DESIGN, MANUFACTURING, SUPPLY, INSTALLATION SUPERVISION, COMMISSIONING, STARTUP & PERFORMANCE TESTING OF NEW CENTRIFUGAL COMPRESSORS AND MODIFICATIONS OF EXISTING TURBO COMPRESSORS TRAINS

Tender No. PROC-FC/CB/PROJ/QADIRPUR-4261/2019

PRE-BID CLARIFICATION No. OGDCL-QP-4261-005

Sr. No.	Bidder Query	OGDCL Response (25-03-2019)
AA	Following information's are still needed after site visit (13-03-2019)	
i	A detailed drawing of the gas turbine rotor and shaft end	Not available with OGDCL. Successful Bidder to corrdinate with Turbine OEM during detailed engineering phase as already mentioned in the tender.
ii	A torsional analysis of the gas turbine rotor after planned upgrade	Upgrade activity is under contract signing between Turbine OEM and OGDCL. However, any such information, Bidder may ask directly from the OEM (SOLAR contact person already nominated) as OGDCL already asked SOLAR to provide relevant
iii	If possible more information's about the planned upgrade on the SOLAR gas turbine	Bidder to ask specific information in this regard.
BB	Kindly provide the clear details of existing Lube Oil Systemincluding Grade Category,Pressure to Compressor,Temperatue and Quantity of Lubricating Oil.	Shell Turbo T-46 is used as lube oil. P&IDs already provided in the tender also uploaded in clarification. Furthermore, please see attached document for further information.
CC	Upgraded Mars 100-16000 Engine is mentioned in Attachment-1 of Compressor Date Sheet(0220-DS-1701-0). Pleaseclarify that whether the existing Engine will be upgraded. If, it is to be upgraded,pleaseprovidethe following documents of the upgraded Gas Turbine: - Environment data of design point performance (ambient temperature, ambient humidity and barometric pressure) - Corresponding power-rotation speed curve of Gas Turbine design point performance - P&ID Diagram - Instruments details - I/O list - Shaft head size - Logic diagram - Dynamical model of Gas Turbine Rotor - General Layout Drawing with Height of Center.	Upgrade activity is under contract signing between Turbine OEM and OGDCL. However, any such information, Bidder may ask directly from the OEM (SOLAR contact person is nominated and informed through Clarification 1) as OGDCL already asked SOLAR to provide relevant data/information to all prospective bidders.

6.1 GENERAL DESCRIPTION

Refer to the Lube Oil System Schematic (149291) when reading this section.

The lube oil system includes the lubricating oil system and the servo oil system. The systems serve a distinct and separate function, and they are fundamentally interrelated. Both systems are supplied oil from the main lube oil reservoir, and both utilize certain common components.

The lubricating oil system provides oil for the engine, accessory gearbox, gear unit, and driven equipment bearings.

The servo oil system generates high pressure servo oil flow to operate the electrohydraulic fuel control actuator, servo valves, and actuators for the engine combustor bleed valve and the variable inlet guide vanes.

6.1.1 Petroleum Lubricating Oil

The selection of a qualified lubricating oil ensures the proper lubrication and long life of the engine and components. Petroleum lubricating oil, ISO VG 46 (S215), is the oil to be used for your installation. Petroleum lubricating oil is used for normal operating service in the turbine engine and accessories, the output drive assembly, and the driven equipment. Refer to Solar Specification ES 9-224 for other qualified oils which may be used for your installation.

⚠ CAUTION

Before changing from one lubricating oil type to another, contact Solar Turbines Customer Services.

Petroleum oil consists of refined paraffinic petroleum oil with suitable additives to meet the physical and chemical requirements in Table 6.1.1. Petroleum oil shall not contain additives that are degradable below 284°F (140°C), or are water-separable. Additives shall remain uniformly distributed throughout the oil at all temperatures above the pour point up to 284°F (140°C). ISO VG 46 (S215) oil is suitable for use in cold to moderate climates. Pour point of the oil shall be 11°F (6°C) below ambient temperature.

NOTE

Petroleum lubricating oil is suitable for preservation of the engine and components for a period of up to 90 days. Contact Solar Turbines Customer Services for special instructions for preservation if storage, shipping, or down-time longer than 90 days is expected.

Petroleum oil operating temperature limits for ISO VG 46 (S215) oil are as follows:

- Ambient air temperature limits of 26°F to 110°F (-3°C to 43°C)
- Operating oil temperature limits into engine of 125°F to 180°F (52°C to 82°C).

