Final Acceptance of Instruction Manual

Customer: Austin Generator Service
W.O. #: 63798-07-43/2
Load Bank Types: Saturn 3000 DV

1 Manual Shipped for the Load Bank described above.
2550KW/3000KW, 480/600V, 60KW Res,
LCL PLC, INT/EXT CP, Powered Louvers
File: 63798-2.p65, Disk: SDCX155

This instruction manual has been reviewed and is approved by me as being fully accurate and representative of the equipment being supplied thereunder and it (the manual) meets the customer's specification/order requirements for manuals.

Approved by: Date:

1 Manual Received by: Date:

LOAD BANK
TECHNICAL MANUAL

Customer: Austin Generator Service

Work Order: 63798-07-43/2

Model: Saturn 3000 DV

June 2007

(File: 63798-2.p65; Disk: SDCX155)

Contents

DESCRIPTION

Simplex Load Banks are precision test instruments specifically designed to apply discrete, selectable electrical load to a power source while measuring the response of the generator to the applied load. They also provide a means for routine maintenance exercise to assure long term reliability and readiness of the standby generator. Exercise Load Banks eliminate the detrimental effects of unloaded operation of diesel engine generators.

The cabinet on this Load Bank is rated NEMA Type 3R outdoor weatherproof.

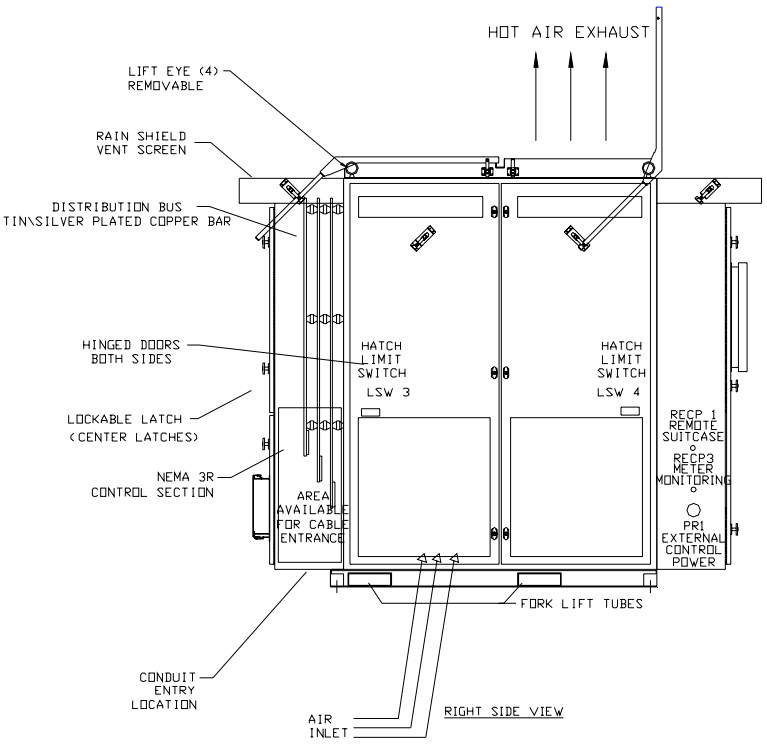
Power source testing is accomplished by applying resistive load steps at unity (1.0) power factor.

Load application is by magnetic contactor. All load branch circuits are protected by 200,000AIC class-T fuses.

Operating controls are located on a Local Control Panel and a Remote Control Panel. The Control System is comprised of 120V and 24VDC discrete components. Common serviceable components include Control Fuses (CF1–CF4) and Load Application Fuses (F1–F189). Lamps on the Local Control Panel indicate the Load Bank operating status. Control priority is determined by the "Mode Selector" switch.

⚠ WARNING ⚠

Always remove all power from the load bus and all fan/control power before servicing the Load Bank. Never operate or service a Load Bank that is not properly connected to an earthground.



Part of Pictorial Drawing 47BD164460C

SPECIFICATIONS

Capacity:	2560KW/3000KW @ 1.0 PF
Voltage:	480/600VAC
Connection:	3-Phase, 3-Wire
Frequency:	60Hz
Fan Power:	Int./Ext. 480/600V, 3ø, 60Hz
Control Power:	Int./Ext. 480/600V, 3ø, 60Hz 120V Transformer
Cooling:	Forced Air
Airflow:	60,000 CFM
Max. Air Intake Temp.:	120°F
Nominal Air Temp. Rise:	125°F–500°F Max.
Temperature Rise:	$°F = \frac{KW \times 3000}{CFM}$
Duty Cycle:	Continuous
Serial Number:	63798-07-43/2

The Local Control Panel contains the following components:

