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(DE92001149)

# INTEGRATED SYSTEM DESIGN REPORT

Topical Report

July 1989

Work Performed Under Contract No. AC21-88MC23174

For
U.S. Department of Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
General Electric Company
Erie, Pennsylvania

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Printed in the United States of America, Office of Scientific and Technical Information, Oak Ridge , Tennessee

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Distribution Category UC-111

DOE/MC/23174--3068

DE92 001149

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For
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Office of Fossil Energy
Morgantown Energy Technology Center
P.O. Box 880
Morgantown, West Virginia 26507-0880

By
General Electric Company
GE Transportation Systems
2901 East Lake Road
Erie, Pennsylvania 16531

July 1989

LOCOMOTIVE DESIGN PROGRESS

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# 1. Overview

The primary objective of the integrated system test phase is to demonstrate the commercial potential of a coal fueled diesel engine in its actual operating environment. The integrated system in this project is defined as a coal fueled diesel locomotive. This locomotive, shown on drawing 41D715542, is described in the separate Concept Design Report. The test locomotive will be converted from an existing oil fueled diesel locomotive in three stages, until it nearly emulates the concept locomotive.

The first of the three development stages will consist of a modified locomotive and a fuel tender car. GE 607, a General Electric Engineering test locomotive, will be used, with modifications, for all three stages. For Stage I, the 16 cylinder engine on GE 607 has been replaced with a 12 cylinder engine. This has been done to provide additional space on the locomotive to accommodate the extra equipment needed for handling the coal-water-slurry (CWS). In addition to GE 607, Stage I will use a railroad flatcar with a special CWS tank, purge water tanks, and associated pumps and controls. The flatcar will serve as a testbed for working with the CWS. The CWS tank has special features which will allow the effectiveness of recirculation at various rates to be evaluated. In addition, it has features such as a removable top and baffles which will allow flexibility to modify during the testing process which would not be possible if the tank were in the location of a standard locomotive fuel tank. The CWS handling systems will be completely tested prior to the installation of the actual coal-fired engine. After the coal-fired engine is installed, locomotive testing will include both stationary testing and testing on the General Electric test track.

Knowledge gained during testing of the Stage I locomotive will be used to design a new, segmented, CWS/diesel tank for the Stage II locomotive. In addition, the recirculating and purge pumps and associated piping and controls will be relocated from the Stage I tender (flatcar) to GE607, thus eliminating the need for the tender. The engine will be modified to convert the fuel system to an accumulator type system. Locomotive testing will include stationary tests, tests on the General Electric test track, and limited running on a commercial railroad.

For Stage III, the locomotive will be modified to allow the installation of emission control equipment. In addition, electrical control functions will be further integrated into the locomotive's control system.

Refer to drawing number 41D715472 for a view of the locomotive equipment location for the three stages.

## 2. Locomotive Design Details

### 2.1 Description of GE 607

GE 607 is a C39-8 Engineering test locomotive used for conducting experimental tests. It forms the basis for the coal-fired locomotive, and is used for all three stages of the program. It is a microprocessor controlled, six axle locomotive, having motor driven blowers and radiator fans. The air compressor is shaft driven.

#### 2.1.1 12-Cylinder Engine Design Description

The engine will be a modified General Electric model 7FDL12, which is normally diesel-fired and rated at 3300 brake horsepower at 1050 rpm. It is a 4-stroke per cycle compression-ignition type engine of 45 degree bank angle, 9 inch cylinder bore and 10.5 inch piston stroke, having a 12.7:1 compression ratio. Some of the standard design features include: unitized cylinder assemblies using welded head-to-liners with four valves per head and external jackets having individual cooling water, intake air, and exhaust gas connections; 3-ring pistons using steel crowns and aluminum skirts on articulated connecting rods; a cast-iron main frame with internal oil passages; aftercooled free-wheeling turbocharger run from a constant-pressure exhaust manifold; hydraulic overspeed and speed control governors.

