ENGINE-ALTERNATORS — DIESEL

STATIONARY

BUDA

Contents Page

1. GENERAL

1.01 This section describes the method of operating Buda diesel engines, models 4DC-645, 6DT-317, 6DT-468, 6DC-844, 6DCS-844, 6DC-1879, 6DCS-1879, 8DCS-1125, and 8DCS-2505.

1.02 It is reissued to:

- Update the format to conform to Pacific Company (PAC) standards.
- Include the appropriate legend on Page 1 in accordance with AT&T's "Guidelines and Procedures for Safeguarding Information" and PAC's System Instruction (SI) 178.

Note: Marginal arrows used to denote changes are omitted.

1.03 The Buda diesel engines are of the 4-cycle vertical type, operating at 1200 RPM. The engine is directly connected to its associated alternator by means of a flexible coupling. The two units with the exciter for the alternator are mounted on a common fabricated steel subbase, which in turn is mounted on vibration dampening supports. The engine is cooled by means of a radiator and engine driven pusher-type fan. Some engines are equipped with a starting motor which uses central office battery for operation, while others are equipped with a starting motor connected to a separate battery and associated battery charging equipment. The electrical controls may be mounted on the same unit or on a panel adjacent to the engine unit. In addition to the above, some sets are equipped with automatic starting equipment and this section shall be used where applicable. It should be noted that automatic start equipment imposes some penalties in operation that can be avoided in manual operation. For example, it is desirable to allow a warming up period before applying a load to an engine alternator set, whereas automatic start equipment does not provide for this. However, the warming up period can be shortened or omitted under manual operation if emergency conditions warrant. Likewise, a shut down without an idling period may be permissible under certain circumstances.

1.04 The following is a list of engines and their respective capacities:

MODEL	CYLINDERS	KW
6DT-317	6	25
6DT-468	6	35
4DC-645	4	50
6DC-844	6	60
6DCS-844	6 Supercharged	80
8DCS-1125	8 Supercharged	100
6DC-1879	6	125
6DCS-1879	6 Supercharged	150
8DCS-2505	8 Supercharged	200

1.05 The Buda diesel engines operate on a 4-stroke cycle, which is described as a series of events which take place in a cylinder between two successive firing periods. The four strokes, which are completed in two crankshaft revolutions, are generally described in the following order:

(a) The intake valve opens just before the piston reaches top dead center. Upon the downward movement of the piston, a supply of fresh air enters the cylinder. When the piston has passed bottom dead center, the intake valve closes, completing the intake stroke.

(b) ***Compression Stroke*** — Both intake and exhaust valves are closed and as the piston moves upward the air is compressed. Sufficient heat (approximately 900° to 1000°F) is produced by the compression to ignite diesel fuel when the piston nearly reaches top dead center.

(c) ***Power Stroke*** — Actual injection of the fuel at 1800 to 2000 pounds per square inch begins before top dead center is reached and, upon ignition, forces the piston downward. Combustion of the fuel charge continues throughout the power stroke.

(d) ***Exhaust Stroke*** — The exhaust valve opens just before bottom dead center and stays open throughout the upward movement of the piston allowing the exhaust gases to be expelled from the cylinder. Near the end of the exhaust stroke, the intake valve opens allowing fresh air to enter and scavenge or clear out remaining exhaust gases from the combustion chamber.

1.06 The fuel system consists essentially of a fuel tank with supply and return lines connected to the engine, fuel shutoff valve, primary filter, fuel transfer pump, secondary filter, fuel injection pump, injectors, and manual priming pump. Fuel is drawn from the supply tank through the primary filter by the transfer pump and pumped through the secondary filter to the high pressure injector pump. This pump is gear driven and functions to operate, by means of tappets, an individual pump plunger for each cylinder. The individual plunger operations are timed to pump fuel at high pressure to their respective injectors in each cylinder at the start of each power stroke. The quantity of fuel injected is determined by the position of a metering helix in the pump plunger, which position is in turn controlled by the control rod setting as adjusted by the engine controls and governor. The return line carries off excess fuel, delivered by the fuel transfer pump, through the check valve in the fuel injection pump and returns it to the fuel tank. Most engines are equipped with an air venting pipe and hand-operated valve on top of the secondary filter. Used in conjunction with the hand priming pump located on the fuel injection pump, the low pressure fuel line can be vented of air. Some sets are provided with an auxiliary fuel tank in the engine base, and a manual fuel pump for pumping fuel from a main tank to the auxiliary tank.

