



**General Motors**

**GM Global Lubrication Standard LS-1  
For Industrial Equipment  
Machine Tools and  
Conveyors**

**General Motors Document No. GM 1720  
For General Motors Global Operations**

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Any questions or comments with respect to this specification should be directed to the Standard Committee Chairman or to the Standard Coordinator.

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The number to the left of the decimal in the version number indicates the major version number. The number to the right of the decimal in the version number indicates the minor version number.

The major version number will change for the following reasons:

- Information added to document.
- Information removed from document.
- Rearrangement of sections in the document.
- Revisions to the scope or purpose of the document.

The minor version number will change for the following reasons:

- Spelling corrections.
- Page layout or formatting corrections.
- Minor changes that do not affect the scope or purpose of the document.

**CHANGES TO THIS STANDARD REQUIRE APPROVAL BY: THE LUBRICATION STANDARDS COMMITTEE CHAIRMAN, (C.H. PAXTON, C.L.S., O.M.A.)  
AND THE STANDARDS COORDINATOR, (DAVID R. KRACKO)**

## **FORWARD**

General Motors Company issues this Lubrication Standard (GM LS-1, GM-1720). The intent is to provide GM Global Facilities with safe reliable new, used and/ or refurbished Industrial Equipment, Machine Tools and Conveyors that consistently produce high quality products. GM Global Facilities and Original Equipment Manufacturers shall use this standard as an engineering guide in developing the lubrication systems.

The Lubrication Standards Committee was charged with developing this 2015 revision of the Standard. The Committee was drawn from GM divisions, which included representatives from Corporate Staffs, Manufacturing and Assembly operations. This Group comprised of engineering and maintenance personnel, both hourly and salaried, provided technical input in their areas of expertise. The mission of the committee was to revise the existing standard as necessary to:

- Enhance worker health and safety.
- Clarify the standard in order for industrial equipment builders to comply at minimum cost.
- Encourage the implementation of new technology into GM Global Facilities.
- Encourage the implementation of diagnostics built into industrial equipment and controls.
- Encourage the use of Recirculating or Recovery type oil systems.
- Design for a minimum of 95% lubrication serviceability while equipment is in operation.
- Improve equipment reliability, maintainability and efficiency while eliminating the housekeeping problems associated with improper amounts of lubricant.
- Establish this document as a common divisional and global standard.
- Mandate global compliance.

This standard is not intended to inhibit new technology in any manner. Accordingly, the Committee and General Motors would expect and encourage all industrial equipment builders to call to the attention of the Company any situation, which inhibits the application of new technology. This approach would allow any new technology proposal to be evaluated as to the merits of its application.

Top priority has been given to the enhancement of worker health and safety in the operation and maintenance of industrial equipment. Priority is also given to compliance with all governmental regulations, safety codes and qualified testing laboratory standards. General Motors has determined that the standards described in this booklet provide a sound basis for safe, reliable and productive industrial equipment in all GM Global Facilities.

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## TABLE OF CONTENTS

	PAGE
<b>L1</b>	<b>GENERAL</b>
	L1.1 DEFINITIONS 6
	L1.2 SAFETY & ERGONOMICS 6
	L1.3 COMPLIANCE TO STANDARD 7
	L1.4 APPROVALS 7
	L1.5 DEVIATIONS 8
	L1.6 FINAL APPROVAL 8
<b>L2</b>	<b>GENERAL REQUIREMENTS</b>
	L2.1 GENERAL DESIGN REQUIREMENTS 9
	L2.2 CENTRAL SERVICE AREAS 10
	L2.3 SEPARATION OF FLUIDS 10
	L2.4 UTILIZATION OF STANDARD LUBRICANTS 10
	L2.5 LOCATION AND SUPPORT OF COMPONENTS 11
	L2.6 PAINTING 12
	L2.8 SOUND 12
<b>L3</b>	<b>INDIVIDUAL POINT LUBRICATION</b>
	L3.1 MANUAL SINGLE POINT LUBRICATION 12
<b>L4</b>	<b>CENTRALIZED LUBRICATION SYSTEMS</b>
	L4.1 GENERAL REQUIREMENTS 12
	L4.2 AUTOMATICALLY ACTUATED SYSTEMS 14
	L4.3 CENTRALIZED MANUALLY ACTUATED SYSTEMS 14
	L4.4 MISTED OIL SYSTEMS 14
	L4.5 AIR OIL / OIL SPRAY SYSTEMS 15
<b>L5</b>	<b>LUBRICATION CONDUCTORS</b>
	L5.1 CONDUCTORS 16
	L5.2 MOUNTING 16
	L5.3 IDENTIFICATION 17
<b>L6</b>	<b>FILTERS AND MAGNETS</b>
	L6.1 FILTERS 17
	L6.2 MAGNETS 17
<b>L7</b>	<b>LUBRICATION PUMPS</b>
	L7.1 ACCESSIBILITY 17



<b>L8</b>	<b>RESERVOIRS</b>	<b>PAGE</b>
	L 8.1 RESERVOIR REQUIREMENTS	18
	L8.2 RECIRCULATION LUBRICATION RESERVOIRS	19
<b>L9</b>	<b>LUBRICATION SYSTEM CONTROLS</b>	
	L9.1 CONTROLLERS	19
	L9.2 SYSTEM INDICATORS	20
	L9.3 SYSTEM MANUAL OPERATION	20
<b>L10</b>	<b>BEARINGS</b>	
	L10.1 BEARING LUBRICANT DISTRIBUTION GROOVES	20
	L10.2 SEALED AND SELF-LUBRICATING BEARINGS	20
	L10.3 PRESSURE RELIEF	21
<b>L11</b>	<b>GEAR BOXES</b>	
	L11.1 GENERAL REQUIREMENTS	21
	L11.2 FILL DRAIN OR LEVEL INDICATOR EXTENSIONS	21
	L11.3 DIAGNOSTICS	21
<b>L12</b>	<b>OPEN GEARING</b>	
	L12.1 APPLICATION	22
<b>L13</b>	<b>CHAINS</b>	
	L13.1 POWER TRANSMISSION ROLLER CHAINS, SILENT CHAINS, AND CHAIN COUPLINGS	22
	L15.2 LUBRICATION	22
<b>L14</b>	<b>PUMPS</b>	
	L14.1 FLUID PROCESS and VACUUM PUMPS	22
	L14.1.1 LUBRICATION	22
<b>L15</b>	<b>CONVEYORS</b>	
	L15.1 GENERAL LUBRICATION	22
	L15.2 AUTOMATIC CONVEYOR CHAIN LUBRICATORS	22
	L15.3 CONVEYOR LUBRICATOR START-UP	24
<b>L16</b>	<b>LUBRICATION IDENTIFICATION LABELS</b>	
	L16.1 LOCATION REQUIREMENTS	24
	L16.2 IDENTIFICATION LABEL MATERIALS AND DATA	25



<b>APPENDIX A</b> LUBRICATION SYSTEM SCHEMATIC DRAWINGS AND LUBRICATION DESIGN DATA CHART	25
<b>APPENDIX B</b> LUBRICATION APPLICATION CHART	26
<b>APPENDIX C</b> LUBRICATION SYSTEM DESIGN CALCULATIONS	27
<b>APPENDIX D</b> GM LS2 COLOR CODE and SYMBOL CHARTS	31
<b>APPENDIX E</b> CONVEYOR LUBRICATOR GUARDING EXAMPLES	36
<b>APPENDIX F</b> CONVEYANCE EQUIPMENT LUBRICATION SYSTEM PIPING & WIRING	37

## **GM LS-1 COMMITTEE ROSTER**

### **L1. GENERAL**

**The use of the word “shall” is understood to be a requirement; use of the word “should” is understood to be a recommendation.**

#### **L1.1 DEFINITIONS**

**Industrial Equipment.** Industrial Equipment is any new, used or refurbished Equipment, Machine Tool or Conveyor utilized in the manufacturing, machining and/or assembly process.

**Lubrication Points.** Lubrication points are points where lubricant is delivered to the moving elements and interfaces of the Industrial Equipment.

**Fill Openings.** Fill openings are designated points on Industrial Equipment designed to accept a quantity of lubricant sufficient to maintain the Industrial Equipment for a specified time.

**Grease Points.** Grease points are those designated lubrication points requiring grease as the lubricant.

**Receiving Facility.** Specific Site / Facility where the Industrial Equipment is installed, operated, and maintained.

#### **L1.2 SAFETY & ERGONOMICS**

**L1.2.1** Personnel shall not be required remove guards, climb over or reach past revolving spindles, shafts, or any other type of moving Industrial Equipment elements or to service or fill lubricated components.

**L1.2.2** The placement of reservoirs, fill openings, grease points and the like, shall consider the machine work envelope. Accordingly, they shall be located in such a manner as to provide access from working height and be clear of the machinery work envelope. Acceptable working height shall be in accordance with **GM GDHS-2** Design for Health and Safety.

### **L1.3 COMPLIANCE TO STANDARD**

**L1.3.1 Compliance.** Compliance to this GM Global Standard shall be mandatory. A written statement, acknowledging complete compliance by the O.E.M. and / or Equipment Supplier or Builder shall be attached to the approval drawings.

### **L1.4 APPROVALS**

**L1.4.1 Approval Requirements.** Lubrication designs, including component stock list shall be approved in writing prior to the purchase of any components.

**L1.4.2 Documentation Required for Approval.** The following documentation is required for approval and shall be submitted as a complete package at the time of approval request:

A Lubrication System Schematic Drawing shall clearly show (but shall not be limited to) the following:

- All components of the system including the Manufacturer name, size and catalog number of filter assemblies and replacement filter elements.
- Conductor sizes, material and connector types and manufacturer.
- Pumps, Distribution/Feeder Blocks and Piston Distributor System Components
- Pump displacement.
- Reservoir capacity.
- Cycling frequency and cycling time.
- Detail letters, numbers and symbols for cross-reference.
- Complete stock lists, which shall include the original component manufacturer's name, part number, description, quantity and detail number.