##### 2.1.1.1 Fuel Injection Systems

The coal-fired engine will be provided with dual fuel injection systems. One is a pilot system for diesel fuel, which will be used to start the engine and run it at lower power levels. The other is the main system for CWS fuel, which will be used only at the higher power levels. For Stage I locomotive testing, the pilot system will be mechanically linked to the main system. The pilot system should change to an electrically operated one for Stage II and later locomotive versions.

The pilot fuel system will be a modified version of the standard engine diesel fuel delivery system. This includes an electrically driven fuel transfer pump which is able to operate from battery power. It pumps the pilot fuel from the internally-baffled tank (standard locomotive tank) located under the locomotive platform, then through a large fuel filter with regulator and pressure relief valve, feeding parallel low-pressure lines to each cylinder bank. Jerk-type high-pressure fuel injections pumps will be specially mounted in the main frame sidecovers, directly cam-driven by an additional lobe per camshaft section, and connected by high pressure fuel lines to the individual pilot fuel injectors. Each pilot fuel injector is sleeve-mounted at the 9 o'clock posi-

tion on the cylinder head and sprays into the combustion chamber from the side. These special pilot fuel pump/injector combinations will be in addition to the CWS jerk-pump/diaphragm pump/injectors provided for each cylinder.

A special fuel rack linkage will be used to control the amount of both CWS and diesel fuel delivered to the cylinders. Refer to the engine Fuel Linkage Layout, drawing number 41D715542. The load control governor power piston will rotate two layshafts (one per cylinder bank) just as on a standard diesel engine. However, this layshaft rotation will control only the pilot (diesel) fuel delivery during the first half of its rotation, and only the main (CWS) fuel delivery during the second half. As previously stated, the pilot fuel will be used to start the engine and run it at lower power levels. Additionally, a second layshaft on each bank will be provided to allow small amounts of pilot fuel to be added to the cylinders, as deemed necessary, during CWS combustion (the second half of the primary layshaft rotation). This secondary layshaft will be rotated by electrically operated actuators, to allow manual control over this feature.

### 2.1.2 CWS Delivery System

The locomotive/tender fuel system includes a CWS storage tank, a recirculation pump, and flow-through heater, all located on the tender (Stage I only). Refer to the Hydraulic Schematic on drawing number 41D715526. A progressive cavity (Moyno) pump is used as a charge pump to pump CWS from the CWS tank to the diaphragm pumps on the diesel engine. Control valves located on the tender determine whether the CWS is just recirculated through the tank and heater on the tender, or also supplied to the charge pump on the locomotive. Control valves on the locomotive determine whether the CWS supplied to the charge pump is then recirculated back to the tender, or supplied to the engine for combustion. A thermostatically controlled water/CWS heater on the locomotive controls the temperature of the CWS supplied to the engine. A strainer is also located on the locomotive to filter any larger contaminants prior to supply of the CWS to the engine. Drain valves are located throughout the tender and locomotive to allow draining of the system.

#### 2.1.2.1 CWS Charge Pump

A Moyno progressive-cavity pump has been selected as the engine CWS charge pump. This pump will supply up to 13 gpm at 400 psi to all the diaphragm pumps on the engine. The basis for selecting this pump is its ability to provide such a relatively high flow rate at the high pressure required to complete filling of the CWS injection pumps. A progressive-cavity pump is specifically designed for difficult pumping applications such that of the abrasive CWS slurry. A smaller Moyno progressive-cavity pump has been used in a similar application on the 2-cylinder combustion research engine in the General Electric Transportation Systems Engine Laboratory. The major disadvantage of the

Moyno pump is its great length, which requires it to be mounted on top of the locomotive fuel tank. No other location on the locomotive could accommodate its approximate 20 foot length.