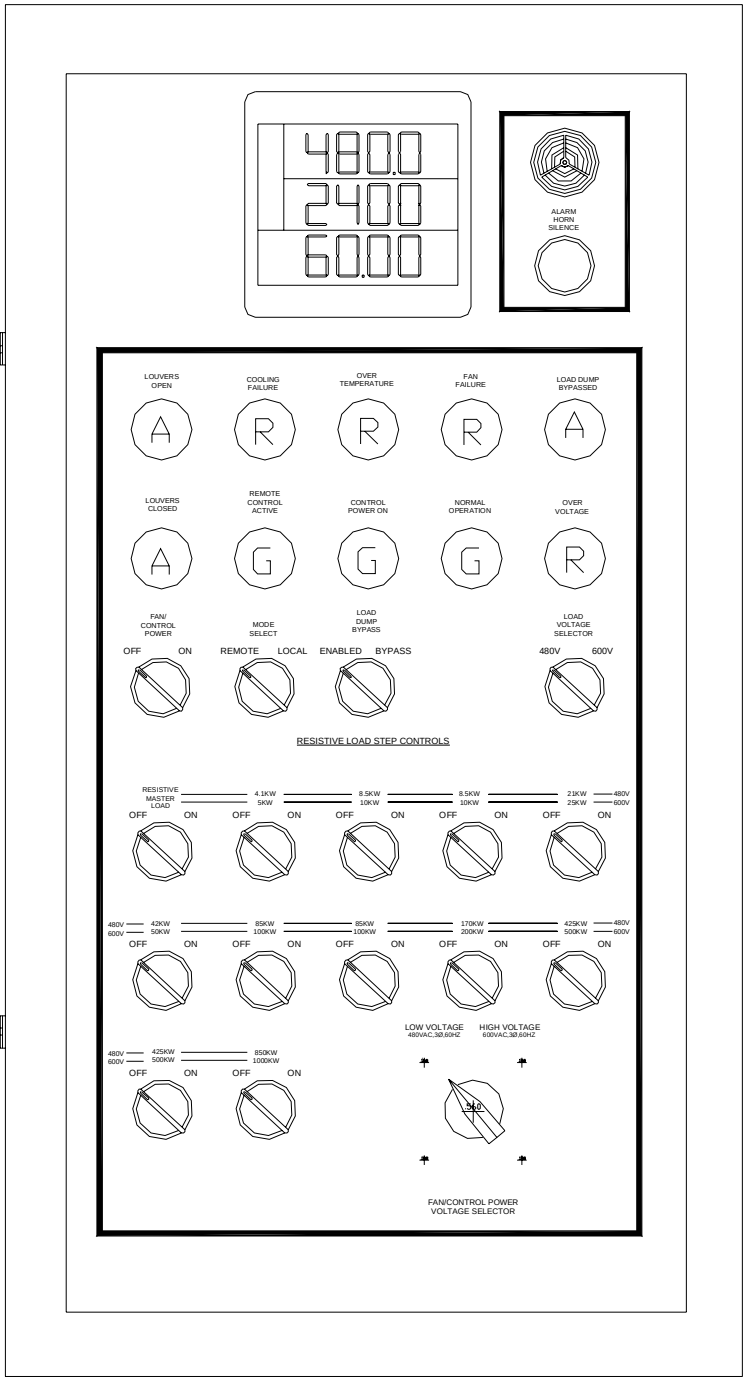
1. Louvers Open, Cooling Failure, Over Temperature, Fan Failure, Access Door Ajar, Louvers Closed, Remote Control Active, Control Power On, Normal Operation, and Load Dump Bypassed indicator lamps
2. Fan/Control Power switch
3. Load Bank Mode switch
4. Auto Load Dump switch
5. Load Voltage Selector switch
6. Master Load and load step switches
7. Fan/Control Power Voltage Selector switch

The Remote Control Touch Panel is housed in a suitcase.

This Load Bank is protected against cooling failures (loss of cooling air flow, high intake or exhaust air temperature which could damage the Load Bank or present a safety hazard to the operator). When a cooling failure occurs the automatic safety features in the Control System immediately remove the load from the load source. The malfunction must be corrected and the system must be reset by turning the Load Bank "Off" then "On" before the load can be re-applied.

The Load Bank consists of three principal systems:

1. Control System
2. Cooling System
3. Load System



CONTROL SYSTEM

The Control System allows the operator to apply a desired load to the test source and measure the response of the test source to the load. This system also contains the circuitry utilized to disconnect the load from the test source in the event of cooling failures and/or improperly positioned operating controls.

Fan power is applied to the Fan Motor (MOT) through the Fan Circuit Breaker (FCB 1A or FCB 1B), the Disconnect Switch (DSW), the Fan/Control Voltage Selector swtich (S1), the Auto Transformer, and the Fan Motor Contactor (FMC) contacts. An Overload Relay (OVR) is used to protect the motor.

COOLING SYSTEM

Resistive Load Elements are cooled by a forced air system consisting of a 60" fan blade belt driven by a 30HP, TEFC motor, creating a 50,000 CFM. The fan motor is energized by a 60A, 600V, 3 pole contactor (FMC) and protected by a 100A frame, 60A trip, 3 pole, 600V circuit breaker (FCB).

LOAD SYSTEM

The Load System consists of independently controlled resistive and/or reactive load elements specifically designed for Load Bank systems. They are protected by 200,000AIC, 600VAC fuses.

Simplex Resistive Load Elements conservatively operate at approximately half the maximum temperature rating of the alloy (1080°F vs. 1920°F). For example:

Alloy: FeCrAl

See Parts Legend Drawing for specific elements used.

These elements are rigidly supported by high-temperature, ceramic-clad, stainless-steel supports. Element-to-element short circuits are virtually eliminated. The elements are assembled in discrete trays which are assembled in a vertical “stack”. Each tray is independently serviceable without disturbing adjacent trays.

PRIMARY INSPECTION

Preventative visual inspections of the shipping crate and Load Bank is advised. Physical or electrical problems due to handling and vibration may occur. Never apply power to a Load Bank before performing this procedure. The following Nine Point/30 Minute Inspection is recommended before installation, as part of the 50 hour / 6 month maintenance schedule and whenever the Load Bank is relocated:

1. If crate shows any signs of damage examine the Load Bank in the corresponding areas for signs of initial problems.
2. Check the entire outside of the cabinet for any visual damage which could cause internal electrical or mechanical problems due to reduced clearance.
3. Inspect all hinged panels and doors for smooth and safe operation, try all latches and knobs.
4. Rotate and push all switches through all positions to ensure smooth operation.
5. Check cooling system by inspecting fan motor and blade. Slowly rotate blade by hand and note clearance of blade tip through its rotation near the housing. Observe free rotation of motor shaft.