Table 6.1.1 Petroleum Oil Physical and Chemical Requirements

ASTM STD	ITEM	PETROLEUM OIL ISO VG 46 (S215)[1]
D445	Viscosity at 104°F (40°C) SSU (cSt - mm²/s) Max	235 (50.6)
D445	Viscosity at 212°F (100°C) SSU (cSt - mm²/s) Min	46.0 (6.04)
D92	Flash Point, COC, °F (°C) Min	390 (199)
D92	Fire Point, COC, °F (°C) Min	450 (232)
D97	Pour Point, °F (°C) Max	+15 (-9.5)
D130	Copper Corrosion at 212 °F (100°C), 3 hours	Class 1b
D664	Neutralization (Total Acid) No., mgKOH/g Max	0.20
D665	Rust Prevention, Procedure B	Pass
D892	Foam Limits, Millimeters Max Sequence 1 Sequence 2 Sequence 3	 25/0 50/0 25/0
D943	Oxidation Resistance, Min No. of Hours to 2.0 Neutralization Number	2000
D1298	Specific Gravity, 60/60°F (15/15°C)	0.86-0.88
D1401	Emulsion Test	40-40-0 (60)
D2788	Zinc, Weight %, Max	0.005
D1744	Water, Weight, Parts Per Million, Max	200 (0.02 wt. %)
D1947	Load Carrying Capacity, lb/in., Min	1000
D2155	Auto Ignition Temperature °F (°C) Min	590 (310)
D2266	Wear Preventative Characteristic, Scar Diameter, Millimeters max (167°F [75°C] 1200rpm, 88.1 lb [40kg], 1 hour)	0.90
D2270	Viscosity Index, Min	90
D2273	Sediment Volume % Max	0.005

NOTES:

(1) Viscosity Grade per ASTM Standard D2422

6.1.2 Startup Limitations

⚠ CAUTION

Solar equipment is not intended to operate above the maximum operating oil temperature limits into engine.

The oil selected must have a pour point at least 11°F (6°C) below the minimum ambient temperature to ensure flow at startup. Before engine startup, oil temperature in the entire lubrication system shall be at least 11°F (6°C) above the oil pour point. Suitable heaters and auxiliary pumps may be used to ensure proper oil viscosity in the system prior to startup.

NOTE

The maximum startup viscosity is 375 SSU (80 mm^2/s, or cSt). This is equivalent to grade S150 (C32) at 32°F (0°C).

6.1.3 Oil Service Life

NOTE

Analyze oil samples of new oil, before use. The results of the analysis can then be used as a basis for comparison in determining oil degradation during service life.

The service life of oil is limited by a viscosity change, an increase in Total Acid Number, or by the presence of water. Check the oil on a regular basis (once a month) for contamination and degradation. Degradation varies with each application. Actual limits must be determined by customer experience. The oil must be drained and replaced whenever any of the following criteria is met:

- Viscosity increases by 20%
- Viscosity decreases by 10%
- Total Acid Number is 0.4 or greater
- Water content is 2000 parts per million or greater

6.2 FUNCTIONAL DESCRIPTION

The following is a functional description of the lube oil system. To follow along with the description or to determine prescribed limits or values in the following paragraphs, refer to the Lube Oil System Schematic (149291).

6.2.1 General Lube Oil Flow

The lube oil system provides oil delivered by the Main Lube Oil Pump/Motor Assemblies (BP901-1, BP901-2) to the lube oil manifold. The oil is maintained at a nominal engine inlet pressure by the Main Lube Oil Pressure Control Valve (PCV901). Oil pressure is supplied by the servo oil system to the Guide Vane Control Actuator (L339), Bleed Valve Control Actuator (L338), and fuel actuator, causing the actuator pistons to move in response to electrical signals from the control system.

A small amount of oil also flows to the Air/Oil Cooler (HX901-1). The Temperature Control Valve (TCV901-1) will divert most of the oil from cooler HX901-1 until oil temperature reaches a predetermined setting. Control valve TCV901-1 then gradually closes to supply oil to cooler HX901-1 in proportion to oil temperature. From oil cooler HX901-1, oil flows through the Main Lube Oil Filters (FS901-1, FS901-2) to the oil supply manifold, then through various branch lines to points of lubrication.

