks

Other housekeeping tasks in addition to those listed above must be scheduled to assure the health, safety and welfare of all plant employees and visitors. The operator should publish a list of housekeeping duties, assign specific personnel to attend to these duties and assure that they are done. In most cases the operator will himself perform these tasks. A record kept of this work will be appreciated by the plant owner, state health inspectors and other interested citizens.

H. LUBRICATION

Each equipment manufacturer's manual of operation and maintenance contains information regarding lubrication of the equipment. Excessive lubrication is just as dangerous as not enough lubrication in many cases. Caution must be exercised in not over greasing motors and overfilling oil wells.

Those individuals responsible for preventive maintenance are also responsible for lubrication. The same lubricator must perform the service each time, if possible, in order to narrow the range or responsibility for lubrication activities.

1. Lubrication Specifications

The plant operator is responsible for lubrication. His duties include the following:

- i. Conduct lubrication studies.
- ii. Prepare lubrication specifications.
- iii. Establish schedules.
- iv. Train lubricators.
- v. Standardize application methods.
- vi. Maintain consumption and inventory records.
- vii. Establish proper handling and storage.
- viii. Investigate new lubricants; evaluate and revise specifications as necessary.
- ix. Standardize lubricants whenever possible to eliminate stocks of identical material under various trade names.

The most important step in establishing a lubrication system involves the gathering of basic lubrication data. Lubrication specifications can be developed from manufacturers' lubrication recommendations, ASLE and ASTM Standards. Lubrication routes should be established and every item of equipment given a route number. Lubrication points, types and frequencies should be defined for each item of equipment. All data pertinent to lubrication of selected equipment should be assembled into a lubrication guidebook.

2. Lubrication Chart

Each manufacturer of equipment will specify some one or more trade name lubricants by the producers number or by an SAE number (Society of Automotive Engineers) or some other designation. This, if used, would result in numerous trade named lubricants being designated for the treatment facility equipment.

On the next few pages of this manual is an interchangeable lubrication chart which indicates in tabular form several companies and their lubricant name. The use of this designation in buying lubricants will very likely reduce the variety and inventory of products required at the treatment works.

3. Color Coded Lubrication Features

For convenience and simplification of the lubrication process, a color coded tag or decal label can be used to identify the part, frequency and type of lubricant required for moving part in question. A suggested color code for various categories is:

<u>Color & Type</u>	<u>Frequency</u>
Blue - Gear Lube	Daily
White - Spindle Oil	Weekly
Green - Way Oil	Monthly
Red - Hydraulic Oil	Semi-Annually
Brown - Grease	Annually

The tag should also indicate the appropriate lubricant.

Equipment can be color coded with decals or fittings and/or fill caps painted to indicate point of service, frequency of application, and type lubricant. Specifying the highest grade lubricant required for more than one application and specifying a single mid-range viscosity oil to replace several within a certain viscosity range are two methods for consolidation of lubricants.

4. Lubrication Records

The lubrication frequency is determined by many factors but a lubrication schedule must be established and followed to insure proper operation of the facility. The equipment card for each piece of equipment requiring lubrication must list the lubricant to be used and frequency advisable for efficient operation. Lubricant consumption requirements ought to be noted on the equipment card.

5. Lubrication Route

The plant size and quantity of equipment at the plant will determine the man-hours required for the lubrication routine. A fixed hour or day should be established for the routine when possible and a record filed on completion of the routine. A master card may be used to facilitate routing and recording operations.

INTERCHANGEABLE LUBRICATION CHART

DuBois
Chemicals

Exxon Co, U.S.A.

Atlantic-Richfield Co.