***(Refer to Appendix A for a sample drawing.)***

**L1.4.3 Lubrication System Data Chart.** The Lubrication System Data Chart shall contain all applicable design information as shown in Appendix A and the supplier's recommendations for the metering and distribution of lubricants. Lubrication System Design Calculation formulas are shown in **Appendix C**. This chart shall be incorporated on the Lubrication System Schematic Drawing.

**L1.4.4 Approval Drawings.** The following items are to be submitted with the request for approval of any lubrication design:

- One reproducible copy of all charts, diagrams, schematics and equipment lists pertaining to the system for which approval is requested
- All diagrams, charts, and schematics are to be drawn using the most recent version of AutoCAD.
- Copies of any / all deviation requests.



**L1.4.5 Approval Request Review Time.** A maximum of thirty (30) working days shall be allowed for the review all diagrams, charts, and schematics, stock lists and drawings of a specific system, submitted for approval.

## **L1.5 DEVIATIONS**

**L1.5.1 Deviation Requests.** Requests for deviations to any part of this standard shall be made in the following manner:

- Request shall be submitted in writing.
- Each request shall apply to only one specific sentence and / or paragraph.
- A specific reason for requesting the deviation shall be part of the written request for deviation.

**L1.5.2 Deviation Life.** Approved deviations shall only apply for the sentence and / or paragraph specified and only for the particular project and operation, for which the original requests was made.

## **L1.6 FINAL APPROVAL**

**L1.6.1 Final Lubrication Data.** Final lubrication data shall be submitted electronically.

**All Drawings, Charts, Diagrams, Manuals and Documentation Shall be provided in English and the Language of choice of the *receiving facility***

**L1.6.2 Lubrication Application Chart.** A lubrication application chart shall be furnished for each piece of equipment. The chart shall contain the applicable information in the format as shown in **Appendix B**. The chart shall consist of Digital Images of the equipment identifying all lubrication action points including, (but not limited to) the following:

- Fill openings.
- Reservoirs.
- Manual oil and grease points
- The Lubrication chart shall contain supplier's recommendations for lubricants for all fill points. Designations shall be in GM LS-2 format. Designations by Brand Names are not acceptable.
- Specific frequency of service for each lubrication point.
- Lubrication instructions shall form part of the general instruction / maintenance manual and shall be posted / displayed on the Industrial Equipment.

**In the regard of the "Lubrication Instructions", the terms "As Needed" "As Required" or similar ambiguous references shall not be used.**



## L2 GENERAL DESIGN REQUIREMENTS

***It shall be the responsibility of the Industrial Equipment O.E.M. and / or Supplier to provide lubricants for the initial system(s) fill or initial component fill at no additional cost to GM.***

**L2.1.1 Lubrication Points.** All moving parts shall be lubricated to minimize wear and ensure the accuracy of the Industrial Equipment. It shall be the responsibility of the O.E.M. and / or Supplier to ensure that All Lubrication Points have been initially Lubricated with the **receiving facility's GM LS2 approved lubricant**

**L2.1.2 Lubricants.** Oil shall be the preferred medium for lubrication, except where Leakage and contamination from the oil will create an environmental concern. If oil Lubrication is not practicable, then grease / fluid grease lubrication shall be utilized. **MICROPOROUS POLYMER LUBRICANT \*** may be considered as an alternative Lubricant in certain applications.

**L2.1.3 Service Frequency.** All Industrial Equipment shall be capable of operation for a minimum of 200 hours without the attention of lubrication personnel.

**L2.1.4 Centralized Lubrication Systems.** All Industrial Equipment, with four or more lubrication points shall be required to incorporate a centralized lubrication system. Large or complex Industrial Equipment may require the use of more than one centralized lubrication system.

**L2.1.5 Fittings.** Any one-pressure fitting or metering valve outlet shall serve no more than one lubrication point.

**L2.1.6 Sight Gages.** Sight gages shall be provided to show the "High" and "Low" levels of oil in all systems, gearboxes, reservoirs, etc. and shall be readily visible to personnel at the fill point. Oil levels that vary from static to a running condition must show "High" and "Low" levels in both conditions. Bubble type sight gages shall not be permitted.

**L2.1.7 Recirculating Oil Systems.** Recirculating oil systems are approved on all metal stamping presses. However, recirculating oil systems shall only be allowed on internal lubrication systems where the oil is recirculated through one component or machine unit such as a gear box or drive unit. Inter-mixing of oil through more than one component or machine unit shall not be allowed. Recirculating oil systems shall not be utilized on auxiliary / multiple spindle units. Recirculating Flow Systems shall have full flow pressure line filtration to prevent the carrying of contaminants to the lubrication points.

**L2.1.8 Gravity Feed Systems.** Gravity feed systems are discouraged.

**L2.1.9 Way Lubrication.** All machine tool ways shall be lubricated by the use of terminal systems and shall incorporate the use of wipers to prevent the ingress of contaminants. Any Leakage of oil from

terminating systems shall be collected in a containment vessel. Lubricants shall not be allowed to mix with other types of fluids.

**L2.1.10 Shields and Seals.** Shields and/or seals shall be used where required to prevent leakage and / or to exclude contaminants

\* **MICROPOROUS POLYMER LUBRICANT** shall consist of a mixture of plastic and **GM LS2** approved oil, with certain additives included. When this mixture is cured at a specified temperature, the oil becomes encapsulated in the plastic to create a sponge like form. Unlike a natural sponge, the oil is contained in the plastic matrix until friction and/or mechanical distortion is created causing the oil to "weep" out through capillary action. The matrix shall have the ability to reabsorb oil when the equipment stops.

## **L2.2 CENTRAL SERVICE AREAS**

**L2.2.1 Central Service Area.** Industrial Equipment designs shall incorporate a central, readily accessible, lubrication service area. Large or complex Industrial Equipment may require the use of more than one central service area.

**L2.2.2 Components.** Central service areas shall contain but shall not be limited to, all grease fitting manifolds, centralized system reservoirs, pumps, pressure gages and filters.

**L2.2.3 Accessibility.** All central service areas shall be safely accessible while the Industrial Equipment is in operation so as to allow for the safe servicing of lubrication components without impeding the operation of the Industrial Equipment.

## **L2.3 SEPARATION OF FLUIDS**

**L2.3.1 Separated Fluid Systems.** The lubrication and hydraulic systems shall be separated unless the lubrication and the hydraulic system shall be capable of performing their required functions with the common fluid.

## **L2.4 UTILIZATION OF STANDARD LUBRICANTS**

**L2.4.1 Operation and Warranties.** All Industrial Equipment shall be designed to operate effectively and provide full O.E.M. and / or builder's warranties when utilizing the **receiving facility's GM LS2** approved lubricants.

**L2.4.2 Approved Lubricants.** All Industrial Equipment O.E.M's and / or suppliers shall be required to have written approval for all fluids and greases used. All lubricants shall be **GM LS2** approved. All lubricants / lubrication system components shall be silicon free.

## L2.5 LOCATION AND SUPPORT OF COMPONENTS

**L2.5.1 Location.** Lubrication devices shall be located so as to prevent damage to other machine components as well as the devices themselves. Lubrication devices shall be located in such a way as to prevent contamination or temperature extremes from deteriorating the lubricant and from causing malfunctioning of the devices.

**L2.5.2 Mounting.** All lubricating devices including all internally mounted nozzles, tips, extensions, etc. used for dispensing lubricants shall be securely mounted / installed. Under no circumstance(s) shall the lubricant or fluid conductors support any of these devices.

**L2.5.3 Port Threads.** All tapped holes for installing oil or grease fittings or terminating conductors at the bearing point(s) shall conform to NPT, Metric or SAE Straight Thread Standards as specified by the receiving facility.

- The minimum NPT Thread size shall be 1/4–28 LT
- The minimum Metric Thread size shall be 6mm x 0.75.
- The minimum SAE Straight Thread size shall be 5/16-24.

**Utilization of “Self Forming Thread” type fittings is unacceptable under any circumstance(s). Utilization of “Drive-In” type fittings is totally unacceptable under any circumstance(s). Rivet type fittings may be utilized for conveyor chain trolley “Welsh Plug” and Carrier Free Trolley “Welsh Plug” application(s) only.**

## L2.6 PAINTING

**L2.6.1 Painting.** No paint shall be applied over nameplates, legend plates, grease fittings, gages, tubing, instruments, metering blocks or lubrication identification labels.

## L2.8 SOUND.

**L2.8.1 Sound.** System noise shall be of prime consideration. All Industrial Equipment shall meet applicable GM Sound Specifications. **Ref. GM SL1**

## L3 INDIVIDUAL POINT LUBRICATION

**L3.1 Manual Single Point Lubrication.** Manual single point lubrication shall only be considered under the following conditions:

- There are fewer than 4 (four) lubrication points and / or the points require re-lubrication at a frequency greater than once in every 200 operating hours.  
And:
- Where the distance between individual lubrication points exceeds GM engineering specification limits.

**L3.1.2 Lubrication Fittings.** Individual grease points shall be serviceable with a standard grease gun and coupler. Hydraulic grease fittings with “ball-checks” in accordance with **ANSI/SAE J534 H-1, H-2, H-3 or DIN 71412 H-1, H-2, H-3 (for metric)** shall be used for the application of grease. Leak proof button-head fittings shall be used for the pressure application of oil. **Utilization of “Flush” type Grease Fittings is prohibited**

**L3.1.3 Location.** Hydraulic oil / grease fittings shall be located in order to provide a 40-degree cone of accessibility extending outward from the fitting for at least two feet. In locations where this clearance cannot be provided, the fitting shall be piped to a central service area or another approved area.