The primary difficulty in pumping CWS fuel is that it is a non-Newtonian fluid (not constant viscosity). Neither is it a normally viscous fluid. The CWS fuels used to date exhibit a characteristic in which above a certain shear rate its viscosity rises very sharply. At the concentration of 50 percent coal (by weight) used, this occurs just above the range of maximum pumping shear rates. Consequently, unless local anomalies in the concentration of the CWS are totally avoided, this has a direct bearing on pump selection. Use of a progressive-cavity pump will provide capability to handle coal-water slurries having non-Newtonian characteristics.

Centrifugal pumps have a high ratio of peak to average velocities inside the pump casing, precluding their use except for very low concentrations of coal. Gear pumps have a pocket at the base of the gear tooth which can fill with coal particles and eventually lock the gears. In vane pumps, the shear rate at the tip of the vanes is high, but the vane motion avoids clogging. Lobe pumps have close clearances, both between lobes and the casing and between other lobes, which would seem to cause high shear rates. However, satisfactory operation has been observed at Otisca. This satisfactory operation may be due to its low rpm. A lobe type pump will be used for the multi-cylinder engine charge pump in the Engine Laboratory.

### 2.1.2.2 Drain Valves

Drain valves will be provided at the low points in the CWS piping system. They will enable the piping to be drained when the locomotive will be shutdown for a long period of time, preventing the water from freezing in the pipes and equipment. The drain valves will also provide a back-up to the water purge capability, enabling the piping to be drained if the pipes cannot be purged for some reason. This is essential, since the CWS piping must be either purged or drained when the engine will remain unloaded for any length of time to prevent the coal particles from settling out of the slurry. The drain valves themselves will be of a type which will, as near as possible, provide no dead volume in which the coal particles might collect. Details of the drain valves are shown on drawings 41D715494 and 41D715559.

Two types of drain valves will be used on the locomotive and tender. The first type will simply be tees located in the piping, fitted with special drain plugs which extend up into the tee to the extent that they are relatively flush with the inside of the piping, to minimize the dead volume into which coal could settle during normal operation. If this were not done, removal of a standard pipe plug might not allow draining of the system if an accumulation of coal particles had solidified above the standard pipe plug.

The second type of drain valve which will be used is a General Electric design specifically for use with the CWS. The basis for its design is to provide zero dead volume for coal to settle in. In addition, it provides a smooth surface for normal flow of the CWS. Refer to drawing 41D715559 for details of the valve.

#### 2.1.2.3 CWS Control Valves

Full port ball valves were selected for use as control valves throughout the system because of their wide-open flow path, with no trapped volume for coal to settle into. The design of the valves allows the valve ball and seals to be removed as a cartridge, without disturbing the piping. This will simplify any maintenance needed. Stainless steel was specified for both the ball and the seat.

Double-acting air actuators will be used to operate the valves.

#### 2.1.2.4 Piping

The CWS piping will require measures to prevent corrosion, since the base liquid for the coal slurry is water. The most expedient solution is to use anti-corrosive steel pipe, since steel pipe is presently used on production locomotives for both cooling water and lubricating oil. Consequently, hot-dip galvanized steel pipe will be used for the majority of the Stage I CWS piping. However, the piping in the immediate area of the flow control valves on the locomotive will be stainless steel. This more expensive anti-corrosive steel will be used because this area of the CWS piping system is not expected to be changed between Stage I and Stages II or III. The use of both stainless and galvanized steel pipe will allow us to gain experience with both throughout the program.

#### 2.1.2.5 Pipe Couplings

The pipe couplings used for the CWS piping for the Stage I locomotive and tender have been specified as Victaulic-type end-groove style couplings. Refer to Figure 1 in the appendages for details of Victaulic-type couplings. The technical justification for their selection is threefold. First, GE Transportation Systems presently uses Victaulic brand end-groove style couplings successfully for both cooling water and lubricating oil piping on production locomotives. Our operating experience with them has been good.

Second, Victaulic has a seal for their couplings which will allow them to act virtually as a continuation of the pipe wall. The seal fills the gap between the two mating pipes, eliminating any dead volume. This may prove to be beneficial in handling a non-Newtonian fluid such as the CWS.