If any problems are observed during Primary Inspection call the Simplex Service Manager at 217-483-1600 (24hrs.)

6. Inspect all relays, timers, and control modules by opening all accessible panels. Make sure all components are secure in their bases and safety bails are in place. Spot check electrical connections for tightness. If any loose connections are found inspect and tighten all remaining connections.
7. Examine all accessible internal electrical components such as fuses, contactors and transformers. Check lugged wires at these components.
8. Inspect bottom of crate/enclosure for any components that may have jarred loose during shipment such as indicator light lenses, switch knobs, etc.
9. Visually inspect element chamber for foreign objects, broken ceramic insulators, mechanical damage.

INSTALLATION

LOCATION

Nema-3R Load Banks are intended for outdoor installation. The load elements in this Load Bank are cooled by a forced air system which discharges through the top of the cabinet. This Load Bank will produce a large quantity of exhaust air. Location of the Load Bank is of prime importance and should be done by trained personnel. It is one of the most critical factors involved in safe operation. The Load Bank must be positioned and installed according to large airflow requirements.

- There must be a minimum clearance of 6 feet on all sides of the Load Bank.
- Load Banks installed indoors must be equipped with an exhaust air duct of minimum back pressure (supplied by others) which routes all Load Bank hot exhaust air outdoors.
- Never install any structure or object at any height above the Load Bank.
- Always locate the Load Bank in a secure area accessible by trained personal only.
- Use the eyehooks and forklift channels provided to position the Load Bank.
- Never move the Load Bank with the exhaust hood attached.
- Never point the exhaust at a nearby surface or object which may be adversely affected by high temperature.
- Never operate the Load Bank in a confined space without regard for adequate intake of air and provision for exit of high temperature exhaust.
- Consider that the Load Bank and a nearby generator set may have to compete for cooling air.
- Never bounce hot exhaust air off nearby objects and allow it to recirculate through the cooling system.
- Never operate the Load Bank in proximity to a sprinkler system.

Failure to properly install this Load Bank may result in substantial damage to or the destruction of the Load Bank, adjacent equipment and the building in which the Load Bank is installed.

⚠ WARNING ⚠

Never operate or service a Load Bank that is not properly connected to an earthground.

PROCEDURE

1. Confirm the test source is properly grounded and ground the Load Bank in compliance with NEC.
2. If Remote Control is desired, using CAT 5 Patch Cable, connect the laptop computer to Receptacle 3 on the Load Bank.
3. Confirm all load command switches are in the "Off" position.
4. Confirm the Disconnect Switch (DSW) is in the "Off" position.
5. *See Fan/Control Power Drawing 47B164462B.* Connect and external 480/600V, 3ø, 60Hz, 60A source to FCB 1A as shown.

   Consult NEC for proper wire size.
6. *See Control Drawing 47B164461C.* Using #14 AWG copper wire or greater with a torque of 35 in. lbs., connect customer supplied Load Dump contacts to TB'LD' 1–2 or place the "Load Dump Mode" switch in the "Bypass" position.

   Load is disengaged when the contact is open.

   Load is engaged when the contact is closed.
7. *See Resistive Load Section 1 Drawing 47B164469.* Cable the load source to the Load Bank as shown.

   Consult NEC for proper wire size.
8. Place the Disconnect Switch (DSW) in the "On" position.
9. Place the Fan Circuit Breakers (FCB 1A or FCB 1B) in the "On" position.

OPERATION

LOCAL

1. Place the "Load Voltage Selector" and "Fan/Control Power Voltage Selector" switches in the appropriate positions.
2. Place the "Load Bank Mode" switch in the "Local Manual" or "Remote" position.
3. Start-up generator or bring other test source on line.

   If External Fan/Control Power is being used, "Fan/Control Power" switch in the "On" position to energize the cooling fan before starting the generator to assure proper fan operation.
4. Adjust power source voltage and frequency.
5. Place the "Fan/Control Power" switch in the "On" position to energize the cooling fan.

   A false "Cooling Failure" lamp indication may be present until the cooling fan creates sufficient airflow to close the Fan Pressure Switch (PS). The "Normal Operation" lamp illuminates and control voltage is supplied to the "Master Load" switch. With voltage supplied to the "Master Load" switch, the operator is now ready to apply load steps.
6. Verify the illumination of the "Normal Operation" lamp before proceeding.
7. Visually observe correct fan operation and investigate any unusual fan related noises.
8. Check air intake for obstructions and confirm positive air flow.

9. Select the desired load steps by placing them in the “On” position.
10. Place the “Master Load” switch in the “On” position.

    This simultaneously applies all of the load steps which are in the “On” position.

    Trim is achieved by flipping the load steps “On” and “Off” while the “Master Load” is in the “On” position.
11. Adjust source voltage and load. Monitor as needed.

Shutdown

1 De-energize the load.

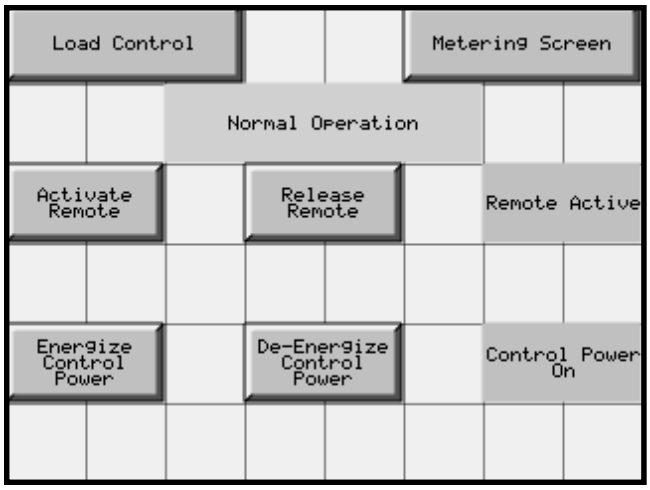
2. Run the cooling fan for 5 minutes to assure a thorough cool down of all load elements (optional).
3. Place the “Fan/Control Power” switch in the “Off” position.