1.07 The supercharger is of the positive displacement type and is gear driven from the timing gear train. Two rotors, each with three louvers, revolve with very close clearances in a housing mounted on the side of the engine. The discharge of fresh air from the blower creates an air pressure of approximately 7 pounds per square inch in the intake manifold at maximum engine speed, thus providing additional air for combustion.

1.08 Lubrication systems vary somewhat, depending on the engine model. Generally speaking, oil is drawn through a suction screen in the crankcase reservoir by the oil pump, and pumped through fittings and drilled passages to various parts of the engine. On engines equipped with an oil cooler, the oil pump first delivers oil to the cooler and associated by-pass valve. An oil pressure relief or pressure regulation valve is also incorporated in the system to maintain proper lubricating oil pressure. The oil pressure gauge indicates the pressure as maintained by the above regulator. An oil filter is also provided to extract foreign matter from the oil before it is returned to the crankcase reservoir.

1.09 The governor is a fly-ball, mechanical type, designed to be pre-set for maintaining with close regulation any desired engine speed within the nominal idling and nominal maximum speed range, irrespective of engine load. In addition, the governor controls the engine idling speed to prevent stalling and the maximum speed to prevent racing. A trip mechanism is provided to stop the engine in case a predetermined overspeed value (usually about 15% overspeed) is exceeded.

1.10 On sets equipped with automatic start equipment, a relay in this equipment is operated upon the failure of commercial power. Engine cranking starts immediately and discontinues when the engine starts. Should the engine fail to start within 8 seconds, a pause of 7 seconds will be followed by a second cranking period of 8 seconds and so on for a total of five 8-second cranking periods. If the engine does not start in the series of five attempts, the control equipment will lock out until manually re-set. When the alternator voltage reaches the proper value the load is transferred to the engine alternator.

1.11 When commercial power returns and remains on the line for a predetermined period, as measured by the power transfer circuit, the load is transferred back to the commercial source.

This transfer releases the controlling relay in the automatic start circuit which causes the engine to continue running for a period of 75 seconds before causing it to stop. This circuit then re-sets its timer and is in position to repeat the same cycle of operations should another power failure occur.

1.12 The control equipment is also provided with a three-position switch which is left in the NORMAL position unless it is desired to test the complete unit or to operate the engine alternator under manual operation. The switch can be operated to the TEST position and this will simulate a power failure by operating the controlling relay in the automatic start circuit, or the switch can be operated to the MANUAL position which disconnects the automatic start circuit and allows the engine to be started and controlled manually.

1.13 Sets equipped for automatic start are also provided with low lubricating oil pressure, and high cooling water temperature shutdown controls in case the oil pressure drops below 20 to 25 pounds or if the water temperature exceeds approximately 195°F.

1.14 The engine should be kept clean and well lubricated as dirt and lack of lubrication cause undue wear. Care should be taken to remove dirt from all points of lubrication before lubricant is applied.

1.15 The following may be used as a guide for purpose of maintaining rust inhibitor in cooling systems as covered in the 200 Division practices. The cooling water capacity of engine jacket circulation system is approximately as follows:

ENGINE	APPROXIMATE CAPACITY GALLONS
Buda 4DC-645	30
Buda 6DT-317	7
Buda 6DT-468	13
Buda 6DC-844	32
Buda 6DCS-844	32
Buda 6DC-1879	45
Buda 6DCS-1879	45
Buda 8DCS-1125	45
Buda 8DCS-2505	45

1.16 Care must be used to prevent dirt entering a fuel oil storage tank. See that the supplier or attendant cleans all equipment used in filling the tank before placing fuel oil in the tank. Always allow new fuel to settle for at least 6 hours before using, if at all practicable. Ordinary fuel oil that has been stored for more than 6 months in a storage tank or engine base has a tendency to form gum. After 6 months it is desirable to remove the fuel from the storage tank and dispose of it, but this may be avoided to a large extent by limiting the quantities of fuel oil to such amounts that they will be used up within this time. Stabilized or compounded fuel oils may have a longer storage rating. Use standard automotive diesel fuel.