Lubricant Type & Viscosity, SSU @ 100 F

Light Inhibited Hydraulic & Gen. Purpose	135-165	Duro S-150	Teresstic 43;Nuto 43	OS-664
Med. Inhibited Hydraulic & Gen. Purpose	194-236	Duro S-215	Teresstic 47;Nuto 48	MPO-15
Med.-Heavy Inhibited Hyd.&Gen. Purpose	284-346	Duro S-315	Teresstic 52;Nuto 53	MPO-30
Heavy Inhibited Hydraulic & Gen Purpose	630-770	Duro 600 or S-700	Nuto 76	EGO-80.90
High-Pressure (Anti-Wear)Hydraulic Oil	135-165	Duro AW S-150	Nuto H 44	OS-664
High-Pressure (Anti-Wear)Hydraulic Oil	194-236	Duro AW S-215	Nuto H 48	MPO-15
High-Pressure (Anti-Wear)Hydraulic Oil	284-346	Duro AW S-315	Nuto H 54	MPO-30
Fire-Resistant Hyd. Fluid/Synthetic			IMOL S 220	
Fire-Resistant Hyd. Fluid/Water-Glycol				
Fire-Res. Hyd. Fluid/Water-Oil Emulsion				
Very Light Spindle Oil (Over 6000 rpm)	29-35	Duro FR-HD	3110 FR Hydraulic Fluid	
Light Spindle Oil (3600-6000 rpm)	54-66	Diamond S-32		OS-664
Spindle Oil (Up to 3600 rpm)	95-115	Diamond 55	Spinesstic 34	OS-664
Light Way Oil	135-165	Diamond S-105	Spinesstic 38	OS-664
Medium Way Oil	248-346	Truslide S-150	Febis K 53	MPO-15
Heavy Way Oil	999-1100	Truslide S-315	Febis K 73	MPO-30
Light Gear Oil	630-770	Truslide S-1000	Nuto 76	EGO-80.90
Medium Gear Oil	900-1100	Rubilene S-700	Nuto 93	EGO-80.90
Heavy Gear Oil	1935-2365	Arco Gear Oil 90	Cylesstic TK 140	EGO-90.140
Light Extreme-Pressure Gear Oil	283-347	Arco Gear Oil 140	Spartan EP 68	MPO-30
Heavy Extreme-Pressure Gear Oil	1350-1650	Pennant NL S-315	Spartan EP 460	EGO-90.140
Cling-Type Gear Shield (Open Gears)	900-1100	Pennant NL S-1000	Surett N 1550	OGG-H
Gen. Purpose E. P. Lithium-Base Grease	NLGI 2	Onyx 8 Grease	Lidok EP 2	MPG-2
Molybdenum Disulfide E.P. Grease		Litholine EP 2 or HEP 2	Beacon Q 2	
		Arco EP Moly D Grease		

INTERCHANGEABLE LUBRICATION CHART

(Continued)

Lubricant Type & Viscosity, SSU @ 100 F

Kendall Refining Co.

Pennzoil Co.