REMOTE

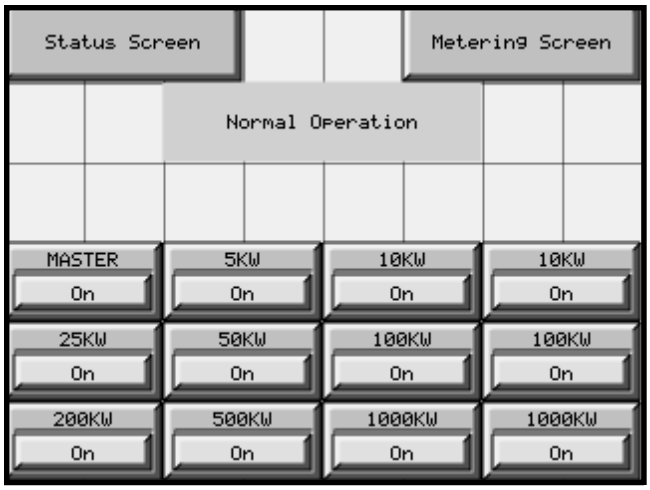
There are three screens on the remote touch panel. They are: Control/Status Screen, Load Screen, and Metering Screen.

1. Press the “Activate Remote” button.
2. Press the “Energize Control Power” to energize the cooling fan.

    A false “Cooling Failure” may be indicated until the cooling fan creates sufficient airflow to close the Fan Pressure Switch (PS).
3. Verify “Normal Operation” via the status window before proceeding.
4. Visually observe correct fan operation and investigate any unusual fan related noises.
5. Check air intake for obstructions and confirm positive air flow.



Control/Status Screen



Load Screen

6. Select the desired load steps by pressing the desired buttons.
7. Press the “Master Load” button.

    This simultaneously applies all of the load steps which are in the “On” position.

    Trim is achieved by pressing the load steps “On” and “Off” while the “Master Load” is in the “On” position.
8. Adjust source voltage and load. Monitor as needed.

SHUTDOWN

1 De-energize the load.

2. Run the cooling fan for 5 minutes to assure a thorough cool down of all load elements (optional).

3. Press the “De-energize Control Power” button.

4. Press the “Release Remote” button.

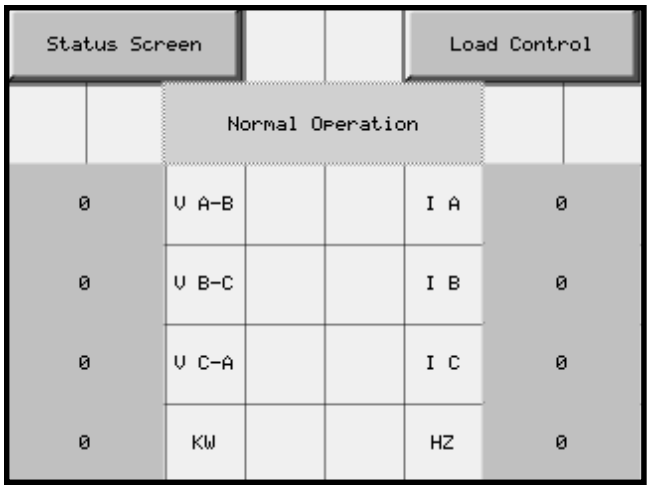
LOAD DUMP

This Load Bank contains a Load Dump feature which de-energizes all applied load when customer supplied contacts open. Normally closed to run, they are rated at 2A @ 24VDC and should be wired to TB‘LD’ 1–2. When these contacts open all applied load will be de-energized and the load section will be disabled. If desired, the customer may install automatic transfer switch contacts, a manual pushbutton or circuit breaker for this use.

The operator also has the option of bypassing these contacts and enabling the load section by flipping the “Auto Load Dump” switch to the “Bypass” position. This disables the load dump feature and illuminates the “Load Dump Bypass” lamp.

⚠ WARNING ⚠

Do Not allow the Load Bank to operate unattended for extended periods.



Metering Screen

FAILURE DETECTION

If a “Failure” occurs the corresponding lamp will illuminate and the load will be de-energized. Before reapplying a load, the failure must be corrected and the system must be reset by turning the Load Bank “Off” then “On”.

This is a permissive/energize-to-run circuit in which all safety sensors must energize their control relays on normal operation before load can be applied. This system includes the following components:

1. Exhaust Temperature Switches (EXTS1–EXTS4)
2. Pressure Switch (PS)
3. Intake Temperature Switch (INTS)

Thermocouple Temperature Switch

The exhaust temperature network consists of a type J thermocouple (TC) and a solid state thermocouple sensor (EXTS). The temperature switch has been factory adjusted for precise Load Bank over temperature protection under normal operating conditions. Unusual operating conditions may require

⚠ WARNING ⚠

For continued safety and for maximum equipment protection, always replace fuses with one of equal rating only.

field adjustment. The setpoint of the Exhaust Temperature Switch (EXTS) may be changed by rotating the adjustment knob. Consult the Simplex Service Department (217-483-1600 24hrs) before changing the temperature switch setpoint.

MAINTENANCE

The Load Bank has been designed to require minimum maintenance. All components have been chosen for a long, reliable life. Two basic intervals of maintenance are required: each operation and every 50 hours or 6 months (whichever comes first).