6.2.2 Lube Oil Pump Checks

NOTE

In the following two paragraphs, the selected Main Lube Oil Pump/Motor Assembly (BP901-1 or BP901-2), is the pump which has been selected on the control console. While the standby Main Lube Oil Pump/Motor Assembly (BP901-1 or BP901-2) is the other pump.

Therefore, in the following paragraphs, we will assume that pump/motor assembly BP901-1 is the selected pump/motor assembly and that pump/motor assembly BP901-2 is the standby pump/motor assembly.

When the start cycle begins, the control system tests the Postlube Backup Lube Oil Pump (MP903) (Figure 6.2.1). If the pump MP903 pressure reaches 8 psi (55.1 kPa), the control system deactivates the pump MP903. When the pressure decreases by 1 psi (6.89 kPa), standby pump/motor assembly BP901–2 is energized.

If the standby pump/motor assembly BP901–2 pressure reaches 8 psi (55.1 kPa), the control system deactivates the standby pump/motor assembly BP901–2. When the pressure decreases by 1 psi (6.89 kPa), selected pump/motor assembly BP901-1 is energized. If the selected pump/motor assembly BP901–1 pressure reaches 8 psi (55.1 kPa), the control system allows the engine prelube cycle to begin.

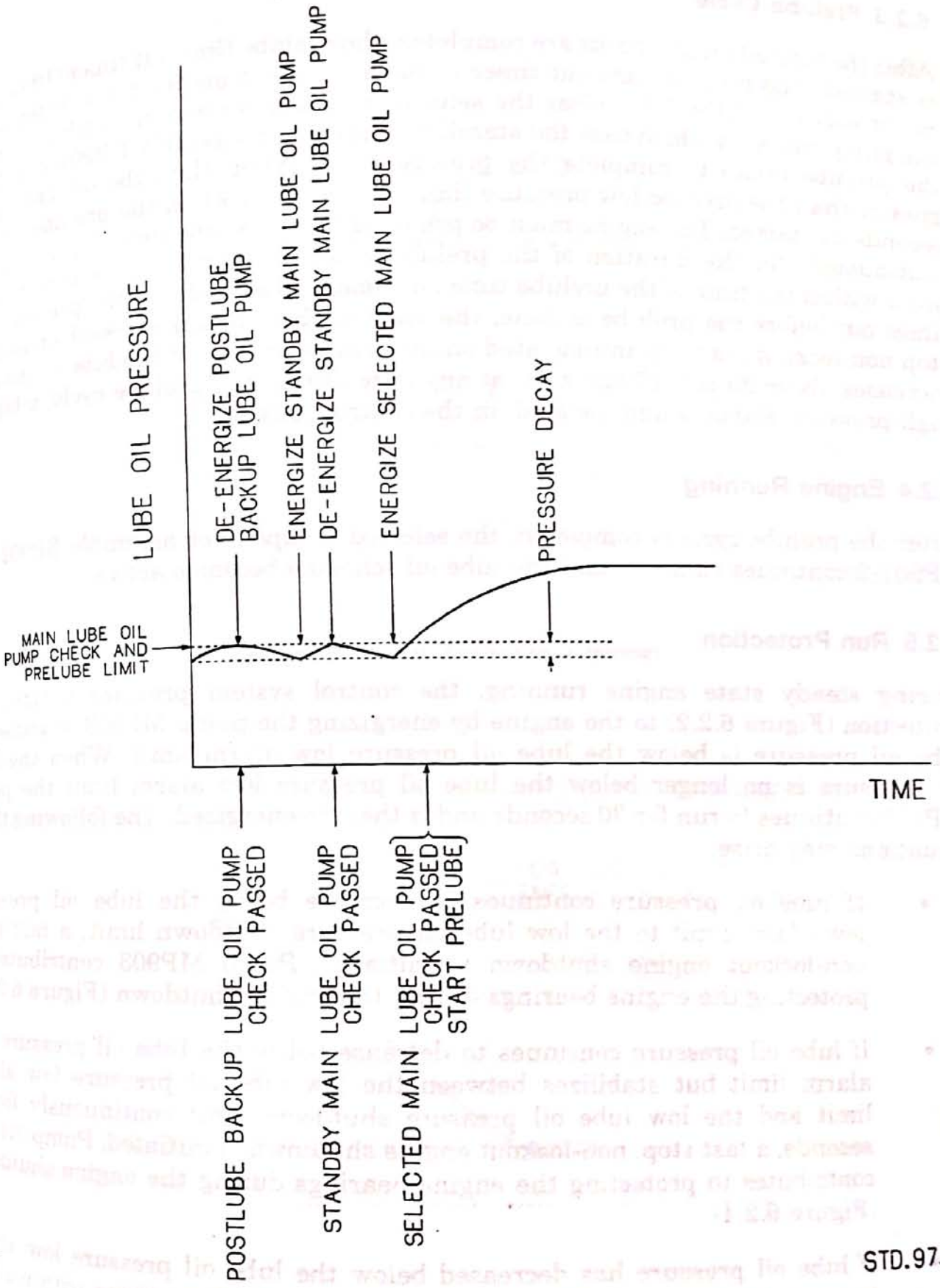

Figure 6.2.1 Postlube Backup Lube Oil Pump and Selected and Standby Main Lube Oil Pump Check

6.2.3 Prelube Cycle

After the lube oil pump checks are completed, the prelube time out timer (10 seconds) is started. The prelube time out timer is the allowable time for the selected pump/motor assembly BP901-1 (unless the selected pump/motor assembly BP901-1 failed the pump check, in which case the standby pump/motor assembly BP901-2 performs the prelube cycle) to complete the prelube cycle. When the lube oil pressure is greater than the prelube low pressure limit of 8 psi (55.1 kPa), the prelube timer (5 seconds) is started. The engine must be prelubed at a pressure above 8 psi (55.1 kPa) continuously for the duration of the prelube timer (5 seconds). This prelube must