Light Inhibited Hydraulic & Gen. Purpose	135-165	Kenoil R&O 043 EP	Pzl Hyd. & Gen. Purp. Oil #1
Med. Inhibited Hydraulic & Gen. Purpose	194-236	Kenoil R&O 047 EP	Pzl Hyd. & Gen. Purp. Oil #2
Med.-Heavy Inhibited Hyd.&Gen. Purpose	284-346	Kenoil R&O 053 EP	Pzl Hyd. & Gen. Purp. Oil #3
Heavy Inhibited Hydraulic & Gen Purpose	630-770	Kenoil R&O 072 EP	Pzl Hyd. & Gen. Purp. Oil #5
High-Pressure (Anti-Wear)Hydraulic Oil	135-165	Kenoil R&O 043 EP	Pzl Hyd. & Gen. Purp. Oil #1
High-Pressure (Anti-Wear)Hydraulic Oil	194-236	Kenoil R&O 047 EP	Pzl Hyd. & Gen. Purp. Oil #2
High-Pressure (Anti-Wear)Hydraulic Oil	284-346	Kenoil R&O 053 EP	Pzl Hyd. & Gen. Purp. Oil #3
Fire-Resistant Hyd. Fluid/Synthetic			
Fire-Resistant Hyd. Fluid/Water-Glycol			
Fire-Res. Hyd. Fluid/Water-Oil Emulsion			
Very Light Spindle Oil (Over 6000 rpm)	29-35		Maxmul Hyd. Fluid FR
Light Spindle Oil (3600-6000 rpm)	54-66		
Spindle Oil (Up to 3600 rpm)	95-115		Pzl Hyd. Gen. Purp. Oil #0
Light Way Oil	135-165	Kenoil 040	Pzl Hyd. & Gen. Purp. Oil #1-C10
Medium Way Oil	248-346	Kenoil 945	Pzl Hyd. & Gen. Purp. Oil #3-C10
Heavy Way Oil	999-1100	Kenoil 965	Pzl Hyd. & Gen. Purp. Oil #6-C10
Light Gear Oil	630-770	Kenoil R&O 085 EP	Pzl Hyd. & Gen. Purp. Oil #5
Medium Gear Oil	900-1100	All Oil Gear Lubricant SAE 85W-90	Pzl Hyd. & Gen. Purp. Oil #7
Heavy Gear Oil	1935-2365	Kenoil R&O 085 EP	Pzl Hyd. & Gen. Purp. Oil #9
Light Extreme-Pressure Gear Oil	283-347	All Oil Gear Lubricant SAE 140	Maxol EP #1 or MP 4080
Heavy Extreme-Pressure Gear Oil	1350-1650	Kenoil NS-MP SAE 80 W	Maxol EP #3 or MP 4090
Cling-Type Gear Shield (Open Gears)	900-1100	Kendall NS-MP SAE	
Gen. Purpose E. P. Lithium-Base Grease	NLGI 2	Kendall SR-12X	
Molybdenum Disulfide E.P. Grease		Kenlube L-426	
		Kenlube L-424	

TTM Lub, MP 705, EP 712
Moly-Sulfide #704

INTERCHANGEABLE LUBRICATION CHART

(Continued)

Lubricant Type & Viscosity, SSU @ 100 F	Ashland Oil & Ref. Co. National Refining Co. Valvoline Oil Co.	Gulf Oil Corp.	Shell Oil Co.
Light Inhibited Hydraulic & Gen. Purpose	ETC (R&O) No. 15	Gulf Harmony 44	Turbo 25
Med. Inhibited Hydraulic & Gen. Purpose	ETC (R&O) No. 20	Gulf Harmony 47	Turbo 29
Med.-Heavy Inhibited Hyd.&Gen. Purpose	ETC (R&O) No. 30	Gulf Harmony 53	Turbo 33
Heavy Inhibited Hydraulic & Gen Purpose	ETC (R&O) No. 70	Gulf Harmony 69	Turbo 69
High-Pressure (Anti-Wear)Hydraulic Oil	Anti-Wear Oil No. 15	Gulf Harmony 43 AW	Tellus 25
High-Pressure (Anti-Wear)Hydraulic Oil	Anti-Wear Oil No. 20	Gulf Harmony 48 AW	Tellus 29
High-Pressure (Anti-Wear)Hydraulic Oil	Anti-Wear Oil No. 30	Gulf Harmony 54 AW	Tellus 33
Fire-Resistant Hyd. Fluid/Synthetic		Gulf FR Fluid P-Series ³	
Fire-Resistant Hyd. Fluid/Water-Glycol		Gulf FR Fluid G-200	
Fire-Res. Hyd. Fluid/Water-Oil Emulsion		Gulf FR Fluid	Irus 905
Very Light Spindle Oil (Over 6000 rpm)	29-35		
Light Spindle Oil (3600-6000 rpm)	54-66	Gulfspin 35	Tellus 15
Spindle Oil (Up to 3600 rpm)	95-115	Gulfspin 41	Tellus 21
Light Way Oil	135-165	Gulf Harmony 43 AW1	Tonna 25
Medium Way Oil	248-346	Gulfway 52	Tonna 33
Heavy Way Oil	999-1100	Gulfway 75	Tonna 71
Light Gear Oil	630-770	Gulf Harmony 76	Turbo 69
Medium Gear Oil	900-1100	Gulf Harmony 88	Tellus 71
Heavy Gear Oil	1935-2365	Senate 145 D & Harmony 121	Tellus 77
Light Extreme-Pressure Gear Oil	283-347	E.P.Lubricant 55	Omala 33
Heavy Extreme-Pressure Gear Oil	1350-1650	E.P.Lubricant SL20	Omala 75
Cling-Type Gear Shield (Open Gears)	900-1100	Gulf Fluid Lubcote No.3	Omala 962
Gen. Purpose E. P. Lithium-Base Grease	NLGI 2	Gulfcrown Grease E.P.No.2	Alvania EP
Molybdenum Disulfide E.P. Grease		Gulflex Moly	Lithall MDS ²