#### **L4. CENTRALIZED LUBRICATION SYSTEMS**

##### **L4.1 GENERAL REQUIREMENTS**

**Centralized Lubrication Systems shall be compatible and interchangeable with the Systems and Components currently utilized.**

Centralized lubrication systems shall be provided on All Industrial Equipment having **four or more** lubrication points. Series progressive proportioning systems are acceptable for oil or grease lubrication systems. Parallel proportioning systems are acceptable for oil only.

**L4.1.1 Filters.** All Centralized **Grease** Lubrication Systems shall have a replaceable element type (100 Mesh min.) Lubricant Pump Reservoir Fill Point Strainer. These Systems shall also incorporate a replaceable element type (325 Mesh min.) Lubricant Block Strainer located between the Lubricant Pump Outlet and the Master Feeder Block.

**L4.1.2 Application.** Centralized lubrication systems shall service all lubrication points, which can be lubricated with the same lubricant.

**L4.1.3 Cross Porting.** Centralized lubrication system metering devices shall not be internally cross-ported to combine output from more than one metering valve. External cross-porting bars or doublers shall be used for this purpose.

**L4.1.4 Diagnostics.** Suitable devices shall be provided for positive indication of system operation. Examples of acceptable indicating devices include, but shall not be limited to:

##### **Progressive Proportioning Systems**

- All Lubricant Metering Block / Segment Manifolds utilizing three (3) or more Lubricant Metering Blocks/Segments shall be supplied with not less than one (1) spare (By-Pass) Block / Segment
- Oil - Performance indicators in all working ports and cycle indicators.
- Grease - Performance indicators in all working ports and cycle indicators on all secondary divider blocks
- Low level indicators

- System Over / Under Pressure indicators
- Positive displacement pumps utilized on Series Progressive Systems shall be protected from excess pressure by the use of a relief valve, or a blowout disc rated at a maximum of 103.4-bar (1500 PSI) for oil or 137.9 bar (2000 PSI) for grease and used in conjunction with an electrical sensing device. Positive displacement pumps utilized on Single line parallel Systems shall be protected from excess pressure by the use of a relief valve, or a blowout disc rated at a maximum of 44.14 bar (640 PSI).

### Parallel Actuated Systems

- Oil – Pressure gauge, end of line pressure switch(es) for high and low pressure
- Low level indicators with pre-warning.
- Lubricant Flow Monitoring.
- Systems containing greater than 50 lubrication points shall be divided into Zones.

### Integral Systems

- Oil Only- Low Level indicators, flow meters with both visual and electrical indication.

**L4.1.5 System Pressure.** A pressure-indicating device shall be provided to monitor pump pressure and provide a high/low pressure warning. A pressure-indicating device is not an acceptable method of indicating lubricant flow.

**L4.1.6 Initial Start Up.** Centralized lubrication systems including all conductors and bearings / lubrication points, shall be pre-filled and cycled by the Industrial Equipment O.E.M. and / or supplier with the proper **GM LS2** approved lubricants as specified by the **receiving facility**.

**L4.1.7 Adjustments.** The Industrial Equipment O.E.M. and / or supplier shall properly adjust all centralized lubrication systems.

**L4.1.8 Maintenance.** All centralized lubrication system metering devices shall be accessible for repair / replacement without the removal of any conductors, conduit, or other components. They shall also be accessible for inspection and / or adjustment during equipment operation.

## L4.2 CENTRALIZED AUTOMATICALLY ACTUATED SYSTEMS

**L4.2.1 Automatically Actuated Systems.** Automatically actuated centralized lubrication systems shall be provided when re-lubrication will be required at a frequency less than once in every 200 operating hours.

**L4.2.2 Centralized Manually Actuated Systems.** Centralized manually actuated lubrication systems shall be provided when re-lubrication will be required at a frequency greater than once in every 200

operating hours. A pressure indicator shall be provided at the pump to permit visual monitoring of the system pressure during system cycling.

#### **L4.4 MISTED OIL SYSTEMS**

**The use of Oil Mist type systems shall require written approval. Their potential contribution to oil mist in the plant air shall be minimized.**

**L4.4.1 Improper Applications.** With the exception of ***Nearly Dry Machining Systems***, Oil mist systems shall not be used to cool or lubricate cutting tools, dies or similar devices, nor shall they be allowed to spray into the open atmosphere.

**L4.4.2 Initial Start Up.** All machine elements to be oil mist lubricated shall be pre-lubricated with the same oil used in the mist system

**L4.4.3 Oil Mist Generators.** Oil mist generators shall be protected from coolant and other environmental contaminants. The system shall not contain parts from more than a single supplier. The mist generator shall include (but shall not be limited to) the following components:

- Air filter and element.
- Water separator with automatic drain.
- Solenoid actuated air supply valve.
- Air pressure regulator.
- Manifold pressure gage.
- Manifold high-low pressure switch.
- Reservoir heater (when specified).
- Low oil level switch.

**L4.4.4 Distribution Headers.** Mist distribution headers shall be constructed of steel tubing. Headers shall be sloped toward the generator and shall be free of loops or low points. If low points are unavoidable, a drain shall be provided at the bottom of each low point. A plugged port shall be provided at the extreme end or ends of the header to accommodate a manometer gage for checking the header pressure.

**L4.4.5 Secondary Mist Distribution Lines.** Secondary mist distribution lines shall be constructed of steel tubing. Mist distribution lines shall enter the header at the top or sides and shall not protrude into the header interior. Each distribution line shall be sloped from the header toward the device to be lubricated. Low points, loops and other restrictions shall be eliminated. Mist distribution lines shall not be connected to tees, spilt-blocks, or other devices designed to distribute the mist from a single supply line to several mist outlets.

**L4.4.6 Vents.** Mist lubricated components shall be provided with vents properly sized and positioned to supplement the action of Reclassifier fittings in directing mist flow over or through each lubricated component. Blind bearing pockets shall be vented internally with a passage to facilitate continuous

circulation of mist through the bearing. Spindle heads, gearboxes and similar reservoirs lubricated with oil mist shall be vented to reduce airborne contaminants.

#### **L4.5 AIR OIL SPRAY SYSTEMS**

**L4.5.1 Application.** Pressurized air-oil spray systems shall be designed to operate separately from other lubrication systems.

**L4.5.2 Air Quality.** Air filtration shall utilize a coalescing filter with a 3 to 5 micron pre-filter.

**L4.5.3 Interlocks.** The system shall be electrically interlocked to prevent the spindles from being started, or to continue operating without the air oil system in operation.

**L4.5.4 Air Regulation.** The system shall have a tamper-resistant, fixed setting air regulator, and a lockable manual shut off valve installed upstream of the regulator.

#### **L5. LUBRICATION CONDUCTORS**

**L5.1 Conductors.** All lubrication conductors shall be capable of withstanding full system pressure. System pressures shall not exceed 103.4 bar (1500 PSI) for oil and 137.9 bar (2000 PSI) for grease. Accordingly, conductor sizing must be considered in system design. **Ref. SAE J1751 5.1.3.3 / 5.1.3.4**

**L5.1.1 Steel Tubing.** Steel tubing shall be used for all non-flexible applications.

**L6.1.2 Tubing Specification.** Tubing used for conductors shall be welded steel annealed DOM hydraulic grade that meets **ISO 3304-R-37-NBK or SAE Standard J-525,**

**L5.1.3 Stainless Steel Tubing.** Stainless steel tubing that meets **ASTM Standard A249/A26** shall be used when corrosive and or high oxidation conditions exist or may be caused by the type of coolant and machining materials that would damage steel tubing.

**L5.1.4 Flexible Conductors.** Flexible conductors shall **only** be used when motion occurs between two or more components. Flexible conductor runs shall be kept to a maximum length of 1 meter (3.28 feet) plus distance traveled by components being lubricated. **ISO 1436-2AT or SAE J-517(100 - R2) type** industrial grade hose shall be used. Female swivel hose ends shall be used on all flexible-tubing ends.

**All flexible conductors and associated fittings shall be of the same manufacturer.**

**Plastic(s) / Polymers including (but not limited to) Tygon®, Nylon®, etc. are prohibited**

## L5.2 MOUNTING

**L5.2.1 Conductors.** All rigid conductors shall be securely mounted to machine structure.

- Tubing clips made of cadmium plated steel are acceptable.
- Hydraulic tube clamps are acceptable.
- The spacing of conductor supports shall comply with **SAE J1751 5.1.8.2**

**L5.2.2 Bulkhead Connectors.** Bulkhead or junction box type connections shall be used where conductors pass through machine structures and shall be terminated at both ends.

**L5.2.3 Location.** Conductors shall be located in such a manner as to prevent their use as a platform or step.

**L5.2.4 Covers.** Covers shall be provided at corners and other areas where conductors are exposed to damage from external sources.

**L5.2.5 Bundling.** "BUNDLING" shall not be permitted under any circumstance. Conductors shall be run parallel and in a common plane.

## L5.3 IDENTIFICATION

**L5.3.1 Conductor Identification.** Conductors that are not readily traceable shall be identified with a permanent label at both ends of the conductor with the same I.D. used on the lubrication drawing.

## L6 FILTERS AND MAGNETS

### L6.1 FILTERS

**L6.1.1 Installation.** Lubrication filters shall be installed to allow for servicing without disturbing conductors or draining the reservoir.

**L6.1.2 Size and Location.** Replaceable cartridge type non-bypass, non-absorptive, full flow filters shall be installed on pressure side of the oil system pumps and / or in the reservoir filtration (Kidney Loop) circuit. The system shall be inoperable with the element removed.

**L6.1.3 Flow Capacity.** The filter flow capacity shall be such that pressure drop across the filter housing and element with a clean element at full flow shall not exceed .344 bar (5 psi)

**L6.1.4 Spin-On Filters.** The use of spin-on filters is allowed at the reservoir fill point and breather only.

**L6.1.5 Filter Condition Indicator.** All filter systems shall have an electrical differential pressure-indicating device to indicate plugging / blockage of the filter element.