occur within the time of the prelube time out timer (10 seconds). If the prelube timer times out before the prelube is done, the start is aborted and a prelube failed fast stop non-lockout alarm is annunciated on the control console. If the lube oil pressure increases above 25 psi (172.25 kPa) at any time during the prelube cycle, a lube oil high-pressure alarm is annunciated on the control console.

6.2.4 Engine Running

After the prelube cycle is completed, the selected pump/motor assembly BP901-1 or BP901-2 continues running, and the lube oil schedule becomes active.

6.2.5 Run Protection

During steady state engine running, the control system provides normal run protection (Figure 6.2.2) to the engine by energizing the pump MP903 anytime the lube oil pressure is below the lube oil pressure low alarm limit. When the lube oil pressure is no longer below the lube oil pressure low alarm limit the pump MP903 continues to run for 30 seconds and is then de-energized. The following three situations may arise:

- If lube oil pressure continues to decrease below the lube oil pressure low alarm limit to the low lube oil pressure shutdown limit, a fast stop, non-lockout engine shutdown is initiated. Pump MP903 contributes to protecting the engine bearings during the engine shutdown (Figure 6.2.3).

- If lube oil pressure continues to decrease below the lube oil pressure low alarm limit but stabilizes between the low lube oil pressure low alarm limit and the low lube oil pressure shutdown limit continuously for 6 seconds, a fast stop, non-lockout engine shutdown is initiated. Pump MP903 contributes to protecting the engine bearings during the engine shutdown (Figure 6.2.4).

- If lube oil pressure has decreased below the lube oil pressure low alarm limit, and the pump MP903 has cycled on and off three times within a minute period, a fast stop, non-lockout engine shutdown is initiated. Pump MP903 contributes to protecting the engine bearings during the engine shutdown (Figure 6.2.5).