INTERCHANGEABLE LUBRICATION CHART (Continued)

Lubricant Type & Viscosity, SSU @ 100 F	Mobile Oil Co.	Phillips Petroleum Co.	Standard Oil Co. (Ohio)
Light Inhibited Hydraulic & Gen. Purpose	DTE Light	Magnus Oil 150	Industron 44
Med. Inhibited Hydraulic & Gen. Purpose	DTE Medium	Magnus Oil 215	Industron 48
Med.-Heavy Inhibited Hyd.&Gen. Purpose	DTE Hvy. Med.	Magnus Oil 315	Industron 53
Heavy Inhibited Hydraulic & Gen Purpose	DTE Oil Ex. Heavy	Magnus Oil 700	Industron 80
High-Pressure (Anti-Wear)Hydraulic Oil	DTE 24	Magnus A Oil 150	Industron 44
High-Pressure (Anti-Wear)Hydraulic Oil	DTE 25	Magnus A Oil 215	Industron 48
High-Pressure (Anti-Wear)Hydraulic Oil	DTE 26	Magnus A Oil 315	Industron 53
Fire-Resistant Hyd. Fluid/Synthetic	Pyrogard 53		
Fire-Resistant Hyd. Fluid/Water-Glycol	Nyvac FR-200		
Fire-Res. Hyd. Fluid/Water-Oil Emulsion	Pyrogard D		
Very Light Spindle Oil (Over 6000 rpm)	Velocity Oil No. 3		Staysol FR
Light Spindle Oil (3600-6000 rpm)	Velocity Oil No. 6		Industron 32
Spindle Oil (Up to 3600 rpm)	Velocite Oil No. 10	Magnus Oil 105	Industron 34
Light Way Oil	Vactra Oil No. 1		Industron 40
Medium Way Oil	Vactra Oil No. 2		Factoway 43
Heavy Way Oil	Vactra Oil No. 4		Factoway 50
Light Gear Oil	DTE Ex. Hvy.	Magnus Oil 700	Factoway 90
Medium Gear Oil	DTE BB	Magnus Oil 1000	Industron 80
Heavy Gear Oil	DTE HH	Hector 2000S Stream Cyl. Oil	Industron 100
Light Extreme-Pressure Gear Oil	Mobilgear 626	Philube 11B Gear Oil EP-3	Industron 156
Heavy Extreme-Pressure Gear Oil	Mobilgear 632*	Philube 11B Gear Oil EP-5	Gearep 80
Cling-Type Gear Shield (Open Gears)	Mobiltac A	Philube 11B Gear Oil EP-5	Gearep 125
Gen. Purpose E. P. Lithium-Base Grease	NLGI 2	Philstik D-1 Grease	Gearep OG
Molybdenum Disulfide E.P. Grease	Mobiltemp 78	Philube EP-2 Grease	Bearing Gard
		Philube MW Grease	Bearing Gard

INTERCHANGEABLE LUBRICATION CHART

(Continued)

Stewart-Warner Corp.
Alemite Division

Cities Service Oil Co.