---



## L6.2 MAGNETS

**L6.2.1 Location.** Magnets shall not be used in machine lubrication systems unless specifically requested by the **receiving facility**. When requested they shall be located in the system filter and not in the system reservoir.

## L7 LUBRICATION PUMPS

**L7.1.1 Accessibility.** Pumps shall be readily accessible for maintenance and adequately protected from damage.

**L7.1.2 Pump Output.** System design shall require full pump output. No pump diversion shall be allowed.

**L7.1.3 Mounting.** Pumps shall be mounted so as to have a flooded inlet.

**L7.1.4 Shut-Off Valves.** All horizontal flange and foot-mounted pumps shall have a 2 position ball valve installed on the inlet line.

**L7.1.5 Alignment.** Motor driven coupled pumps shall be aligned to **GM Laser Alignment Specification 1907 (Table 1)**.

**L7.1.6 Over-Pressure Protection.** Over-pressure detection shall cause machine or equipment to drop out of automatic mode and go into manual mode at end of cycle.

**L7.1.7 Pump Inlet Ports.** Pump inlet ports shall not be reduced in size, and shall not exceed pump manufacturer's vacuum specifications.

**L7.1.8 Pump Inlet Sizes.** Pump inlet sizes for pumps of less than 3.785 lpm (1 gpm) shall conform to the following table:

Line Size	Maximum Line Length
8mm 3/8"	76.2mm 3"
12mm 1/2"	152.4mm 6"
25.4mm 1"	457.2mm 18"

**Pump inlet lines shall not exceed 457.2 mm (18 inches) in length.**

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## **L8 LUBRICATION SYSTEM RESERVOIRS**

### **L8.1 RESERVOIR REQUIREMENTS**

**L8.1.1 Location.** All lubrication reservoirs shall be located in a central service area. Location shall allow for easy inspection and filling without machine shut off or creating a hazard to personnel.

**L8.1.2 Sight Gages.** Reservoir sight gages shall be provided to show high, safe operation and low liquid levels of lubricant and shall be visible to personnel while filling the reservoir. Sight gages shall be replaceable from the reservoir exterior without the need to drain the reservoir.

**L8.1.3 Fill Fittings.** Reservoirs shall be filled through a pre-fill filter(s), utilizing a quick-disconnect coupler

**L8.1.4 Clean-Outs.** Reservoirs shall be contamination proof, with an adequately sized top-mounted clean-out which requires the use of hand tools to remove.

**L8.1.5 Drains.** All reservoirs shall be provided with accessible drain plugs. The drains shall be located at the lowest point of the reservoir and shall be at least 203.2mm, (8 inches) above the containment tray. The drains shall allow for complete draining of the reservoir. The use of containment trays is mandatory. All Reservoirs shall have a "Ball-Valve" installed in the drain port.

**L8.1.6 Breather Filters.** All reservoirs shall be vented with replaceable Coalescing (desiccant) type breather filters of 3 micron absolute rating (maximum). All reservoir breather filters shall be mounted at least 25.4 mm, (1 inch) above the top of the reservoir.

**L8.1.7 Reservoir Interiors.** Interior of reservoir shall be pickled and oiled unpainted, slag and scale free.

**L8.1.8 Top of Reservoirs.** The top of the reservoir shall remain free of all fittings, brackets and filters with the exception of the breather / filter and level switches.

**L8.1.9 Capacity.** Reservoirs of terminating lubrication systems shall contain sufficient lubricant for a minimum of 200 hours of system operation at maximum demand.

**L8.1.10 Low Level Switch.** All reservoirs shall have a low-level switch, which will shut down the equipment at the completion of the cycle when the lubricating fluid level drops below the set minimum. Reservoirs shall be appropriately sized to insure that the minimum set point shall not be reached in less than 200 hours of machine operation.

**L8.1.11 Shut-Off Valves.** All modular unit type reservoirs shall have shut-off valves incorporated in the mounting to stop the oil flow when the pump is removed for service.

---

## L8.2 RECIRCULATION LUBRICATION RESERVOIRS

**L8.2.1 Capacity.** Reservoirs used in conjunction with Recirculating lubrication systems shall conform to the following requirements.

- Reservoir capacity shall be sufficient to maintain an adequate lubricant supply to the lubrication system.
- Reservoir capacity shall be designed such that the reservoir will contain all system lubricant draining back to the reservoir by gravity after the machine is shut down.

**L8.2.2 Contamination.** Recirculating system reservoirs shall be designed to promote rapid de-aeration of lubricant and the settling out of solid contaminants.

**L8.2.3 Temperature Rise.** The maximum stabilized reservoir temperature shall be limited to 17 degrees C (30 degrees F) above ambient or 54 degrees C (130 degrees F), whichever is less.

## L9 LUBRICATION SYSTEM CONTROLS

**L9.1 Controllers.** Controls for the lubrication System should be integrated into the machine control circuit and shall include, but shall not be limited to:

- Automatic lubrication logic.
- Manual lubrication logic.
- System diagnostic messages.

Lubrication systems may be controlled by their own integral control system. The controller shall be isolated from shock, adjustable without requiring access to machine power panels, and provide for complete manual operation of the lubrication system. If the controller becomes inoperable, a system fault shall be so indicated.

**L9.2 System Indicators.** Each lubrication control system shall be furnished with, (but not limited to), the following indicators visible from the operator's panel or station.

- **Normal Condition.** An indicating device that when activated, indicates system ready for operation.
- **System Cycle.** An indicating device that when activated, indicates system in operation.
- **System Fault.** An indicating device that when illuminated indicates system in an abnormal condition and termination of the machine's automatic cycle occurs as a result of the fault.
- **Low Fluid Level.** An indicating device that when activated, indicates required reservoir fluid level is below safe operation limit.
- **System Pressure.** An indicating device that when activated, indicates system pressure above/below normal operating limits for Series Progressive Systems. Single Line Parallel Systems shall require a pressure relief device in addition to the indicator.

**L9.3 System Manual Operation.** On terminal systems a manual push-button and fault condition indicating device shall be mounted at the operation station. Where the central service area is not in close

proximity to the operator's station or where there are multiple central service areas, remote push buttons shall be required.

## **L10. BEARINGS**

All rolling element bearings / housings shall be provided to the **receiving facility** pre-packed with the **receiving facility's GM LS2 approved lubricant**. Pre-packing quantities shall be in accordance to the rolling element bearing / housing manufacturer's recommendations.

**L10.1 Bearing Lubricant Distribution Grooves.** All Journal Bearings, Rolling Element Bearings, Bearing Housings, Sliding / Rotating Bushings, Sliding Bearings and Sliding Ways, shall be provided with appropriate lubricant distribution grooves.

**L10.2 Sealed and Self-Lubricating Bearings.** The use of permanently lubricated and sealed ("Lubed-for-life") Rolling Element Bearings, Self-Lubricating Bearings, Bushings, Ways and Slides shall require written approval. Approval then shall only be granted upon receipt of a written guarantee from the Industrial Equipment builder / supplier providing full unconditional warranty of these specific elements for the specified / designed life of the Industrial Equipment.

**L10.3 Pressure Relief.** Pressure relief fittings (vents) shall be incorporated into all housings of Rolling Element bearings.

## **L11 GEAR BOXES**

### **L11.1 GENERAL REQUIREMENTS**

It shall be the responsibility of the Industrial Equipment O.E.M. and / or supplier to ensure that all Gear Boxes are initially filled with the **receiving facility's GM LS2** approved lubricant(s) prior to start up of any equipment, machinery, or conveyor.

**L11.1.1 Fill, Level and Drain Ports.** Gear boxes shall be provided with a set of fill openings, drain openings and lubricant level indicators, located so that the set shall be properly positioned regardless of the mounting position of the unit.

**L11.1.2 Drain Size.** Each drain opening shall be sized to permit total gravity draining of the recommended lubricant in less than five minutes.

**L11.1.3 Port Labeling.** Fill points, drain points and oil level indicator positions shall be clearly and permanently identified on gearboxes. Gearboxes incorporating only one set of fill-drain-indicator devices shall be clearly and permanently marked to show proper mounting position.

**L11.1.4 Drain Opening.** Gearboxes shall be located on the equipment so that the drain shall be accessible and convenient for servicing. The drains shall be located at the lowest point of the reservoir. All Gearboxes shall be equipped with a "Ball Valve" installed in the drain opening. The use of containment trays is mandatory.

## **L11.2 FILL or DRAIN EXTENSIONS**

**L11.2.1 Requirements.** Proposed extensions shall comply with the following:

- Extensions shall be of 12.7 mm (½ inch) pipe or larger.
- All extensions shall be rigidly supported. Elbows shall not be considered adequate support.

**L11.2.2 Vents.** Vents shall be designed to prevent entry of contaminants into gearboxes.

**L11.3 DIAGNOSTICS.** All Gearboxes with a Lubricant Sump (reservoir) capacity of 3.785 liters (1 Gallon) or larger;

- Shall be supplied with a Bottom Sediment and Water Monitoring Device installed in the Gearbox drain port.
- Shall be supplied with a lubricant sampling port(s). The sampling port(s) shall be an integral part of the Gearbox and allow for the extraction of the Lubricant while the unit is in operation. The sampling port(s) shall incorporate a valved quick-connect style coupler attached to a rigid conductor (tube) which extends midway into the lubricant sump.

## **L12 OPEN GEARING**

**L12.1.1 Application and Use.** Industrial equipment shall be designed to eliminate open gearing wherever practical.

- If open gearing cannot be eliminated, the preferred method is to utilize Oil Bath lubrication.
- If Oil Bath lubrication is not possible, tooth contact surfaces shall be lubricated by a pressurized Oil, or Open Gear Lubricant spray system.