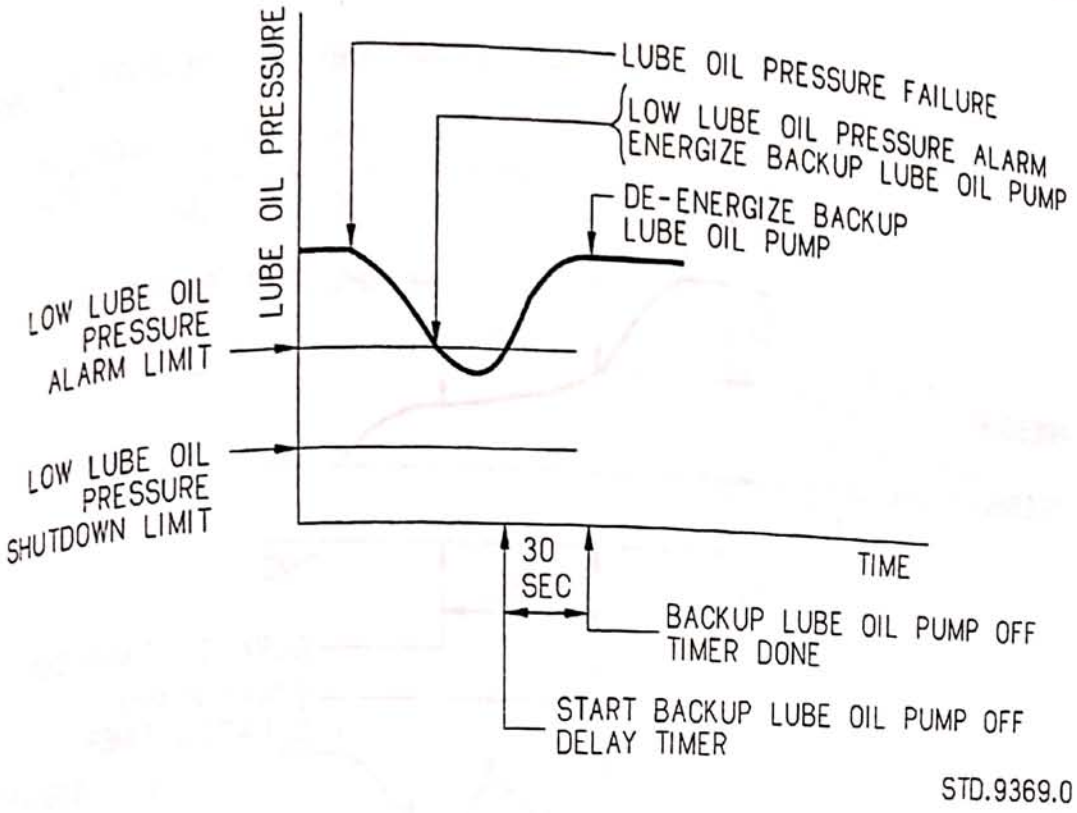

Figure 6.2.2 Run Protection - Normal

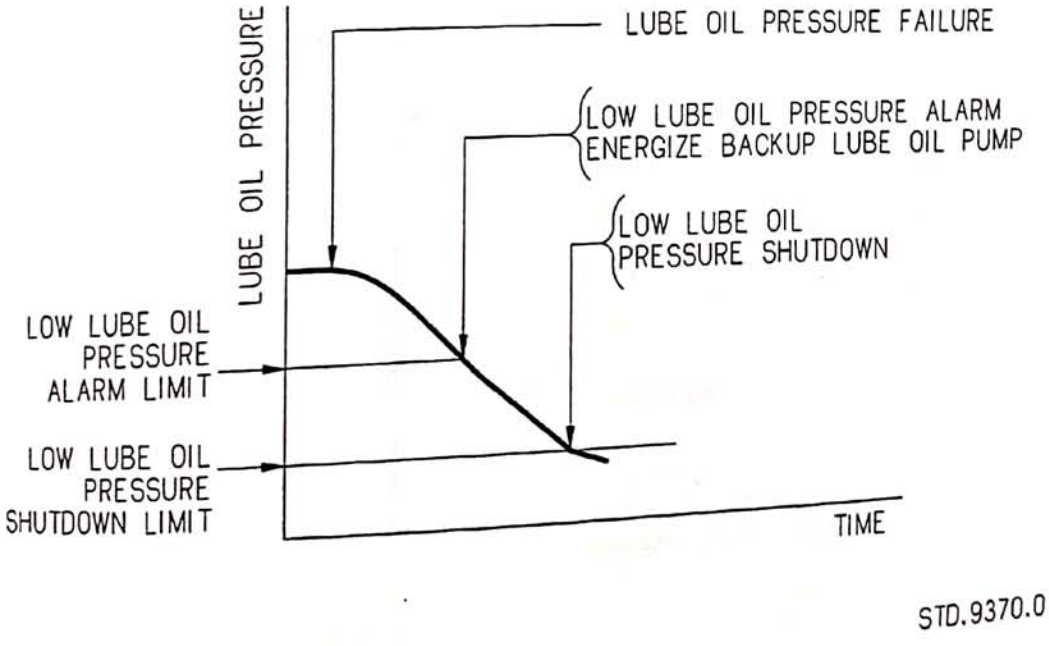

Figure 6.2.3 Run Protection - Lube Oil Pressure Below Shutdown Limit

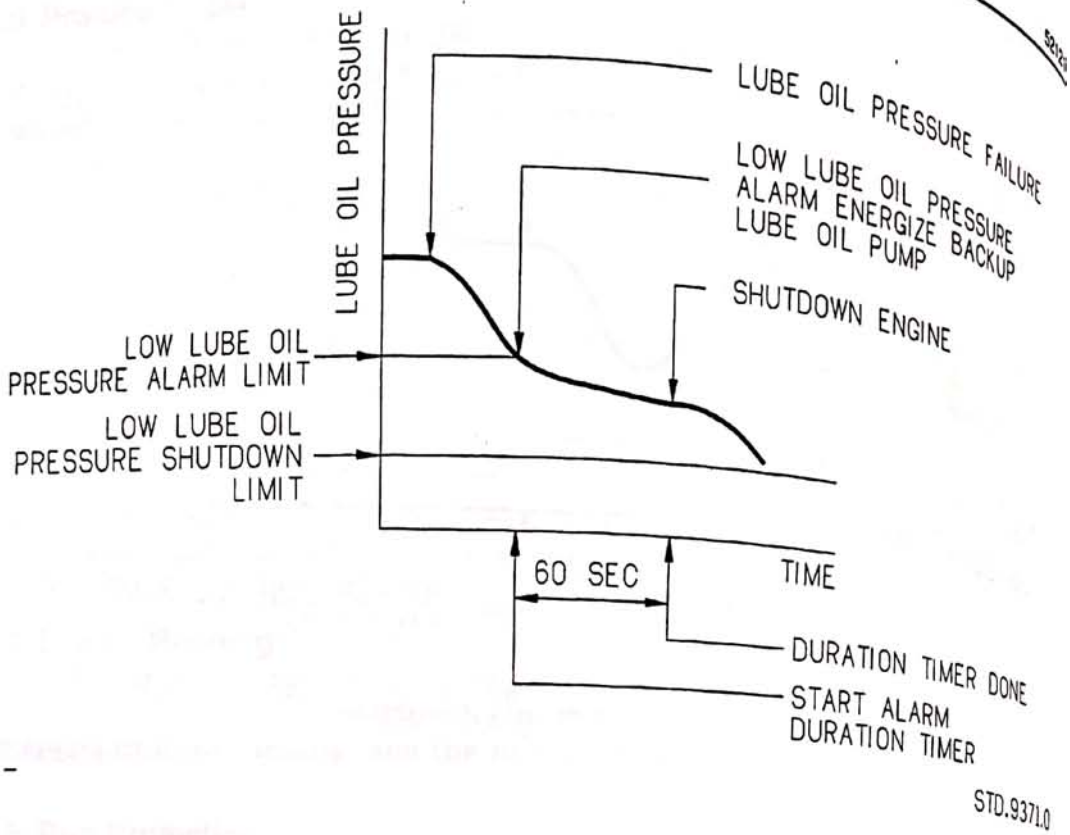

Figure 6.2.4 Run Protection - Lube Oil Pressure Stabilized Low

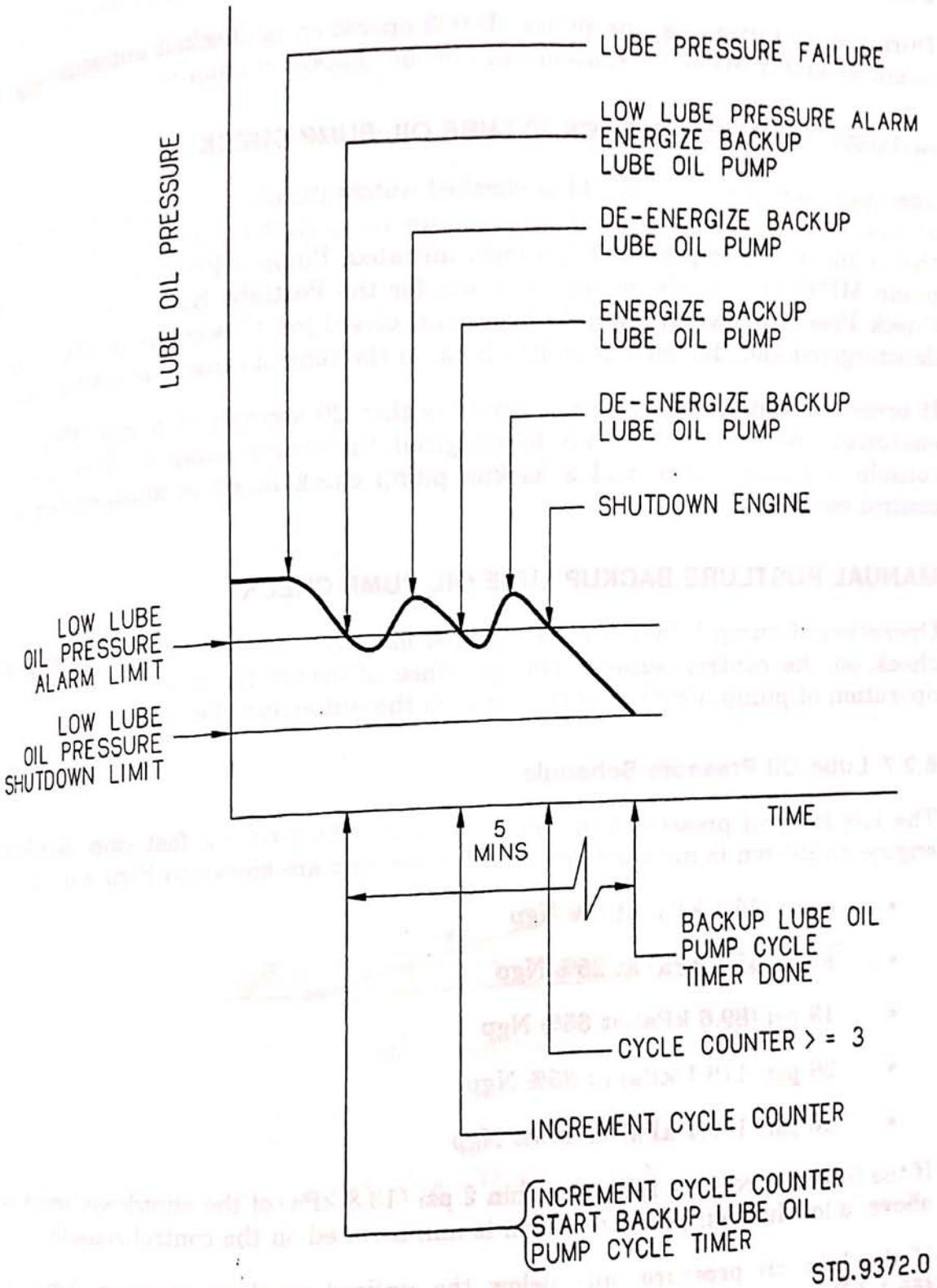

Figure 6.2.5 Run Protection - Lube Oil Pressure Cycling

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6.2.6 Postlube Backup Lube Oil Pump Checks

During engine running, the pump MP903 operation is checked automatically. The pump assembly MP903 operation can also be checked manually.

AUTOMATIC POSTLUBE BACKUP LUBE OIL PUMP CHECK