EACH OPERATION

The air intake screens and louvers, fan and cooling chamber, and exhaust openings must be checked for any obstructions or foreign objects. Due to the high volume of air circulated, paper and other items can be drawn into the air intakes. During Load Bank operation insure that air is exiting from the top exhaust vent.

The load branches should be checked for blown fuses or opened load resistors. To check the fuses or load resistors, operate the Load Bank from a balanced 3-phase source and check the three line currents. The three current readings should be essentially the same. If a sizeable difference is noted one or more load fuses or load resistors may have malfunctioned.

⚠ WARNING ⚠

Overgreasing is a major cause of bearing and/or motor failure. The amount of grease added should be carefully controlled. Also make sure dirt and contaminants are not introduced when adding grease.

⚠ WARNING ⚠

If lubrication instructions are shown on the motor nameplate, they will supersede this general instruction.

⚠ WARNING ⚠

If motor is nameplated for hazardous locations, do not run motor without all of the grease or drain plugs installed.

⚠ WARNING ⚠

The Pillow Block Bearings (PN 22691040), which are used on Saturn Load Banks, are pre-lubricated at the time of manufacture. These bearings are lubricated with Mobil Mobilith AW2 grease (a Lithium based grease). Lubrication using another grease may cause bearing failure. *See Appendix D - Pillow Block Bearings Lube Interval for additional information.*

EVERY 50 HOURS OR 6 MONTHS

Check the tightness of the electrical connections. The expansion and contraction caused by Load Bank operation may result in loose connections. The vibrations caused by the cooling fan may also loosen electrical connections. If the Load Bank is transported "over the road", the electrical connections should be checked for tightness at a shorter-than-normal time interval. See "Primary Inspection".

RELUBRICATION TIME INTERVAL for motors with regreasing provisions.

	NEMA Frame Size					
	140 – 180		210 – 360		400 – 510	
	1800 RPM and less	Over 1800 RPM	1800 RPM and less	Over 1800 RPM	1800 RPM and less	Over 1800 RPM
Standard	3 yrs.	8 mo.	2 yrs.	8 mo.	1 yr.	3 mo.
Severe	1 yr.	3 mo.	1 yr.	3 mo.	6 mo.	1 mo.
Seasonal	See Note 2.					

Standard: Up to 16 hours of operation per day, indoors, 100°F maximum ambient.

Severe: Greater than 16 hours of operation per day. Continuous operation under high ambient temperatures (100° to 150°F) and/or any of the following: dirty, moist locations, high vibration (above NEMA standards), heavy shock loading, or where shaft extension end is hot.

Seasonal: The motor remains idle for a period of 6 months or more.

Note:

1. For motors nameplated as "belted duty only" divide the above intervals by 3.
2. Lubricate at the beginning of the season. Then follow service schedule above.

MOTOR LUBRICATION

Motors are properly lubricated at the time of manufacture. It is not necessary to lubricate at the time of installation unless the motor has been in storage for a period of 12 months or longer (refer to lubrication procedure that follows).

Inspect the fan motor supplied with your Load Bank for grease fittings. If the motor contains grease fittings you must lubricate the motor. If lubrication instructions are shown on the motor nameplate, they will supersede this general instruction. Belt driven cooling fans have bearings which should be lubricated. Bearings should be lubricated every 50 hours of operation or 6 months whichever comes first.

Lubrication Procedure

1. Stop motor. Disconnect and lock out of service.
2. Remove contaminants from grease inlet area.
3. Remove filler and drain plugs.
4. Check filler and drain holes for blockage and clean as necessary.
5. Add proper type and amount of grease. See the **Relubrication Time Intervals** table for service schedule and **Relubrication Amounts** table (see next page) for volume of grease required.
6. Wipe off excess grease and replace filler and drain plugs.

7. Motor is ready for operation.

   Warning: If motor is nameplated for hazardous locations, do not run motor without all of the grease or drain plugs installed.

Grease Type

Unless stated otherwise on the motor nameplate, the motors on this Load Bank are pregreased with a polyurea mineral oil NGLI grade 2 type grease. Some compatible brands of polyurea mineral base type grease are:

- Chevron SRI #2
- Rykon Premium #2
- Exxon Polyrex EM
- Texaco Polystar RB

RELUBRICATION AMOUNTS for motors with regreasing provisions.	
NEMA Frame Size	**Volume cu. in. (fluid oz.)**
140	.25 (.14)
180	.50 (.28)
210	.75 (.42)
250	1.00 (.55)
280	1.25 (.69)
320	1.50 (.83)
360	1.75 (.97)
400	2.25 (1.2)
440	2.75 (1.5)
500	3.00 (1.7)

TROUBLESHOOTING

This section is designed to aid the electrical technician in basic Load Bank system troubleshooting. All of the problems listed can be verified with a basic test meter and/or continuity tester. For safety reasons, when troubleshooting Load Bank systems always remove all test source power, fan/control power, anti-condensation heater power, etc.

⚠ WARNING ⚠

When troubleshooting Load Bank systems always remove all test source power, fan/control power, anti-condensation heater power, etc.