1.17 Routine checks on emergency power plant equipment shall be made during a period when they will cause the least service reaction.

1.18 Additional information on the control of these sets which involves the equipment for engine and alternator control, voltage regulation, and automatic start equipment, may be found in the drawings and manuals furnished by the manufacturer. In some cases locally prepared drawings have been issued for use in this connection.

1.19 More detailed information on the operation and maintenance of individual pieces of apparatus, including information which would be useful when an overhaul of the set is required, is to be found in the instruction manuals which are furnished by the manufacturer with each set.

CAUTION: AVOID THE USE OF AN OPEN FLAME OR A PORTABLE LAMP WITHOUT A PROTECTING GUARD WHILE WORKING AROUND THE ENGINE, PARTICULARLY NEAR ANY PART OF ITS FUEL SYSTEM. WHILE DIESEL OIL IS NOT NORMALLY EXPLOSIVE, IT WILL IGNITE AND BURN IF SUFFICIENT HEAT IS APPLIED THROUGH THE MEDIUM OF AN OPEN FLAME.

2. OPERATION

Preparation for Starting

2.01 Before starting, go over the engine carefully to see that there are no tools or other objects on it which could interfere with its operation.

2.02 Make certain that there is fuel in the fuel tank sufficient for the expected run.

2.03 Make certain that the oil in the crankcase is at the proper level indicated by the marks on the gauge. The oil level in the crankcase should never be permitted to fall below the LOW mark on the gauge while the engine is operating. Should oil in the crankcase show a higher level than a previous reading, examine the odor of the lubricating oil for a trace of fuel oil. If fuel oil is present, tighten all fuel line connections, drain crankcase, and refill with fresh lubricating oil. If the appearance of emulsion or water in the crankcase is noted, steps should be taken to reseal the head gasket and then change the oil.

Note: On engines equipped with forced feed lubrication, the FULL mark on the gauage is designed to assure an adequate supply of lubricating oil for long runs. However, experience with oil consumption of a particular engine may indicate that it is preferable to replenish the oil in the crankcase to a level slightly below this mark.

2.04 Lubricate parts requiring lubrication (see Chart A).

2.05 Close drain valves in exhaust line and silencer. If the engine is equipped with an air exhaust duct extending from the engine radiator to the outside see that any louvers, etc, provided in this duct are properly operated.

2.06 Open valves in fuel lines and start auxiliary fuel pump if one is provided in the line from the main storage tank to the engine. If an auxiliary tank is provided in engine base, operate auxiliary pump to fill this tank.

2.07 Close all water jacket or radiator drains if open. When necessary, fill the cooling system to within 2 inches of the top of the radiator cap. On installations equipped with a permanently piped water supply to the radiator, open the water supply valve and note that water flows from the overflow drain. ***Do not*** allow excessive amounts of water to drain, as this will reduce the rust inhibitor concentration.

2.08 Note that the "Overspeed Trip" lever on the governor is in the FORWARD position.

2.09 Starting in normal temperatures without an air heater:

(a) On large Buda engines equipped with a "Decompression" lever, set the lever in the DECOMPRESSION position. Set the throttle in mid-position. If provided, turn the heavy duty starting switch slowly, pausing at the first terminal to allow time for the starter gear to engage before turning the starting switch to the CRANKING position. Otherwise, operate START switch. As soon as the engine has turned a few revolutions, place the "Decompression" lever in the OPERATING position while allowing the starting motor to continue cranking. ***Do not*** crank the engine for more than 10 seconds at one time. Allow 15 seconds between cranking periods.

(b) On smaller Buda engines not equipped with a "Decompression" lever, set the throttle in the IDLING 650 RPM (approximately) position and operate the START switch. If the engine does not start in 10 to 15 seconds release the START switch and allow a 15 second interval before attempting to start the engine again.