## **L13 CHAINS**

### **L13.1 POWER TRANSMISSION ROLLER CHAINS, SILENT CHAINS AND CHAIN COUPLINGS.**

#### **L13.2 LUBRICATION**

- The preferred method of lubrication shall be Oil Bath.
- If Oil Bath lubrication is not possible, the chain Pins, Side-Plates, Bushings and Rollers etc. shall be lubricated by a pressurized oil spray / mist system, or by a pressurized feed, Oil Brush type system.

The use of **MICROPOROUS POLYMER LUBRICANT** \* may be considered as an alternative lubricant for use on ANSI type chains only.

## L14 PUMPS

### L14.1 FLUID PROCESS and VACUUM PUMPS

**L14.1.1 Lubrication.** All Fluid Process and Vacuum Pumps with oil lubricated bearing housings shall be Equipped with a Constant Level Oiler.

## L15 CONVEYORS

**L15.1 GENERAL LUBRICATION.** Manual lubrication points of conveyor system components shall be accessible from any authorized maintenance working surface / platform. Those lubrication points which are not accessible shall be piped to the nearest specified maintenance working surface / platform. It shall be the responsibility of the Conveyor System O.E.M. and / or supplier to insure that **ALL** conveyor system components are fully pre-lubricated, 80% capacity minimum, with the **receiving facility's GM LS2** approved lubricant prior to the installation and operation of the conveyor system. Conveyor system components shall include, but shall not be limited to:

- Traction/Sprocket Wheel Turn bearings.
- Conveyor Take-Up Traction/Sprocket Turn bearings.
- Conveyor Take-Up Frame bearings.
- Conveyor Roller Turn Nest Roller bearings.
- Conveyor Return Track Rollers/Bearings.
- Conveyor Drive Chains.
- Conveyor Drive bearings.
- Conveyor Drive Chain Back-Up Roller bearings.
- Conveyor Drive Frame bearings.
- Conveyor Track Switches
- Conveyor Limit Switch Actuators.
- Conveyor Anti-Runaway and/or Anti-Backup Devices
- Conveyor Carrier Stop Blades.
- Conveyor Product Carriers and related Tooling / Fixtures
- Conveyor Carrier Positioners
- Pallets, Skids, Skucks and related Tooling / Fixtures
- Vertical Lifts, Transfers and Fork Type Transfers
- Turn Tables, Swing Tables, Cross Transfers and Accumulators
- Skillets, Shuttles and Related Tooling / Fixtures

**The receiving facility shall reserve the right to have any conveyor system component(s) dismantled for inspection of pre-lubrication.**

**L15.2 Automatic Conveyor Chain Lubricators.** Automatic Conveyor Chain Lubrication Systems shall be utilized on all Conveyor Systems. All Automatic Conveyor Chain Lubrication Systems shall meet, but shall not be limited to the following requirements:

- All ejection or capillary tubes for the Lubricators shall extend not more than 1" beyond the required support brackets. Rigid ejection / capillary tubes shall be utilized. Plastic or thin wall metallic tubes are unacceptable. The LubeCon "Lube Tubes" are acceptable for use on traditional CC5, Flat Top, ANSI (RC) and Caterpillar Chains. ***It shall be the responsibility of the Conveyor O.E.M and / or Supplier to properly position all Lubricant ejection, capillary, or "Lube Tubes" tubes to ensure Lubricant is applied to all applicable Lubrication points.***
- Automatic Conveyor Chain and / or Carrier Lubricators shall be designed so that if the conveyor chain backs up, the lubricator mechanism will not be damaged.
- Automatic Conveyor Chain and / or Carrier Lubricators shall have a clear, unobstructed view of the lubricant dispensing nozzles / couplers to facilitate inspection and adjustment.
- Automatic Conveyor Chain and / or Carrier Lubricators shall have an easily opened access cover of 305 mm (12 inches) length minimum on any conveyor(s) that are required to have guarding installed, final design of any / all Lubricator Guarding shall be approved by the ***receiving facility*** prior to fabrication and / or installation. ***Ref. APPENDIX E.***
- Drip pans shall be provided under all automatic lubricator modules and / or reservoirs and shall have a drain plug at a low point.
- Automatic Conveyor Chain and / or Carrier Lubricators with integral reservoirs shall be filled remotely by a centralized fill system. All Centralized fill systems shall include lockable "Ball Valves" at the reservoir and at each individual lubricator module to isolate the individual module for the purpose of repair and / or replacement. Automatic Conveyor Chain and / or Carrier Lubricators with Pressurized Central / Manifold (Demand) type Lubricant Supply Systems shall include lockable "Ball Valves" at the Lubricant Supply Reservoir and at each individual Lubricator module to isolate the individual module for the purpose of repair and / or replacement.
- Automatic Conveyor and / or Carrier Lubricators shall be controlled by their own proprietary control system.
- Automatic Lubricators shall be utilized on all associated conveyor drive chains. Conveyor Systems utilizing multiple strands of Conveyance Chain shall require lubrication system(s) designed / capable of independently dispensing lubricant(s) to each individual strand of Chain.
- Service / Inspection Platforms shall be provided for all Lubrication systems not accessible from a maintenance walking / working surface. Access ladders or stairs shall be incorporated into the design of these platforms. Final design the Platforms shall be approved prior to fabrication and / or installation.

**L15.3 CONVEYOR LUBRICATOR START-UP.** It shall be the responsibility of the Conveyor O.E.M. and / or Supplier to ensure that all Conveyor Drives, Conveyor Drive Chains, Conveyor Transport Chains and Carrier Free Trolley / Guide Roller Lubrication Systems are ***FULLY*** functional prior to the Start-Up of any Conveyor System. The Conveyor O.E.M. and / or Supplier shall operate all of the lubrication systems for a minimum of 2 (two) complete cycles of each system. Functionality and proper aiming of the Oil discharge nozzles / Grease discharge couplers shall be verified to ensure that all conveyor system components are



adequately lubricated. The Conveyor O.E.M. and / or Supplier shall provide GM detailed documentation showing all lubricator settings and their correlation to the Conveyor Data Charts. The Conveyor O.E.M. and / or Supplier shall provide GM detailed documentation showing the calculations utilized to establish lubricant dispense rates and replenishment cycles.

In any circumstance where the Lubrication systems are not operable prior to start-up of the conveyor system, the Conveyor O.E.M. and / or Supplier shall provide, at no additional cost to GM, manpower and lubricant(s) to manually lubricate all components of the Conveyor System(s) at start-up for the required minimum of 2 (two) complete cycles of the system(s). The Conveyor O.E.M. and / or Supplier shall continue to re-lubricate all of the Conveyor System components manually at the prescribed re-lubrication intervals until such time as the Lubrication Systems are **FULLY** functional.

## **L16 LUBRICANT IDENTIFICATION LABELS**

**L16.1.1 Location.** Appropriate lubrication identification labels, shall be securely and permanently fastened to the machine or equipment and shall individually identify each location where lubricant is applied to the machine or equipment.

**L16.1.2 Vicinity.** Some machine configurations may make compliance physically impossible. In these cases, identification labels shall be located in the vicinity of each lubricant application point, and shall be supplemented by an arrow pointing to the location of the lubricant application point.

## **L16.2 IDENTIFICATION LABEL MATERIALS & DATA**

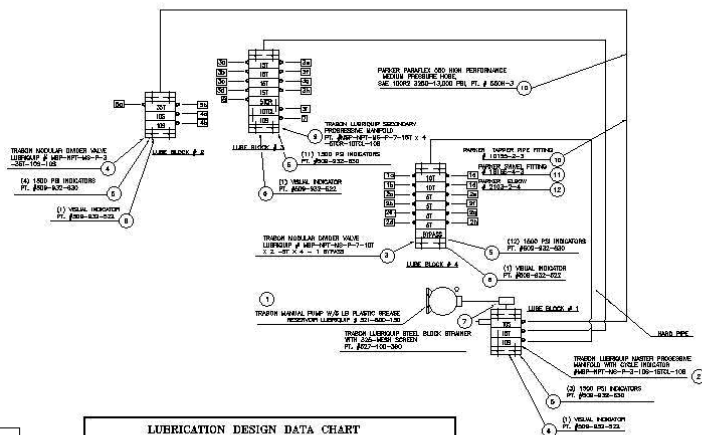
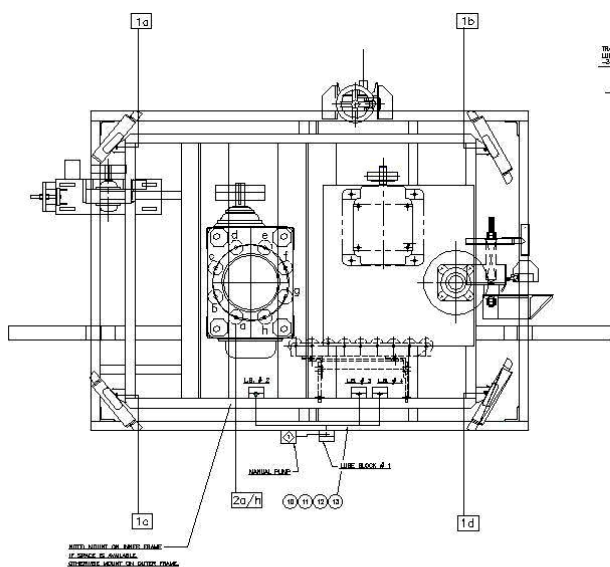
All labels shall conform to the appropriate Shape and Color as outlined in the **GM LS2 Color & Symbol Chart**.

**L16.2.2 Identification Label Data.** Each label shall utilize the appropriate General Motors lubricant code number; **AGMA and / or ISO** Viscosity Grade to identify the oil required at specific oil fill point. Each label shall utilize the appropriate General Motor's **LS2** lubricant code number and **NLGI** Grease code number for each specific grease lubricated point. General Motors lubricant code numbers are found in **GM LS2**.