COOLING FAN MOTOR WILL NOT OPERATE

1. Inoperative Fan Circuit Breaker (CB)
2. Fan/Control Power not available/ incorrect
3. Inoperative Fan Motor (MOT)
4. Fan Motor Contactor (FMC) de-energized
5. Restriction of air (intake or exhaust)
6. Fan pressure switch inoperative

SOME LOAD STEPS CANNOT BE ENERGIZED

1. Inoperative load step switches
2. Open load step resistor(s)
3. Inoperative load step relays
4. Inoperative load step contactors
5. Open load step fuses

COOLING FAILURE INDICATED

Exhaust temp above EXTS setpoint:

1. Over temperature sensor failure
2. Fan failure
3. Air restriction (intake or exhaust)
4. Overvoltage condition present

Exhaust temp below EXTS setpoint:

1. Restriction of air (intake or exhaust)
2. Fan pressure switch inoperative
3. Overtemperature sensor failure

DRAWINGS AND PARTS LIST

The drawings included in this manual are the most accurate source of part numbers for your Load Bank. When ordering replacement parts for Simplex Load Banks, always consult the Parts Drawing. When contacting the Simplex Service Department always have your work order and drawing number ready for reference. The Work Order Number and the Drawing Numbers are also located on each drawing legend. *A typical drawing legend and parts list is illustrated at right.*

SIMPLX® SPRINGFIELD, ILLINOIS

SCALE :	APPROVED BY :	DRAWN BY : JPC
DATE : 3/22/07		REVISED :

RESISTIVE LOAD BANK 2550KW/3000KW,480V/600V,3ø,60Hz — SATURN 3000 DV FAN/CONTROL SECTION

W.O.# 63798-07-43/2 — DRAWING NUMBER 47B164462B

ITEM	QTY.	PART #	DESIG.	DESCRIPTION
43	1	14015000	CF5	FUSE 2A, 600V, 200KAIC
44	1	14016500	CF7	FUSE 25A, 600V, 200KAIC
45	3	13906000	CF10-CF11	FUSE 1/2A, 600V, 200KAIC
46	3	14014000	MF1-MF3	FUSE 2A, 600V, 200KAIC
47	1	--------	DCS	DC POWER SUPPLY 85-264VAC INPUT 24VDC 25.0A OUTPUT
48	1	24955000	PLC	PLC 2 COMMUNICATIONS PORTS RS232C OR RS485
49	2	24955010	[PLC]	OUTPUT MODULE 8PT RELAY
50	1	--------	[PLC]	INPUT MODULE 8PT 120V AC INPUTS
51	1	--------	[PLC]	ETHERNET MODULE 10/100BASE T ETHERNET PORT
52	1	--------	[PLC]	ANALOG INPUT MODULE 0-5VDC
53	1	--------	CABLE 1	CABLE 15 PIN D-SUB TO WIRES
54	1	--------	DMP	DIGITAL METERING PACKAGE 600V, 5A, 120V CONTROL 60HZ W/ DATA LOGGER
55	1	--------	[DMP]	METERING SOFTWARE
56	3	24290110	L1, L5, L6	INDICATING LIGHT 120V, AMBER
57	4	24290100	L2-L4	INDICATING LIGHT 120V, RED
58	3	24290105	L7-L9	INDICATING LIGHT 120V, GREEN
59	6	25231100	LSW1-LSW6	HATCH LIMIT SWITCH SPDT 6A, 125V 83-853-10
60	1	--------	RECP3	ETHERNET BULKHEAD RECEPTACLE 10/100 BASE T
61	1	--------	[RECP3]	RECEPTACLE COVER
62	1	24955045	RDP	OPERATOR INTERFACE 6" MONOCHROME TOUCHSCREEN 24VDC CONTROL POWER ETHERNET CAP

APPENDIX A - ABBREVIATIONS USED IN THIS MANUAL

Listed below are abbreviations of terms found on Simplex Load Bank Systems. When following a load bank drawing utilize this guide to define abbreviated system and component names. As this is a master list, drawings and text pertaining to your equipment may not contain all these terms.

AC-Alternating current

AIC-Ampere interrupting current-maximum short circuit fault current a component can safely interrupt

AM-Ammeter

AMSW- Ammeter selector switch-selects any phase for current reading

CF-Control fuse

CFM-Cubic feet per minute-used to rate fan air flow capacity and load bank cooling requirement

CFR-Cooling failure relay-normally energized relay in cooling failure subsystem

CPC-Control power contactor

CPF-Control power fuse

CT-Current transformer- used in metering circuits

DC-Direct current

EXTS-Exhaust air temperature switch

FCB-Fan circuit breaker-circuit breaker in series with fan control power

FCVR-Fan control voltage relay-normally energized relay on relay sub-panel

FM-Frequency meter-monitors frequency of test source

FMC-Fan motor contactor-controls power to fan motor

FMSW-Frequency meter switch

FPS-Fan power switch-used to energize cooling system

GFB-Ground fault breaker

GBTR-Ground breaker tripped relay

HVR-High voltage relay

Hz-Hertz-cycles per second, measurement of frequency

IFCV-Incorrect fan/control voltage

INTS-Intake air temperature switch

K-Relay coil/contact designation

KVA-Kilovolt amperes

KVAR-Kilovolt amperes-reactive

KW-Kilowatts

KWM-Kilowatt meter

KWT-Kilowatt meter transducer

LM-Louver motor

LMC-Louver motor contactor

LR-Load resistive element

LX-Load reactive element

L1-Line 1

L2-Line 2

L3-Line 3

MCB-Main circuit breaker

MDS-Main Disconnect Switch

MF-Meter fuse

MLB-Main Load Bus

MOT-Motor

NEMA-National electrical manufacturer's association

ODP-Open, drip-proof-refers to motor enclosure

OVR-Overvoltage relay-relay used in overvoltage failure system, located on relay sub-panel

OLR-Overload relay-used for motor protection

OTR-Overtemperature relay-used in failure system

PF-Power factor-in resistive only loads expressed as unity (1.0), in inductive loads expressed as lagging, in capacitive loads expressed as leading

PAR-Control power available relay-relay energized when control power is available

PFM-Power factor meter

PS-Pressure switch-switch used to detect fan failure

RR-Reset relay

RTM-Running time meter-keeps time log of equipment use.