2.10 After engine starts, observe that the lubricating oil pressure gauge shows a positive registration, indicating that oil is being supplied to moving parts. If, after 10 or 15 seconds, no pressure is indicated on the oil gauge, stop engine immediately and locate trouble. If oil pressure is indicated, adjust throttle to operate engine at minimum speed until water temperature gauge starts to indicate a temperature rise.

2.11 Starting in cold temperatures using an air heater or a flame primer:

(a) On engines equipped with electric air heater, operate the AIR HEATER switch 45 seconds prior to operating the START switch. Hold the AIR HEATER switch operated until engine starts and release when START switch is released as described in 2.09.

(b) On engines equipped with a flame primer, if necessary to aid in starting, proceed as follows: Turn on primer ignition switch. Open throttle wide. Operate START switch and be sure engine is turning over before operating flame primer. Release pump plunger by turning 1/4 to 1/2 turn in counter-clockwise direction and operate primer pump with smooth, even strokes, using

a firm pressure of 10 pounds or more on the pumping stroke. With engine running, regulate throttle, push priming plunger all the way in and turn clockwise until spring catch engages. Turn off primer ignition switch. At low temperatures the engine may fire for a time with the combined help of the starter and primer before developing sufficient power to run unassisted. Under these conditions, it is advisable to pause briefly at the end of each pumping stroke to allow the engine time to absorb the heat generated.

Note: Both the electric air heater and flame primer (sometimes called a flame thrower) are designed to preheat air which is drawn into the cylinders and thus facilitate starting in colder temperatures.

2.12 After engine has warmed up, advance throttle to RUN or operating position. Note that the frequency meter reads the value, between 60 and 63 cycles, which from experience indicates the proper ***no-load*** frequency.

2.13 Note that the AC voltage rises to the proper value (208 to 210 volts). The exciter field rheostat and the voltage regulator rheostat are preset and should not require adjustment. If necessary, adjust voltage by means of voltage regulator rheostat. On installations equipped with a voltage regulator OFF-ON or MANUAL-AUTOMATIC switch, this may be left in the AUTOMATIC or ON position at all times unless the voltage regulator gives an indication of failure. Should it become necessary to remove the voltage regulator from service, remove the load, adjust exciter field rheostat to minimum voltage position, operate voltage regulator switch to OFF or MANUAL position, and adjust voltage by means of exciter field rheostat. With voltage at proper value, load may then be applied and voltage adjusted as required by use of the exciter field rheostat.

Note: If the voltage regulator is not equipped with a switch for cutting it out of service, determine from circuit drawings which leads or terminals to short in order to by-pass the rheostat element of the voltage regulator. Also, the voltage regulator potential and stabilizer leads should be disconnected. This method may be used to remove control of exciter field by voltage regulator if necessary to remove regulator from service as described above.

2.14 Start the room ventilating fan, if provided, or open windows as much as local conditions permit.

2.15 When it has been determined that the load can be connected, close the main line circuit breaker. Load can then be applied. Gradual application of the load is desirable.

Running

2.16 During a prolonged run, endeavor to keep the oil in the fuel oil tank above the 1/4 full mark.

2.17 See that the oil pressure, as indicated by the pressure gauge, does not fall below 20 pounds. Normal oil pressure is 35 to 40 pounds. Should the oil pressure fall below 20 pounds, stop the engine, determine cause, and remedy the condition.

2.18 The maximum temperature of the cooling water, as indicated on the water temperature gauge, should not exceed 185°F for installations where the surrounding air temperature is below 110°F. Where the surrounding air temperature is above 110°F, the temperature of the cooling water should not be permitted to exceed 195°F.

2.19 Under prolonged operation, the crankcase oil level should be checked 8 hours, or oftener if required to meet the requirements outlined in 2.03. Feel the cover on top of the lubricating oil filter occasionally to see that it is warm. If cold, it indicates the filter is clogged. Correct as necessary.

2.20 Keep the engine clean and well lubricated. Lack of lubrication causes undue wear. Care should be taken to remove all dirt from points of lubrication before lubricant is applied.