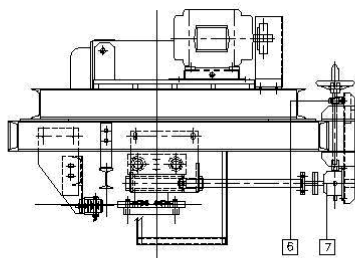
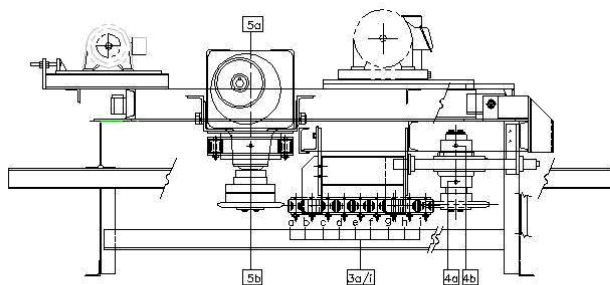
**Lubricant identifications by brand name are not acceptable.**



GM LS1 APPENDIX "A"

[illegible]

MATERIAL LIST		
ITEM	QTY.	DESCRIPTION
1	1	TRABON MANUAL PUMP w/ #5 PLASTIC GREASE RESERVOIR #51-800-130
2	1	TRABON MODULAR DIMER VALVE LUBRIQUIP #N5P-NPT-W5-P-3-105-15TCL-105
3	1	TRABON MODULAR DIMER VALVE LUBRIQUIP #N5P-NPT-W5-P-7-10T x 2-ST x 4 - 1" BVM55
4	1	TRABON MODULAR DIMER VALVE LUBRIQUIP #N5P-NPT-W5-P-3-30T-105-105
5	30	TRABON 1500 PSI AUTOMATIC RELIEF TO ATMOSPHERE INDICATOR LUBRIQUIP #508-632-632
6	4	TRABON VISUAL INDICATOR w/ "D" RING LUBRIQUIP #508-632-622
7	1	TRABON LUBRIQUIP STEEL BLOCK STRAINER w/ 325 MESH SCREEN #527-100-360
8	1	PARKER PARAFLEX 590 HIGH PRESSURE, WIRE REINFORCED HOSE, 100PSI 2000-5000 PSI, PT. #590-6 X 50'-0" LGL
9	1	TRABON MODULAR DIMER VALVE LUBRIQUIP #N5P-NPT-W5-P-7-15TX 4-BTCL-10TCL-105
10	8	PARKER MALE TAPERED PIPE FITTING RIGID # 1015S-2-3 (1/8"-27 N.P.T.)
11	7	C/J 37 SWIVEL, PARKER # 1065S-4-3 (7/16-30 THD)
12	8	MALE 90 ELBOW, MALE PIPE, MALE JC 37 FLARE, PARKER # 2103-2-4



**NOTE:**

SYSTEM LUBE REDMT = 9.00 in<sup>3</sup>/200 HRS  
9.00 in<sup>3</sup>/200 Hrs/ 0.150 in /Pump Stroke = 60 Pump Strokes Every 200 Hrs

TUBING & HOSES REQ'D

TUBING - 1/4" O.D. STEEL Wn. (SAE J-525 OR J-527 OR EQUIV.)  
HOSE - 1/4" I.D. Wn. (SAE 100-R2 OR EQUIV.)

HL	CHARGE	DT	DECT		
OVERHEAD POWER AND FUEL INCL. DELIVERY CORRECTOR DIME USE					
GENERAL MOTORS CORPORATION					
STATION ID:	DATE	DEPT	READING	COUNT	CATEGORY
INVENTOR (NAME):	DATE:	NO. TAG NO.			
		DO NOT WRITE HERE			

Figure 1 consists of two photographs of the MK-6102-A unit. The main photograph shows the unit with labels 1, 4, and 5. Label 1 points to the control panel, label 4 points to the top of the unit, and label 5 points to the base of the unit. The inset photograph shows the unit with labels 2 and 6. Label 2 points to the top of the unit, and label 6 points to the base of the unit.

Unit: Fascia Conveyor Drive

[illegible]

## APPENDIX C

GM LS1 LUBRICATION DESIGN DATA CHART											
Appendix C THIS FORM SHALL BE SUBMITTED AS PART OF THE APPROVAL DRAWINGS. ONE CHART FOR EACH TYPE OF LUBRICATION.											
BT #: NA			EQUIP. MFG. NAME: Fascia Conveyor Drive				MODEL NO.: NA				
GM LS2 Designation: LG-01			FACILITY STOCK #: 4020/460-1				ISO and/or AGMA # - NLGI Grade NLGI Grade 1				
TYPE OF LUBRICANT:		OIL		GREASE <input checked="" type="checkbox"/>		OTHER DEFINE:					
TYPE OF SYSTEM:		AUTOMATIC		MANUAL <input checked="" type="checkbox"/>		HAND		MIST		AIR-OIL SPRAY OTHER	
BLOCK LD.#	NAME AND LOCATION	NO.	TAPS	BEARING DATA							
				TYPE	SPEED/LOAD DIN #	SIZE	AREA SQ. IN.	LUBE PER BRG CU. IN. PER HR.	TOT. LUBE CU. IN. PER HOUR	LUBRICATING UNIT SIZE	
				NOTE 1		NOTE 2	NOTE 3		NOTE 4	NOTE 5	
1	Frost Wheel #0990300 4 13/16" x 1 1/2"	4	1	AF	6 in/sec	4 13/16" x 1 1/2"	4.00	.004	.016	10T	
2	3" x 2 3/4" Face Rollers	8	1	AF	6 in/sec	3" x 2 3/4"	3.00	.003	.024	5T	
3	3" x 2 3/4" L.T.B. Rollers	9	1	AF	3 in/sec	3" x 2 3/4"	3.00	.003	.027	15T	
4	Link Belt Flange Bearing 2 15/16"	2	1	AF	3 in/sec	2 15/16" x 1"	17.00	.017	.034	10S	
5	Falk Reducer 30DTC-3	2	1	AF	3in/sec	NA	18.00	.018	.036	35T	
6	Link Belt Pillow Block 3/4" ID	1	1	AF	NA	3/4" ID	1.00	.001	.001	5TCR	
7	Duff Norton Jactuator	1	1	AF	NA	NA	6.00	.006	.006	10S	

\* CONT. NEXT SH. \*

**INSTRUCTIONAL NOTES:**

1. STATE WHETHER ROTATING PLAIN BEARING (PF), SLIDING BEARING (SF), OR ANTI-FRICTION BEARING (AF).
2. INDICATE DIAMETER, LENGTH, AND CLEARANCE OF PLAIN BEARINGS, WIDTH AND LENGTH OF SLIDES, AND AFBMA PART NUMBER OF ANTI-FRICTION BEARINGS.
3. STATE AREA OF BEARINGS USED TO DETERMINE AMOUNT OF LUBRICANT REQUIRED PER BEARING.
4. STATE THE AMOUNT OF LUBRICANT THE GROUP OF BEARINGS IS RECEIVING PER HOUR (MORE THAN ONE BEARING PER TAP).
5. UNIT SIZE, IS DEFINED AS THE BLOCK SIZE, RECLASSIFIER SIZE, MIST HEAD SIZE; INCLUDE MODEL NUMBER.



## **LUBRICATION SYSTEM DESIGN CALCULATIONS**

### **VOLUME REQUIRED**

$$V = A \times T$$

A = Equivalent Area

T = Film Thickness

### **FACTORS AFFECTING VOLUME**

Service Conditions

Shock Loading

Extreme Heat

High Speed

Dirt & Water Environment

Product Contamination

## **FILM THICKNESS, REPLACEMENT**

### **Manual System – Terminating**

Grease - .0508 mm (.002 in.) Film Thickness per application  
(8 hours)

### **Automatic System -Terminating**

Oil - .0254 mm (.001in.) Film Thickness every 1 hour period

Grease - .0254 mm (.001in.) Film Thickness every 4 hour period

### **Automatic System -Circulating**

Oil - .0254 mm (.001in.) Film Thickness every 1 minute period

## **EQUIVALENT AREA**

### **Anti Friction Bearings**

$$A = D^2 R$$

D = Shaft Diameter

R = Number of Rows

### **Plain Bearings**

$$A = \pi D L$$

D = Shaft Diameter

L = Length of Bearing



### **Slides, Gibbs, and/or Ways**

A = Area of Contact  
Of Largest Contact Surface

### **Gears - Calculate Each Gear in Train**

$A = \pi \text{ P.D.} \times W$   
P.D. = Pitch Diameter of Gear  
W = Width of Gear

### **Large Bull Gears**

$A = 2\pi \text{ P.D.} \times W$   
P.D. = Pitch Diameter of Pinion  
W = Width of Pinion Gear

### **Worm Gears**

$A = \pi(\text{P.D.} + \text{PD2}) W$   
P.D. = Pitch Diameter of Worm  
P.D.2 = Pitch Diameter of Worm Gear  
W = Width of Worm Gear

### **Labyrinth Seals**

$A = \pi(D \times L) \times 3$   
D = Shaft Diameter  
L = Length of Each Contacting Surface of Seal

### **Ball Screw**

$A = \pi \text{ P.D.} \times \text{Rows} \times \text{Length of Travel}$   
P.D. = Pitch Diameter of Ball Race  
Rows = No. of Rows in Engagement with Shaft

### **Cams**

$A = C L$   
C = Cam Surface Circumference  
L = Face Width of the Cam Surface



## **Chains, and/or Conveyors**

















Due to the many variations of Conveyor Types and Conditions, Conveyor Lubrication depends a great deal upon the following:

- (1) Speed
- (2) Temperature variations
- (3) Environmental conditions
- (4) Housekeeping concerns
- (5) Conveyor load

















Consult your Conveyor manufacturer as well as the lubrication Supplier for proper application.