TB-Terminal block

TDR-Time delay relay-relay which times out before contacts change state

TEFC-Totally enclosed, fan cooled-refers to motor enclosure

TEAO-Totally enclosed, air-over-refers to motor enclosure

UPS-Uninterruptable power source

V-Voltage

VSR-Voltage sensing relay

XCB-Reactive load controlling circuit breaker

APPENDIX B - CALCULATIONS & FORMULAS

The following calculations are used to determine the actual kilowatt load being applied by the Load Bank, when line voltages and currents are known (at 1.0 power factor).

3 Phase

1. Read all three line currents and find the average reading.
2. Read all three line-to-line voltages and find the average reading.
3. Multiply the average current times the average voltage.
4. Multiply the answer of step #3 times the square root of 3 (1.732).
5. Divide the answer of step #4 by 1000. The answer is the actual kilowatts of load being applied by the Load Bank.

Single Phase

1. Determine the line current.
2. Determine the line-to-line voltage.
3. Multiply the line current times the line-to-line voltage.
4. Divide the answer of step #3 by 1000.
5. The answer of step #4 is the actual kilowatts being applied by the load bank.

EXAMPLES

Using line voltages and currents:

3 Phase

Current Readings	Voltage Readings
A_1 = 249A	V_{1-2} = 481V
A_2 = 250A	V_{2-3} = 479V
A_3 = 254A	V_{3-1} = 483V

$$\text{Average Current} = \frac{A_1 + A_2 + A_3}{3} = \frac{249+250+254}{3} = 251\text{A}$$

$$\text{Average Voltage} = \frac{V_{1-2} + V_{2-3} + V_{3-1}}{3} = \frac{481 + 479 + 483}{3} = 481\text{V}$$

$$\text{Kilowatts} = \frac{\text{Volts x Amps x 1.732}}{1000} = \frac{481 \times 251 \times 1.732}{1000} = 209.1\text{KW}$$

Single Phase

Current Reading: 150A Voltage Reading: 240V

$$\text{Kilowatts} = \frac{\text{Volts x Amps}}{1000} = \frac{150 \times 240}{1000} = 36.1\text{KW}$$

The following calculations are used to determine the amount of current when the desired amount of kilowatts is applied at 1.0 power factor.

3 Phase

1. Multiply the desired amount of kilowatts to be applied by 1000.
2. Multiply the operating voltage times the square root of 3 (1.732)
3. Divide the answer of step #1 by the answer of step #2.
4. The answer of step #3 is the average line current with the desired kilowatts applied at 1.0 power factor.

Single phase

1. Multiply the desired amount of kilowatts to be applied by 1000.
2. Divide the answer of step #1 by the operating voltage.
3. The answer of step #2 is the average line current with the desired amount of kilowatts applied at 1.0 power factor.

The following calculations are used to determine a step kilowatt rating at other than a rated voltage. This is accomplished by referencing the load step to a KW value at a known voltage.

1. Determine the new unrated operating voltage.
2. Divide the new operating voltage by the reference voltage.
3. Square the answer of step #2.
4. Multiply the answer of step #3 times the reference kilowatt value of the load step which the new kilowatt rating is desired.
5. The answer of step #4 is the kilowatt rating of the load step at the new voltage.

EXAMPLES

When desired amount of kilowatts is applied at 1.0 PF:

3 Phase

Applied: 50KW Operating Voltage: 480V

$$\text{Amperage} = \frac{\text{KW} \times 1000}{\text{Volts} \times 1.732}$$

$$= \frac{50 \times 1000}{480 \times 1.732}$$

$$= \frac{50{,}000}{831.36}$$

$$= 60.1$$

Single Phase

Applied: 25KW Operating Voltage: 240V

$$\text{Amperage} = \frac{\text{KW} \times 1000}{\text{Volts}}$$

$$= \frac{25 \times 1000}{240}$$

$$= \frac{25{,}000}{240}$$

$$= 104.2$$

Determining step KW at other than rated voltage:

Applied: 80KW Operating Voltage: 450V
Rated Voltage: 480V

$$\text{Step KW} = (\text{Oper. Volt.} \div \text{Rated Volt.})^2 \times \text{Applied KW}$$

$$= (450 \div 480)^2 \times 80$$

$$= .9375^2 \times 80$$

$$= 70.3$$

FORMULAS

		Alternating Current	Direct Current
Kilowatts	1 phase	$\frac{\text{Volts x Amps x PF*}}{1000}$	$\frac{\text{Volts x Amps}}{1000}$
	3 phase	$\frac{\text{1.732 x Volts x Amps x PF*}}{1000}$	
Amperes *(KW known)*	1 phase	$\frac{\text{KW x 1000}}{\text{Volts x PF}}$	$\frac{\text{KW x 1000}}{\text{Volts}}$
	3 phase	$\frac{\text{KW x 1000}}{\text{1.732 x Volts x PF}}$	
KVA	1 phase	$\frac{\text{Volts x Amps}}{1000}$	
	3 phase	$\frac{\text{1.732 x Volts x Amps}}{1000}$	
Amperes *(KVA known)*	1 phase	$\frac{\text{KVA x 1000}}{\text{Volts}}$	
	3 phase	$\frac{\text{KVA x 1000}}{\text{1.732 x Volts}}$	
KVAR	1 phase	$\frac{\text{Volts x Amps x } \sqrt{1-PF^2}}{1000}$	
	3 phase	$\frac{\text{1.732 x Volts x Amps x } \sqrt{1-PF^2}}{1000}$	

*Power Factor, expressed as decimal.
(Resistive Load Bank PF is 1.0)