Lastly, Victaulic style couplings will allow us to pipe the locomotive much faster and easier than other couplings or joining methods. This is important, in that the piping must be routed around existing cabling, equipment, and structures on the locomotive. They also are reusable, and allow quick, easy disassembly, which will be beneficial not only during the changes between the three stages of construction, but may be helpful at times during testing. They will expedite changes and disassembly for cleaning of pipe or equipment.

### 2.1.2.6 CWS Heater

A tube-in-shell heat exchanger was selected for heating of the CWS on the locomotive, using the engines cooling water as the source of heat. The construction of the heat exchanger is very similar to that of the one used on production GE locomotives for heating the diesel fuel. The CWS flows on the tube side because the coal would settle out in non-turbulent areas if it were to flow through the shell side. The heat exchanger is designed to raise the CWS temperature 40 degrees-F at a flow rate of 18 gpm, with engine water of 150 degrees-F. Actual flow through the heater will be approximately 13 gpm at most. The engine cooling water is approximately 150 degrees-F at idle, and 180 to 210 degrees-F when operating under load. The temperature of the CWS will be controlled thermostatically. Based on our experience to date in the Engine Laboratory, an operating temperature of approximately 80 degrees-F has been chosen. At CWS temperatures above 80, the engine cooling water will bypass the heat exchanger. The thermostatic control valve has not yet been selected, but will be similar in nature to the AMOT valve used on production GE locomotives. The heat exchanger will be located under the locomotive platform, just behind the CWS charge pump. Refer to drawings 41E914186 and 41E914188.

### 2.1.2.7 Back-Pressure Orifice

An orifice is used in the CWS supply header to the engine to provide sufficient back-pressure to allow supply of the CWS to the engine at approximately 400 psi. At full load, the engine will burn approximately 5 gpm of CWS. At this flow rate, it has been calculated that an orifice size of 0.5 inches in diameter will provide the desired 400 psi pressure. A pressure transducer located upstream of the orifice will be used to control the charge pump speed to maintain 400 psi. Excess flow through the orifice will provide recirculation to maintain the coal in suspension.

### 2.1.2.8 CWS Strainer

A filtration strainer will be used to remove solid particles larger than fuel injection and control orifices. This strainer will have a removable stainless steel wire mesh basket, capable of passing all particles 0.030 inches

in diameter and smaller. It will be located on the pressure side of the CWS engine charge pump, easily accessible for cleaning.

### 2.1.3 Lubricating Oil Centrifugal Filter

The standard engine lubrication system utilizes a single engine-driven helical gear pump in tandem with a pressure relief valve. Lubricating oil is supplied from the engine sump through a strainer to the suction side of the pump. It is then pumped through a large tube-in-shell heat exchanger, where it is cooled by the engine cooling water, and then filtered in a large paper element filter housing. The lubricating oil is then distributed throughout the engine from an oil gallery cast in the main frame, and then through drilled passages.

To remove the additional contaminants caused by the combustion of coal, a bypass centrifugal filtration system is being added to the system described above. The larger particles from the oil will be filtered by the ten, standard paper element filters. The centrifugal filter will be used to further clean the lubricating oil, bypassing the paper element filter housing, and then returning to the engine crankcase after cleaning. Approximately 10 percent of the total lubricating oil flow will pass through the centrifugal filter. The centrifugal filter is driven by the high-pressure oil supplied to it (approximately 100 psi at full engine speed).

### 2.1.4 Modifications Necessary to GE 607

It is necessary to make a number of modifications to the locomotive (GE 607) to accommodate conversion to a coal-fired locomotive. Refer to drawing 41E914186 for details of the modifications.