**Note:**  $\pi = 3.14$

## APPENDIX D

GM Code	Lubricant Type	Symbol	Color
LA-0X-1	Air Cylinder/Valve, Air Tool Oils		Light Purple
LB-04-1	General Purpose Oil – 46 cSt		Yellow
LB-22-1	Heavy Press and Machine Oil - 220 cSt		Blue
LC-06-1	Submerged Clutch and Brake Oil - 68 cSt		Brown
LD-00-1	Dry Film Lubricant		Black
LD-XX-2	Chain/Conveyor Lubricant Oil Based		Orange
LE-XX-1	Environmentally Acceptable Industrial Lubricants		Green
LF-04-1	Phosphate Ester Hydraulic Fluid - 46 cSt		Black/White
LF-04-2	Water-Glycol Hydraulic Fluid - 46 cSt		Red/White
LF-10-3	Invert Emulsion Hydraulic Fluid - 100 cSt		Yellow/White
LF-XX-4	Polyol Ester Hydraulic Fluid		Green/White
LF-03-5	High Water-Based Hydraulic Fluid		Blue/White
LG-0X-1	Multi-Purpose Greases - NLGI No. 0,1,2		Red
LG-01-2	Fretting, Corrosion Inhibiting Grease NLGI No. 1		White
LG-02-3	High-Speed Bearing Grease NLGI No. 2		Blue
LG-0X-4	High-Temperature EP Greases Synthetic NLGI No. 1,2		Orange

## APPENDIX D (Cont.)

GM Code	Lubricant Type	Symbol	Color
LH-0X-1	Antiwear Hydraulic Oils 22, 32, 46, 68 cSt		Purple
LH-0X-2	Zinc Free Antiwear Hydraulic Oils		Purple
LJ-XX-1	Compressor/Turbine Oils 32, 46, 68, 100 cSt		White
LJ-XX-2	Synthetic Compressor/Turbine Oils Ester Based		Gray/White
LJ-XX-3	Synthetic Compressor/Turbine Oils Non-Ester		DkGray/White
LM-10-1	Misting Oil - 100 cSt		Pink
LR-XX-1	EP Gear Oils - 68, 100, 150, 220, 320, 460, 680 cSt		Light Blue
LR-XX-2	Worm Gear Oil - 460, 680, 1000 cSt		Light Green
LR-XX-3	Synthetic EP Gear Oils		LtBlue/White
LS-0X-1	Spindle Oils - 10, 22, 32 cSt		Brown
LS-0X-2	High-Speed Spindle Oils - 2, 5, 10 cSt		Brown
LW-XX-1	Way Oils - 32, 68, 220 cSt		Red
LX-XX-__	Straight Cutting and Grinding Oils 1,2,3,4,5,6		Blue
LY-00-__	Aqueous Metal Removal Fluids Soluble Oils – 1,2,3,4		Red
LY-00-__	Aqueous Metal Removal Fluids Semi-synthetic Fluids – 5,6		Yellow
LY-00-__	Aqueous Metal Removal Fluids Synthetic Fluids – 7,8		Light Green



## APPENDIX D (Cont.)

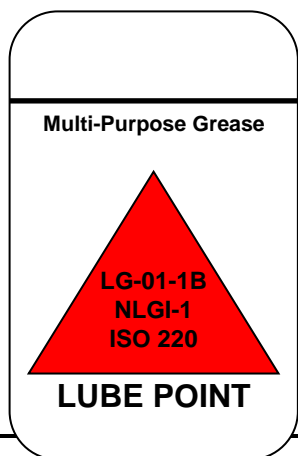
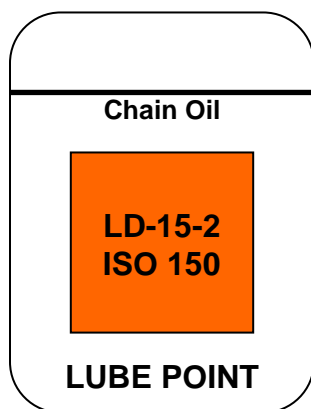
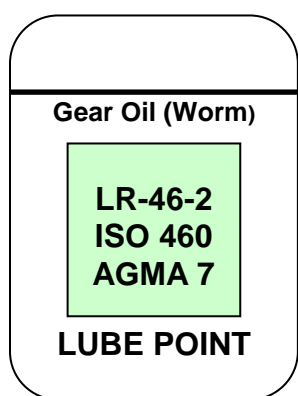
GM Code	Lubricant Type	Symbol	Color
LD-XX-2	Chain/Conveyor Lubricant Oil Base Viscosity XX	Example: ISO Viscosity 15	Orange
Use this symbol & designation for all of the following LD fluids & types		<div>LD-15-2 ISO 15</div>	
LG-XX-1X	Multi Purpose Grease	Example: ISO Base Oil Viscosity 150 NLGI Grade 0	Red
LG-00-1A	Viscosity 150 NLGI 0	<div>LG-00-1A NLGI 0 ISO 150</div>	
LG-00-1B	Viscosity 220 NLGI 0		
LG-01-1A	Viscosity 150 NLGI 1		
LG-01-1B	Viscosity 220 NLGI 1		
LG-02-1A	Viscosity 150 NLGI 2		
LG-02-1B	Viscosity 220 NLGI 2		
Use this symbol & designation for all of the following LG fluids & types			
LH-0X-1	Antiwear Hydraulic Fluid Viscosity 0X	Example: ISO Viscosity 22	Purple
LH-02-1	Viscosity 22 - 02	<div>LH-02-1 ISO 22</div>	
LH-03-1	Viscosity 32 - 03		
LH-04-1	Viscosity 46 - 04		
LH-06-1	Viscosity 68 - 06		
Use this symbol & designation for all of the following LH fluids & types			
LR-XX-2	Worm Gear Oil Viscosity XX	Example: ISO Viscosity 460	Light Green
LR-46-2	Viscosity 460 - 46	<div>LR-46-2 ISO 460 AGMA 7</div>	
LR-68-2	Viscosity 680 - 68		
LR-99-2	Viscosity 1000 - 99		
Use this symbol & designation for all of the following LR fluids & types			

## APPENDIX D (Cont.)

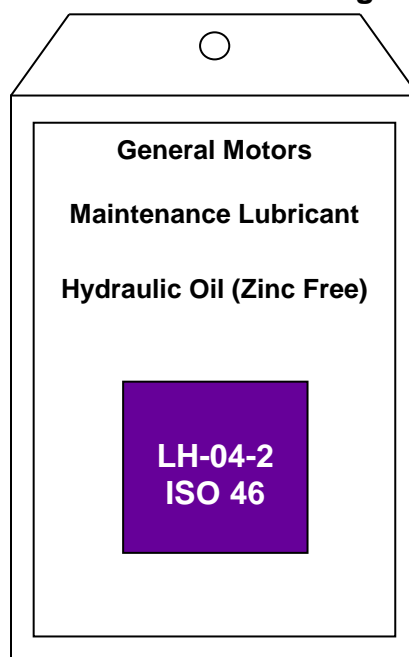
GM Code	Lubricant Type	Symbol	Color
LR-XX-1	EP Gear Oil Viscosity XX	Example: ISO Viscosity 68	Light Blue
LR-06-1	Viscosity 68 - 06	<div>LR-06-1 ISO 68 AGMA 2</div>	
LR-10-1	Viscosity 100 - 10		
LR-15-1	Viscosity 150 – 15		
LR-22-1	Viscosity 220 – 22		
LR-32-1	Viscosity 320 – 32		
LR-46-1	Viscosity 150 – 46		
LR-68-1	Viscosity 150 – 68		
Use this symbol & designation for all of the following LR fluids & types			
LS-01A-1	Spindle Oil	Example:	Light Brown
LS-01B-1	Viscosity 10(A) or 15(B)	ISO Viscosity 10	
LS-02-1	Spindle Oil Viscosity 22	<div>LS-01A-1 ISO 10</div>	
LS-03-1	Spindle Oil Viscosity 32		
LS-00A-2	High Speed Spindle Oil		
LS-00B-2	Viscosity 2(A) or 5(B)		
LS-01-2	High Speed Spindle Oil Viscosity 10		
Use this symbol & designation for all of the following LS fluids & types			
LW-XX-1	Way Oil Viscosity XX	Example: ISO Viscosity 32	Red
LW-03-1	Viscosity 32- 03	<div>LW-03-1 ISO 32</div>	
LW-06-1	Viscosity 68- 06		
LW-22-1	Viscosity 220- 22		
Use this symbol & designation for all of the following LW fluids & types			