APPENDIX C - TORQUE VALUES

FAN BLADES		
FAN PART NO.	BOLT SIZE	TORQUE FT LBS // IN LBS
13820000	SET SCREW	11.7 // 140
13820500	SET SCREW	11.7 // 140
13821000	SET SCREW	8.3 // 100
13822000	1/4 — 20	7.5 // 90
13823000	1/4 — 20	7.5 // 90
13824000	1/4 — 20	7.5 // 90
13825100	1/4 — 20	7.5 // 90
13826000	1/4 — 20	7.5 // 90
13827500	5/16”	13 // 156
13827600	5/16”	13 // 156
13828000	3/8”	24 // 288

MOTORS, BRACKETS, BUS BAR CONNECTIONS		
BOLT/NUT SIZE	GRADE	TORQUE FT LBS // IN LBS
.250 (1/4-20)	Grade 5, dry	8 // 96
.250 (1/4-20)	Grade 2, dry	5.5 // 66
.312 (5/16)	Grade 5, dry	17 // 204
.312 (5/16)	Grade 2, dry	11 // 132
.375 (3/8)	Grade 5, dry	30 // 360
.375 (3/8)	Grade 2, dry	19 // 228
.437 (7/16)	Grade 5, dry	50 // 600
.437 (7/16)	Grade 2, dry	30 // 360
.500 (1/2)	Grade 5, dry	75 // 900
.500 (1/2)	Grade 2, dry	40 // 480
.562 (9/16) & up	Grade 5, dry	110 // 1320
.562 (9/16) & up	Grade 2, dry	55 // 660

CONTACTORS
See torque values on the front of the contactor.

ELEMENTS/TRAYS		
TERM/NUT SIZE		TORQUE INCH LBS
#6	Rod ends	4
#10	Element Conn.	20
1/4-20”	High Voltage	Contact Simplex

MAIN LOAD BLOCKS- ALL SIZES		
CONNECTION	WIRE SIZE	TORQUE FT LBS // IN LBS
LOAD SIDE	4-14AWG	2.9 // 35
LINE SIDE	500MCM-4/0	31 // 375
	3/0-4/0	20 // 240
	2/0-6AWG	10 // 120
	8AWG	3.3 // 40

CIRCUIT BREAKERS		
STYLE	WIRE SIZE	TORQUE INCH LBS
Cutler-Hammer 1-Phase	14-10 AWG	20
	8 AWG	25
	6-4 AWG	27
	3-1/0 AWG	45
Merlin Gerin 3-Phase	14-1/0	50

APPENDIX C - TORQUE VALUES CONT'D

FUSEBLOCKS		
MANUF. PART NO.	WIRE SIZE	TORQUE INCH LBS
BM6031SQ, BM6032SQ, BM6033SQ; 600V, 30A	10-18 AWG	20
T60060-2SR 600V, 60A	10-18 AWG	20
T60030-3CR, 600V, 30A T60060-3CR, 600V, 60A 60100-3CR, 600V, 100A	10-14 AWG	35
	8 AWG	40
	4-6 AWG	45
	2-3 AWG	50

MISCELLANEOUS-TERMINALS, METERS, SWITCHES, COILS, RELAYS, XFORMERS	
CONNECTION SIZE	TORQUE INCH LBS
4	5
6	10
8	19
10	31
1/4-20"	66

TAPER-LOCK BUSHINGS	
BUSHING NUMBER	TORQUE
1008, 1108	55 IN LBS
1210, 1215, 1310, 1610, 1615	15 FT LBS
2012	23 FT LBS
2517, 2525	36 FT LBS
3020, 3030	67 FT LBS
3535	83 FT LBS
4040	142 FT LBS
4545	204 FT LBS
5050	258 FT LBS
6050, 7060, 8065	652 FT LBS
10085, 12010	1142 FT LBS

CAM-LOK STUDS	
THREADED STUD	MAXIMUM TORQUE
5/16" – 18	15 FT LBS
1/2" – 13	40 FT LBS

APPENDIX D - PILLOW BLOCK BEARINGS LUBE INTERVAL

The Pillow Block Bearings (PN 22691040), which are used on Saturn Load Banks, are pre-lubricated at the time of manufacture. These bearings are lubricated with Mobil Mobilith AW2 grease (a Lithium based grease). **Lubrication using another grease may cause bearing failure.**

If the lube interval is less than a month use the **Weekly Relube Quantity** at each relube cycle.

If the lube interval is greater than a month and less than a year use the **Monthly Relube Quantity**.

If the lube interval is greater than a year use the **Yearly Relube Quantity**.

		8 hrs./day	16 hrs./day	24 hrs./day
Minimum Lube Interval	6500 hrs.	116 wks.	58 wks.	38 wks.
Maximum Lube Interval	9100 hrs.	162 wks.	81 wks.	54 wks.

Weekly Relube Quantity	0.14 ozs.
Monthly Relube Quantity	0.21 ozs.
Yearly Relube Quatity	0.28 ozs.

APPENDIX E - DRAWINGS

Title	Drawing
Pictorial	47BD164460C
Control Section	47B164461C
Fan/Control	47B164462B
Local Manual Control	47B164463B
PLC Control	47B164464C
PLC Communications Control	47B164465A
PLC Control Wiring	47B164466B
Metering	47B164467A
Resistive Contactors Coil	47B164468
Load Section 1 of 3	47B164469
Load Section 2 of 3	47B164470
Load Section 3 of 3	47B164471
Load Strapping 1 of 4	47B164472
Load Strapping 2 of 4	47B164473
Load Strapping 3 of 4	47B164474
Load Strapping 4 of 4	47B164475
Load Tray Layout	47BD164476A
Non-Standard Elements	47B164477A
Local Control Panel	47BD164478B
Remote Control Panel	47BD164479
Parts Legend 1 of 2	47B164480A
Parts Legend 2 of 2	47B164481B
Subpanel Layout 1 of 2	47BD164482C
Subpanel Layout 2 of 2	47BD164483B
Nameplates	47BD164484B