#### 2.1.4.1 Engine Mounting

GE 607 was originally designed and built with a GE 16 cylinder engine. To provide sufficient room on the locomotive for the CWS handling equipment, especially for Stages II and III, the engine has been changed from a 16 cylinder to a 12 cylinder. This was done by keeping the location of the rear of the engine in its original position, and shifting the front of the engine and alternator rearward 32 inches. This created sufficient room forward of the alternator of the necessary equipment. After removal of the 16 cyl. engine, the forward two engine supports were removed, and new ones were welded in place 32 inches rearward. This also included the addition of a bulkhead inside the platform, between the new supports, to provide the necessary strength to support the engine.

### 2.1.4.2 Blower Cab

To provide additional equipment room over the alternator, the traction motor blower and alternator blower package was shifted forward on the blower cab. A new cab was then fabricated to fit over the alternator. Incorporated into this new cab is a full width platform, which will provide a location for mounting the air-operated control valves which are used on the locomotive. The platform is equipped with a drip-pan and drain to catch any potential CWS leaks from the valves and piping. Refer to drawing number 41E914189.

Because of the relocation of the traction motor and alternator blowers, it was necessary to fabricate a new alternator air duct (connecting the blower to the alternator) and modify the traction motor air duct. Refer to drawing number 41D715501 and 41D715502 for construction details.

Relocation of the alternator rearward by 32 inches results in the need to re-route the cables from the locomotive to the alternator. They are being re-routed to the other side of the locomotive to allow the use of a full height doorway into the new CWS equipment area. Because it was not previously necessary to provide easy access to this area before, these cables were previously located at a height of about 4 feet.

### 2.1.4.3 Traction Motor Cables

The traction motor cables have been raised approximately 8 inches to provide the necessary height over the fuel tank for the charge pump. Because of is extreme length (approximately 20 feet), the only acceptable location for the engine charge pump is on top of the locomotive fuel tank. As originally built, there was not sufficient height to allow installation of the pump over the fuel tank.

### 2.1.4.4 Air Compressor

The air compressor on a locomotive is used to charge the train air brake lines and provide air for locomotive air brake equipment and pneumatically controlled devices. The original three cylinder air compressor on GE 607 was shaft-driven off the free-end of the diesel engine. The shaft and couplings used were specifically designed to provide the necessary torsional stiffness to allow satisfactory operation of the air compressor with the 16 cylinder engine. The change to a 12 cylinder engine would necessitate changing the driveshaft and couplings to those providing the necessary torsional stiffness for use with a 12 cylinder engine. For the Stage III locomotive, installation of the emission control equipment will necessitate lengthening of the locomotive platform, and relocation of the equipment rearward of the engine. This would involve relocation of the air compressor, which, if shaft-driven, would be either diffi-

cult or impossible. For this reason, it has been decided to replace the present shaft-driven air compressor with a motor-driven one as is currently used on current DASH 8 locomotives. This will allow locating the air compressor without concern for the ability to drive it with a shaft. Making the change at this time will eliminate the need to replace the drive shaft and couplings.

The new air compressor will be driven by a special dual winding 6/12-pole AC electric motor. This motor allows the air compressor to run about twice engine speed during no-load and low power levels (6-pole operation). When the engine speed increases, the motor becomes a 12-pole machine, running at about the same speed as the engine. The use of a motor driven air compressor also reduces the locomotives' auxiliary losses by not rotating the compressor when it is not needed. A shaft-driven compressor is driven at all times.

Conversion to a motor-driven air compressor necessitates the addition of a electrical control box for control of the drive motor.

## 2.2 Description of Fuel Tender Car

A railroad flatcar serves as the mounting base for the CWS tank, heater, recirculating pump, purge water tanks, and purge water pump for Stage I. It will serve as a test bed for the development of CWS handling techniques which will be incorporated into the Stage II locomotive. It will provide the room and flexibility needed to allow experimentation with CWS tank design and recirculation techniques. The electrical control cabinet for system control is located on the tender car (Stage I only). The types of valves, piping, and couplings are the same as those defined for the locomotive. An engine-generator set is located on the tender car to provide AC power for the pumps and electrical controls. The location of equipment is shown on 41E914197, and the piping layout is shown on 41E914191.