**For a Complete Listing Refer to GM LS-2 Standard Appendix G**

## GM LS-2 Lube Standards Color & Symbol Tag Examples



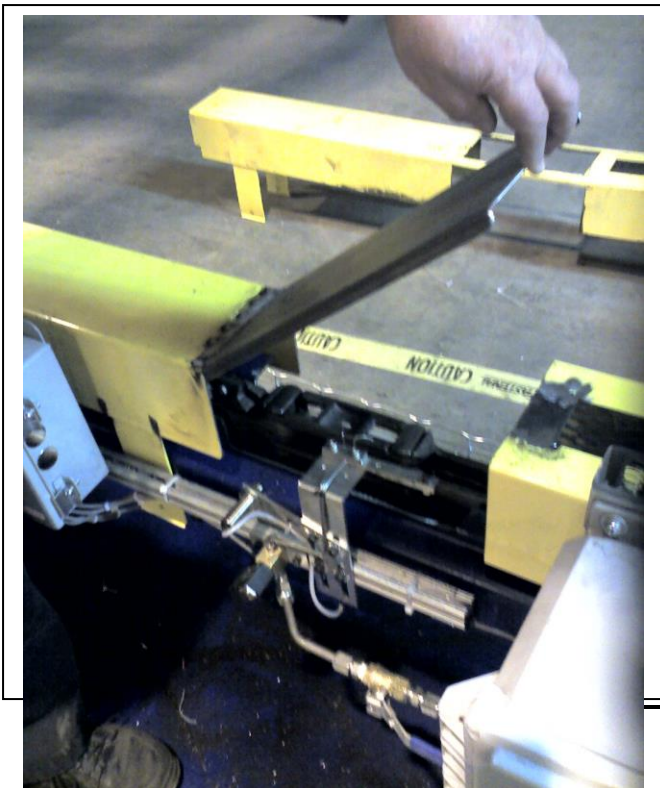
### Transfer Container Tag



LORDSTOWN ASSEMBLY	
<b>Tribol 1066-68</b>	<b>343397</b>
Chemical Name	FID
<b>Castrol - Tribol</b>	<b>04 Metal Working Fluids &amp; Lubricants</b>
Manufacturer	Safe Use Category
<b>Warning</b> 04 Overexposure may result in respiratory irritation. Eye and skin irritation. Dry or cracked skin, rash, redness and/or burning, itching. May cause dermatitis in sensitive individuals. Gastrointestinal disturbance. May be harmful by skin absorption	
<b>HEALTH HAZARD</b> 4 DEADLY 3 EXTREME DANGER 2 HAZARDOUS 1 SLIGHTLY HAZARDOUS 0 NORMAL MATERIAL	<b>FIRE HAZARD</b> <b>FLASH POINT</b> 4 BELOW 73°F 3 BELOW 100°F 2 ABOVE 100°F NOT EXCEEDING 200°F 1 ABOVE 200°F 0 WILL NOT BURN
<b>LW-06-1</b> <b>ISO 68</b>	<b>REACTIVITY</b> 4 MAY DETONATE 3 SHOCK AND HEAT MAY DETONATE 2 VIOLENT CHEMICAL CHANGE 1 UNSTABLE IF HEATED 0 STABLE
GLOVES CHEMICAL GOGGLES	
Comments:	

## Appendix E

### CONVEYOR LUBRICATOR GUARDING EXAMPLES



## Appendix F

### GM CONVEYANCE EQUIPMENT LUBRICATION SYSTEM PIPING & WIRING GENERAL CONDUCTOR REQUIREMENTS:

#### Air

Rigid Air Supply Conductor(s) shall be ANSI / ASME schedule 40 Black Pipe.  
Flexible Air Supply Conductors shall be Fiber Reinforced Industrial Grade Rubber Air Supply Hose.

#### Lubricants

Rigid Steel Conductors that meet or exceed **ISO 3304-R-37-NBK or SAE Standard J-525** shall be utilized on all grease and/or oil lubrication applications where there is no motion between components.  
Stainless steel conductors that meet or exceed **ASTM Standard A249/A26** shall be used when corrosive and or high oxidation conditions exist.

Where motion occurs between components, Flexible Conductors that meet or exceed **ISO 1436-2AT or SAE J-517 (100-R2) Standard** shall be used. Flexible conductor runs shall be kept to a maximum length of 3.28 feet (1 meter). **SAE J-516 (37 degree)** female swivel end fittings / connectors shall be used on all flexible conductor ends.

System pressures shall not exceed 1500 PSI (103.4 bar) for Oil, and 2000 (137.9 bar) for Grease. All rigid and flexible conductors must be capable of handling maximum / full system pressure. All flexible conductors and associated fittings / connectors shall be of the same manufacturer. All joints and connections shall be free of any leaks.

All rigid and flexible conductors shall be securely mounted. Cadmium plated steel clamps shall be utilized for rigid conductors. Hydraulic tube clamps shall be utilized for flexible conductors.

All rigid and flexible conductors that are not readily traceable shall be identified with a permanent label at both ends of the conductor for identification.

#### **Grease Lubricated Systems**

**Automatic Conveyor Trolley, Carrier Trolley, Side Guide Roller, Pivot Point, Transfer and / or Transport Lubrication Systems.**

#### Air Supply

1. Rigid Air Supply Conductors shall be 3/8 inch (9.25mm) minimum
2. 3/8 inch (9.25mm) minimum "Venting" type lockable Ball Valve shall be utilized at all terminating ends of the Rigid Air Supply Conductors.
3. A 3/8 inch (9.25mm) minimum Flexible Industrial Grade Rubber conductor with Quick-Connect" shall be utilized for connection between the Ball Valve and the Pump Air inlet.

4. A 3/8 inch (9.25mm) minimum Flexible Industrial Grade Rubber conductor with “Quick-Connect” shall be utilized for connection between the Ball Valve and all Lubricator Modules requiring Air to operate.

### **Grease Supply**

One Grease Supply Pump shall serve not more than 1 (one) Lubricator Module.  
“Quick-Connect” fittings shall not be utilized in any grease supply conductors.

1. A 3/4 inch (19.05mm) minimum Flexible conductor shall be utilized for connection between the grease supply Pump and the Lubricator Module.
2. A 3/4 inch (9.25mm) minimum “Non-Venting” type lockable Ball Valve shall be utilized between the Pump and the Flexible Conductor.

### **Remote Grease Supply**

Rigid Grease Supply Conductor(s) shall be 3/4 inch (19.05mm) x .120 inch (3.05mm) wall thickness minimum, 4600 PSI (31.716 mPa) minimum pressure rated.

1. A 3/4 inch (19.05mm) minimum Flexible conductor shall be utilized for connections at both ends of the Rigid Grease Supply Conductor.
2. A 3/4 inch (19.05mm) minimum 5000 PSI (344.74 bar) pressure rated lockable Hydraulic Ball Valves shall be utilized at both ends of the Rigid Grease Supply Conductor.

### **Conveyor Drives, Conveyance Lift, Transfer and Positioning Systems**

1. All rigid conductors less than 5 foot in length shall be 1/4 inch (6.5mm) O.D. minimum.
2. All rigid conductors over 5 foot in length shall be 3/8 inch (9.525mm) O.D. minimum.
3. GM CS-1 and / or GM CS-2 Conveyor Drives, Conveyance Lift, Transfer and Positioning Systems may utilize Parker HLB03 flexible Lubrication Tube with Parker 206 BU or 106 CY Fittings (or equivalents) for all Lubrication lines less than 5ft (1.5241m) in length
4. All Conductors shall be pre-filled with the **Plant Specified** GM LS-2 approved Grease.

### **Oil Lubricated Systems**

**Automatic and / or Manually Actuated Conveyor Chain, Trolley, Carrier Trolley, Side Guide Roller, Pivot Point, Transfer and / or Transport Chain Lubrication Systems**

### **Oil Reservoirs**

Lubricant Supply Conductor Vertical Runs (Head) shall not exceed 40ft (12.192m) elevation from the Reservoir. Lubricant Supply Conductor Horizontal Runs shall not exceed 300ft (91.44m) from the Reservoir.

All Lubricant Supply piping systems shall be pressure tested with Air, at 3 (Three) times anticipated Maximum System Pressure prior to system fill with Lubricant. Allowable pressure drop shall be no more than 1lb (.344 bar) over a 24 hour test period.

### **Power Supply**

All Central Supply Reservoirs shall be "Hard Wired" to their respective power supply. The power supply shall be labeled to indicate the source / origin of the power.

All Central Supply Reservoirs shall be labeled to identify the contents of the Reservoir.

All Central Supply Reservoirs shall be labeled to identify by name / number and location, the Specific Lubrication Modules / Systems they Supply.

### **Remote Central Oil Supply / Feed Systems (Manifold Piping)**

1. All Vertical Run Conductors shall be 1/2 inch (12.7mm) x .035 (.89mm) wall thickness minimum.
2. All Horizontal Run Conductors shall be 3/8 inch (9.53mm) x .028 (.71mm) wall thickness minimum.
3. All Individual Lubricator Module Feeder Drops shall be 1/4 inch (6.35mm) x .028 (.71mm) wall thickness minimum.
4. A 1/2 inch (12.7mm) minimum Non-Venting low pressure lockable Hydraulic Ball Valve shall be installed at the end of the Main Vertical conductor nearest the Supply Reservoir.
5. A 1/2 inch (12.7mm) Flexible conductor shall be utilized for the connection between the Remote Central Oil Supply Reservoir and the Main Vertical Conductor Ball Valve.

### ***Individual Lubricator Modules***

#### **Power Supply**

All individual Lubricator Modules, Controllers and Lubricant Supply Reservoirs requiring Electrical Power shall be "Hard Wired" to their respective power supply. The power supply shall be labeled to indicate the source / origin of the power.

All Individual Lubricator Modules and / or Controllers shall be labeled to identify the Central Supply Reservoir, by location, that supplies Lubricant to them.

#### **Air Supply**

1. Rigid Air Supply Conductors shall be 3/8 inch (9.25mm) minimum
2. 3/8 inch (9.25mm) minimum "Venting" type lockable Ball Valves shall be utilized at all terminating ends of the Rigid Air Supply Conductors.
3. A 3/8 inch (9.25mm) minimum Flexible Industrial Grade Rubber conductor with "Quick-Connect" shall be utilized for connection between the Ball Valve and all Lubricator Modules requiring Air to operate.

### **Lubricant Conductors**

1. 1/4 inch (6.35mm) minimum Non-Venting low pressure lockable Hydraulic Ball Valve shall be installed in the Feeder Drops for each / every individual Lubricator Module / Solenoid. The Ball valve shall be located not more than 6 inches (152.4mm) from the individual Lubricator Module(s) / Solenoid(s).
  2. Flexible Conductors shall not be utilized to connect the Oil Supply Lines / Drops to the individual Lubricator Modules except in those cases where the individual Lubricator Module incorporates an integral oil reservoir.
  3. Where individual Lubricator Modules utilize an integral reservoir a 1/4 inch (6.35mm) minimum Flexible Conductor with a "Quick-Connect" suitable for use with Petroleum or Synthetic Lubricants shall be utilized.
-



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