Lubricant Type & Viscosity, SSU @ 100 F

Light Inhibited Hydraulic & Gen. Purpose	135-165	Hydraulic HD Oil No. 0	Citgo Pacemaker 15
Med. Inhibited Hydraulic & Gen. Purpose	194-236	Hydraulic HD Oil No. 1	Citgo Pacemaker 20
Med.-Heavy Inhibited Hyd.&Gen. Purpose	284-346	Hydraulic HD Oil No. 2	Citgo Pacemaker 30
Heavy Inhibited Hydraulic & Gen Purpose	630-770	Hydraulic HD Oil No. 3	Citgo Pacemaker 80
High-Pressure (Anti-Wear)Hydraulic Oil	135-165	Hydraulic HD Oil No. 0	Citgo Pacemaker XD-15
High-Pressure (Anti-Wear)Hydraulic Oil	194-236	Hydraulic HD Oil No. 1	Citgo Pacemaker XD-20
High-Pressure (Anti-Wear)Hydraulic Oil	284-346	Hydraulic HD Oil No. 2	Citgo Pacemaker XD-30
Fire-Resistant Hyd. Fluid/Synthetic			Citgo Pacemaker Synthetic FR Fluid ³
Fire-Resistant Hyd. Fluid/Water-Glycol			Citgo Glycol FR-20 XD
Fire-Res. Hyd. Fluid/Water-Oil Emulsion			Citgo Pacemaker Invert FR Fluid
Very Light Spindle Oil (Over 6000 rpm)	29-35		
Light Spindle Oil (3600-6000 rpm)	54-66		
Spindle Oil (Up to 3600 rpm)	95-115	Hydraulic HD Oil No. 0	Citgo Pacemaker 10
Light Way Oil	135-165	Hydraulic HD Oil No. 1 ¹	
Medium Way Oil	248-346	Hydraulic HD Oil No. 2 ¹	Citgo SlideRite No. 2
Heavy Way Oil	999-1100	Hydraulic HD Oil No. 5 ¹	Citgo SlideRite No. 3
Light Gear Oil	630-770	HD Gear Oil No. 3	Citgo Pacemaker 80
Medium Gear Oil	900-1100	HD Gear Oil No. 5	Citgo Extra Duty Circulating Oil 85
Heavy Gear Oil	1935-2365	HD Gear Oil No. 7	Citgo Extra Duty Circulating Oil 135
Light Extreme-Pressure Gear Oil	283-347	HD Gear Oil No. 3	Citgo EP Compound 55
Heavy Extreme-Pressure Gear Oil	1350-1650	HD Gear Oil No. 7	Citgo EP Compound 110
Cling-Type Gear Shield (Open Gears)	900-1100	Alemite Gear Shield	Citgo Gear and Chain Oil 100
Gen. Purpose E. P. Lithium-Base Grease	NLGI 2	EP Lithium	Citgo HEP-2 Grease
Molybdenum Disulfide E.P. Grease		Moly EP Lithium	Citgo Extra Range Grease

INTERCHANGEABLE LUBRICATION CHART

(Continued)