### 2.2.1 CWS Tank

The CWS tank is a one quarter segment of a full size 4000 gallon locomotive fuel tank. This was done to minimize problems when scaling it up to locomotive size for Stage II. The main stiffeners and load carrying members are placed outside of the tank. Consequently, all baffles are stress-free and replaceable. Various cutouts between the six compartments will be tested by measuring concentration of the coal in each of the compartments.

The tank is designed to allow testing of three methods of maintaining the coal in suspension in the CWS:

Recirculation
Bubbling of compressed air in the CWS
Stirrers

When the baffles are removed, it is possible to exchange the recirculating and compressed air tubes. This exchange will be required if the preliminary location and sizes of the holes in the recirculating tubes are not satisfactory. The fuel inlet mechanism will be incorporated into one compartment of the tank.

### 2.2.1.1 CWS Tank Construction

The tank walls are made of 0.1875 inch thick mild steel plate. All stiffeners are external. Both sides of the tank are fitted with raised walkways to allow easy access and inspection of the tank. It is equipped with handrails on both sides for safety. Two, removable covers allow access to the top of the tank for observation and modification. The internal baffles can be removed through these covers. Each of the two covers is equipped with three, 4 inch diameter inspection holes, with covers, to allow a quick check to be made into each of the tank's six compartments. Refer to drawing number 41E914098 for details of the tank.

The tanks four transverse baffles are removable, and are made of aluminum to allow modification of hole sizes and locations without concern for corrosion. They will be tested in many configurations including completely blanked off and completely open.

The recirculating tubes consist of a longitudinal placed 2 inch I.D. pipe each running through three of the tanks compartments. Each of the tubes has drilled holes spaced 4 inches apart, at angles between 10 and 30 degrees, to discharge the CWS towards the bottom of the tank.

One of the compartments is fitted with a suction line to supply the CWS to the recirculation pump. It is intended that the CWS be drawn off the top of liquid level in the tank. In the event the coal settles to the bottom during a period of non-recirculation, the pump would be able to draw water off the top, discharging it into the bottom of the tank and providing the necessary action to re-disperse the coal.

The inside of the tank will be epoxy coated to prevent corrosion. The outside will initially be painted, and perhaps insulated at a later time to reduce heat loss during cold weather operation.

### 2.2.2 Purge Water Tanks

A clean purge water tank and a dirty purge water tank will be located on the tender. During periods of inoperation, the CWS must be purged from the systems. One tank provides a source of clean water for the purging, while the other tank provides a place to store the dirty purge water. Both tanks are

fabricated steel, epoxy coated on the inside for corrosion protection. Refer to drawing number 41D715481 for details of theses tanks.

### 2.2.3 Purge Water Pump

A motor-driven centrifugal pump having a 10 gpm capacity at 50 psi is used to pump the purge water.

### 2.2.4 CWS Recirculation Pump

A motor-driven lobe type pump having a capacity of 100 gpm at 50 psi is used to recirculate the CWS. Its speed will be varied to determine the optimum recirculation rate for the CWS.

### 2.2.5 CWS Electric Heater

An electric circulation heater will be used in the CWS fuel storage tank recirculation line to prevent freezing of the CWS during low ambient temperatures. This heater is a pass-through type, with several individual elements, allowing the CWS flow to be thoroughly heated. The electric heater is sized to make maximum use of the heat added by the recirculation pump. It will be located between the pressure side of the recirculation pump and the pipe branch-off for transferring CWS to the locomotive, permitting heating of the total CWS flow through the recirculation pump.

### 2.2.6 Engine Generator Set

A diesel engine driven generator set will be located on the CWS tender to provide power for pumps and controls. Details are given in the electrical section.

## 2.3 Electrical System

The electrical system provides the necessary control and sequencing logic for operation of the CWS and purge water systems in their various modes of operation. All pumps and the electric heater are 220 VAC.