Stopping

2.21 Remove the load. Gradual removal is preferable. Ventilating fans, water pumps, etc, which may be part of the load should be stopped last.

2.22 Open the main line circuit breaker.

2.23 Gradually retard the throttle to the idling speed position. Allow the engine to idle for 15 minutes in order to cause a more uniform cooling of engine parts.

2.24 Pull the engine stop control back to the STOP position and hold until the engine is completely stopped.

2.25 Close valves in fuel lines, and stop auxiliary fuel pump, if provided.

2.26 Stop the room ventilating fan, if provided and operating from another power source, or close windows.

2.27 Open valve or drain in exhaust line and silencer. If an air exhaust duct is provided between the engine radiator and the outside, see that any louvers, etc, are properly closed.

2.28 If there is any danger of water freezing in the water jackets or other parts of the cooling system and an antifreeze is not used, drain cooling system and leave drains open. Draining of the cooling system should preferably be done only as an emergency means, since the loss of rust inhibitor would be uneconomical as a general practice.

2.29 Replenish the oil in the crankcase as necessary.

2.30 Clean the engine thoroughly and be sure it is in proper shape for the next run.

2.31 Check the amount of fuel in the tank and replenish as required to ensure that an ample supply of fuel is available for the next run.

Note: Certain of the above shutdown procedures may be omitted on automatic starting type plants where various valves are under solenoid control with spring loading in the reverse operating direction.

Routine Runs and Checks

2.32 Routine runs shall be made in accordance with Bell System Practices.

2.33 On engines equipped with a Calrod or similar type heater, provided to keep the water temperature at a point which will facilitate quick starting, checks shall be made as frequently as practicable to ensure that the heater is functioning. Ordinarily, this heater is connected to the main building power source and is inoperative at the time of power failure, or during test runs if a thermostatic control is provided to disconnect it.

2.34 On installations equipped with starting batteries and trickle chargers, frequent checks shall be made, wherever practicable, to ensure that the charger is functioning and that the battery is fully charged. If possible, use the same maintenance procedures as are used for other batteries in the power plant.

Report

2.35 Record each attended run as per items on the Engine Run Log, Form E 5697-PAC. Readings shall be taken at the start and end of each run and at one-half hour intervals during the run. When changes are made in the load during a run, readings shall be taken as soon as practicable after changes have been made.

2.36 A copy of Form E 5697-PAC covering each attended run shall be retained in the central office file.

3. LUBRICATION

3.01 All main bearings of the engine and certain accessories such as supercharger, water pump, fuel pump, governor, etc, are provided with automatic lubrication and do not require lubrication by the operator. For parts requiring lubrication, see Chart A.

3.02 Sudden failure of the oil pressure would indicate failure of the oiling system, whereas a normal pressure when starting with cold oil, then a gradual drop in pressure below normal as the engine warms up may indicate a low oil supply, oil dilution, wear on crankshaft bearings, or sticking oil pump relief valve. Should the oil pressure fall below normal, stop the engine, determine cause, and remedy.

4. GENERAL TROUBLES

4.01 Any trouble with the exception of minor mechanical difficulties, is usually traceable to air in the fuel lines, weak compression, improper mixture of fuel and air, poor combustion, lack of proper lubrication, or improper cooling.

4.02 For a list of the possible troubles, which may be encountered in the operation of the engine and suggested means of correcting these troubles refer to the manufacturer's maintenance manual (see 1.06).