Lubricant Type & Viscosity, SSU @ 100 F	Chevron Oil Co. (Standard Oil of California)	West Penn Oil Co., Inc.
Light Inhibited Hydraulic & Gen. Purpose	Chevron OC Turbine Oil 32	W/P HBM-150
Med. Inhibited Hydraulic & Gen. Purpose	Chevron OC Turbine Oil 46	W/P HBM-200
Med.-Heavy Inhibited Hyd.&Gen. Purpose	Chevron OC Turbine Oil 68	W/P HBM-300
Heavy Inhibited Hydraulic & Gen Purpose	Chevron OC Turbine Oil 150	W/P HBM-650
High-Pressure (Anti-Wear)Hydraulic Oil	Chevron EP Hyd. Oil 32	W/P AWH-150
High-Pressure (Anti-Wear)Hydraulic Oil	Chevron EP Hdy. Oil 46	W/P AWH-200
High-Pressure (Anti-Wear)Hydraulic Oil	Chevron EP Hyd. Oil 68	W/P AWH-300
Fire-Resistant Hyd. Fluid/Synthetic	Chevron FR Fluid ³	
Fire-Resistant Hyd. Fluid/Water-Glycol	Chevron Glycol FR Fluid ³	
Fire-Res. Hyd. Fluid/Water-Oil Emulsion	Chevron FR Fluid D	W/P Hydrau FR-700
Very Light Spindle Oil (Over 6000 rpm)		W/P Westpin #3
Light Spindle Oil (3600-6000 rpm)	Chevron EP Machine Oil 10	W/P Westpin #6
Spindle Oil (Up to 3600 rpm)	Chevron EP Machine Oil 22	W/P Westpin #10
Light Way Oil		W/P GPM No. 1
Medium Way Oil	Chevron Way Oil 68	W/P GPM No. 2
Heavy Way Oil	Chevron Way Oil 220	W/P GPM No. 4
Light Gear Oil	Chevron OC Turbine Oil 150	W/P HBM-650
Medium Gear Oil	Chevron OC Turbine Oil 220	W/P HBM-900
Heavy Gear Oil	Chevron EP Machine Oil 460	W/P HBM-2100
Light Extreme-Pressure Gear Oil	Chevron NL Gear Compound 68	W/P Hi-Gear Compound No. 1
Heavy Extreme-Pressure Gear Oil	Chevron NL Gear Compound 320	W/P Hi-gear Compound No. 3
Cling-Type Gear Shield (Open Gears)	Chevron Pinion Grease MS2	W/P Westgrease OG-S2
Gen. Purpose E. P. Lithium-Base Grease	Chevron Duralith Grease EP-2	W/P Westgrease IEP #2
Molybdenum Disulfide E.P. Grease	Chevron Moly Grease 2	W/P Westgrease ML #2

INTERCHANGEABLE LUBRICATION CHART

(Continued)

Lubricant Type & Viscosity, SSU @ 100 F	Sun Oil Co.	Texaco Inc.
Light Inhibited Hydraulic & Gen. Purpose	Sunvis 916	Rando Oil A
Med. Inhibited Hydraulic & Gen. Purpose	Sunvis 921	Rando Oil B
Med.-Heavy Inhibited Hyd.&Gen. Purpose	Sunvis 931	Rando Oil C
Heavy Inhibited Hydraulic & Gen Purpose	Sunvis 975	Rando Oil F
High-Pressure (Anti-Wear)Hydraulic Oil	Sunvis 706	Rando Oil HD 150
High-Pressure (Anti-Wear)Hydraulic Oil	Sunvis 747	Rando Oil HD 215
High-Pressure (Anti-Wear)Hydraulic Oil	Sunvis 754	Rando Oil HD 315
Fire-Resistant Hyd. Fluid/Synthetic		Safetytex 215
Fire-Resistant Hyd. Fluid/Water-Glycol		Hyd. Safety Fluid 200
Fire-Res. Hyd. Fluid/Water-Oil Emulsion		Fire Res. Hdy. Fluid
Very Light Spindle Oil (Over 6000 rpm)	Sunsafe	
Light Spindle Oil (3600-6000 rpm)	Sun Spindle Oil 35	
Spindle Oil (Up to 3600 rpm)	Solnus 55	Spintex Oil 60
Light Way Oil	Sunvis 911	Spintex Oil 100
Medium Way Oil	Lubeway 1706	Clearartex 1402
Heavy Way Oil	Sunoco Way Lubricant 80	Way Lubricant D
Light Gear Oil	Sunoco Way Lubricant 90	Way Lubricant G
Medium Gear Oil	Sunvis 975 & 775	Regal Oil F-R&O
Heavy Gear Oil	Sunvis 999 & 790	Regal Oil G-R&O
Light Extreme-Pressure Gear Oil	Sunvis 135	Regal Oil K
Heavy Extreme-Pressure Gear Oil	Sunep 1050	Meropa 68
Cling-Type Gear Shield (Open Gears)	Sunep 1090	Meropa 320
Gen. Purpose E. P. Lithium-Base Grease	Sun C-892-T; Sunaplex 781	Crater 1
Molybdenum Disulfide E.P. Grease	Prestige 742 EP	Multifak EP 2
	NLGI 2	Molytux Grease 2
	Sunaplex 882 EPM	