The operation of pump MP903 is checked automatically each 24 hours. Every day at 12:00 pm, a backup pump check is annunciated on the control console, indicating that a check of pump MP903 has been initiated. Pump MP903 is energized. When pump MP903 has made enough pressure for the Postlube Backup Lube Oil Pump Check Pressure Switch (S322-5) to remain closed for 10 seconds, pump MP903 is de-energized and the backup pump check on the control console is extinguished.

If pressure switch S322-5 is not closed within 20 seconds of pump MP903 being energized, then: pump MP903 is de-energized; the backup pump check on the control console is extinguished; and a backup pump check failed is annunciated on the control console.

MANUAL POSTLUBE BACKUP LUBE OIL PUMP CHECK

Operation of pump MP903 can be checked manually by selecting the backup pump check on the control console. The sequence of events for manually checking the operation of pump MP903 are the same as the automatic check above.

6.2.7 Lube Oil Pressure Schedule

The low lube oil pressure shutdown limits, at which time a fast stop, non-lockout engine shutdown is initiated, are listed below and are shown in Figure 6.2.6.

- 8 psi (55.1 kPa) at 0% Ngp
- 8 psi (55.1 kPa) at 25% Ngp
- 13 psi (89.6 kPa) at 65% Ngp
- 26 psi (179.1 kPa) at 85% Ngp
- 26 psi (179.1 kPa) at 110% Ngp

If the lube oil pressure falls to within 2 psi (13.8 kPa) of the shutdown limits listed above, a low lube oil pressure alarm is annunciated on the control console.