CHART A

LUBRICATION CHART

INTERVAL	LUBRICANT SECTION 065-330-101	PART	AMOUNT
Beginning of Each Run	(See ***Note***)	Crankcase	Where oil level has fallen more than 1/3 distance from FULL mark to LOW mark on oil level gauge, fill to FULL mark on gauge.
		Governor and Fuel Injection Pump	Check oil level, ***do not*** overfill. To check pump level, add oil until a few drops appear from oil level overflow cock. To check governor, open drain cock at rear of governor. Add oil slowly until it drips from drain cock. Close drain cock.
		Alternator and Exciter Bearings	Check oil level. Add oil if necessary to bring up to indicated level.
	In Lubrication System	Primary Lube Oil Strainer	On engines equipped with primary lube oil strainer, turn "T" handle atop strainer two or three turns to dislodge any solids which may have accumulated on the element discs.
Every 8 Hours of Continuous Operation	(See ***Note***)	Crankcase	Add oil as required to bring up to FULL mark on gauge. ***Never let the oil level go below LOW mark.***
	Grease (See 500 Hour Interval)	Water Pump	Screw down on grease cup one turn while engine is running.
Every 100 Hours Operation Or At Least Once A year	(See ***Note***)	Crankcase	Drain old oil and refill with fresh lubricant until level shows FULL on gauge, and start engine. After 5 minutes, recheck level and add oil as required to bring the level up to FULL mark. The approximate amount of oil required to fill the crankcase for each type engine is shown below. These amounts include the oil normally carried in the oil cooler, filters, strainers, lubricating passages, etc, which depending upon their state of fullness, may sometimes vary the amounts shown. Engine — Approximate Gallons BUDA 317 — 2 to 3 BUDA 468 — 3 to 4 BUDA 645 — 5 to 6 BUDA 844 — 6 to 7 BUDA 1125 — 7 to 8 BUDA 1879 — 22 to 30 BUDA 2505 — 28 to 30
100 hours	(See ***Note***)	Governor and Fuel Injection Pump	Drain old oil and refill according to instruction under "Beginning of Each Run".
		Air Cleaner	Disassemble cleaner and remove dirty oil and sludge from reservoir. Wash the filter element in fuel oil or petroleum spirits to remove dirt. Fill reservoir with fresh oil to indicated level. After filter element has drained, blow out with air and reassemble cleaner. ***DO NOT*** pour any oil over filter element.
	Oil 44-47 S210	Crankcase Oil Filler Cap	Remove filler cap and clean by washing in fuel oil or petroleum spirits and blowing out with air. Dip in oil and drain before replacing.
	Oil 58-65 S210	Starting Motor and Drive Bearings	Two or three drops. ***CAUTION: DO NOT OVERLUBRICATE.***
	Oil 58-65 S210	Throttle and Stop Control Linkage	3 to 5 drops. Flex stop control cable when applying lubricant.

CHART A (Contd)

INTERVAL	LUBRICANT SECTION 065-330-101	PART	AMOUNT
	In Lubrication System	Lubricating Oil Filter	Remove element and replace with new element.
	In Lubrication System	Primary Lube Oil Strainer	On engines equipped with primary lube oil strainers, turn shut-off valve to OFF position (flattened section of valve in line with OFF). Remove drain plug and drain housing. Remove cap holding top of strainer housing. Remove cartridge and wash thoroughly with fuel oil or petroleum spirits. Flush out housing with a like solvent, and wipe with a lintless cloth. Reassemble and be sure to turn shut-off valve to ON position.
500 Hours	Grease 200-250P	Fan Hub	Fill with grease through fitting or through hole from which grease plug has been removed. ***Do not*** force excessive amounts of grease through fitting. Replace plug, if provided.
		Water Pump 4DC-645 8DCS-1125	Fill cup with grease. ***Do not*** force excessive amounts of grease into cup.
	Grease Water Pump 70-200P	Water Pump 6DT-468 6DCS-844 6DC-844 6DCS-1879 6DC-1879 8DCS-2505	
	Grease Andok C(195P)	Supercharger Closed End Bearing	Remove bearing cap, check that bearing chamber is 2/3 full. Add grease, if necessary, to fill chamber 2/3 full.

Note: Use SAE 40, 68-75 S210 oil for air temperatures over 60°F. Use SAE 30, 58-65 S210 oil for air temperatures between 32°F. and 60°F. Use SAE 20, 50-55 A210 for air temperatures between 10°F. and 32°F. In those cases where water jacket continuous heaters are ***NOT*** provided, oil changes should contemplate seasonal changes with the lighter grade of oil used where freezing temperatures are expected. Where water heating is constantly applied, seasonal changes in ambient temperature may be disregarded.