If the lube oil pressure falls below the unfired rundown pressure limit, 8 psi (55.1 kPa), when the engine is turning, a bearing inspection may be required alarm is annunciated on the control console.

The high lube oil pressure alarm limit, at which time a lube oil high-pressure limit alarm is annunciated on the control console, is as follows:

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- 25 psi (172.25 kPa) at 0% Ngp
- 45 psi (310.05 kPa) at 30% Ngp
- 45 psi (310.05 kPa) at 110% Ngp

There is a running region above 68.1 percent Ngp that allows a lower pressure of 15 psi (103.4 kPa) for a period of five seconds to accommodate transfers between the selected pump/motor assembly BP901-1 or BP901-2 and the standby pump/motor assembly BP901-1 or BP901-2.

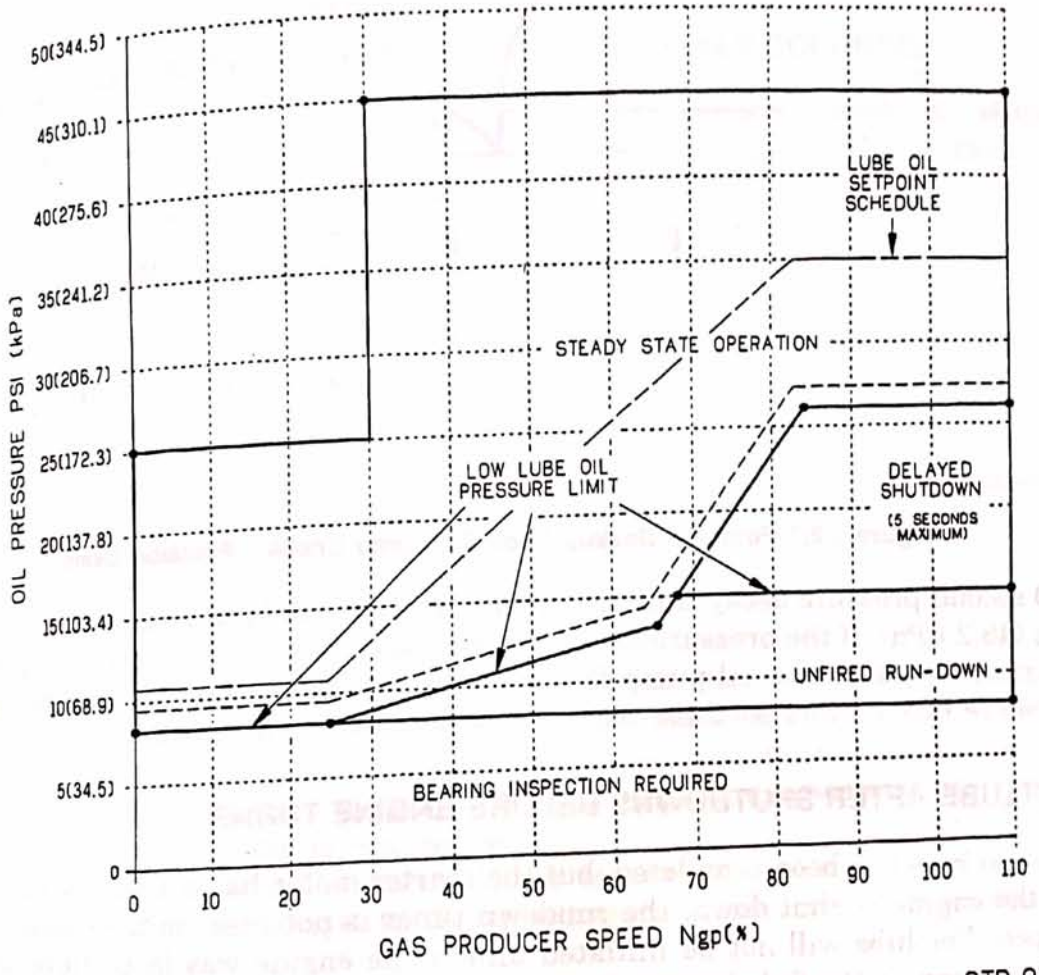

Figure 6.2.6 Lube Oil Pressure Schedule