### 2.3.1 Power Sources

The fuel tender will require AC power as follows:

CWS Heater.....220VAC, 3-phase
Recirculation pump....220VAC, 3-phase
Engine Charge pump....220VAC, 3-phase
Purge Pump.....220VAC, 1-phase
Instrumentation.....110VAC, 1-phase

Power will be supplied initially from the Locomotive Test building, and then later by a portable diesel-powered source mounted on the tender car.

### 2.3.2 DC Control System

The electrical control system schematics for CWS control are shown on sketches GRC-890106C (sheets 1-3) and GRC-881222K (sheets 1-5). The CWS hydraulic schematic is shown on sketch 41D715526. Main control is through a selector switch with the following 6 positions:

[1] Startup/Shutdown
[2] Charge Recirculation System
[3] Charge Engine
[4] Run
[5] Purge Engine
[6] Standby

#### 2.3.2.1 Start

The cycle begins in the Startup position. Circuit breakers CB1,2,and 4 are open and no pumps are running. Note that Start and Shutdown are the same switch position except that in Start the lockout relay (LOR) is dropped out to prevent initiation of a purge cycle when the circuit breakers are first closed. The circuit breakers are then closed.

#### 2.3.2.2 Charge Recirculation

Moving the switch to position [2] picks up relay RECR to start the recirculation pump and closes valves V4, V8, and V10 to initiate the charging of the recirculation lines. Purge water is cleared from the recirculation lines by pumping CWS from the CWS tank through the valves V4, V8, and V10. When all purge water has been pushed into the dirty water tank, time delay relay TD20 picks up. V10 is opened and V9 is closed to re-route the slurry back into the CWS tank. Picking up TD20 also latches in relay RCCR to indicate

that the recirculation lines are fully charged. The pump continues recirculating CWS from the tank through the electric heater and the CWS heat exchanger on the locomotive. Pump speed is controlled by an inverter drive control. The pump may be shut off manually, if required by opening switch RPSD.

#### 2.3.2.3 Charge Engine

Moving to position [3] picks up ECR1 to start the engine charge pump at slow speed. A second inverter drive control is used to regulate engine charge pump speed. Valve V4 is opened and valves V2 and V5 are closed to pump CWS to the engine charge pump. The charge pump then pumps the CWS through the engine pushing purge water through V2 and into the dirty water tank. Valve V4 is opened to preclude starving the charge pump.

When all the purge water has been pushed into the dirty water tank, TD30 picks up to open V2 and close V3. This re-routes CWS from the engine back to the CWS tank where it is recirculated. Picking up TD30 also latches in relay ECCR to indicate the engine is fully charged.

#### 2.3.2.4 Run

Moving to position [4] picks up ECR4 to run the engine charge pump at high speed to run the engine. Note that both RCCR and ECCR must be picked up in order to pick up ECR4. Feedback from pressure transducer PT1 mounted near the orifice is used to control pump speed to maintain a CWS pressure of 400 psi at the engine.

#### 2.3.2.5 Purge Engine

Moving to position [5] drops out ECR4 to return the engine charge pump to low speed and picks up relay PURP to start the purge pump. Valves V2 and V6 are closed, and V3 and V5 are opened. This routes water from the clean water tank through the engine to the dirty water tank. CWS in the engine will be pushed through V2 into the dirty water tank. Valve V4 is also closed to resume recirculating the CWS through the heat exchanger. When the engine purge is complete, TD52 picks up to stop the purge and charge pumps and to open valves V2 and V6. Note that the EPR relay is picked up at the start of the engine purge cycle causing ECCR to drop out. This prevents running the engine until another full engine charge cycle has been completed.

### 2.3.2.6 Stand By

Moving to position [6] puts the system in a standby mode. The recirculation pump continues to recirculate CWS through the heaters while the engine idles on diesel fuel. It is possible to move directly from Run to Standby without initiating an engine shutdown sequence by holding the engine purge bypass switch (EPBS) open while moving from [4] to [2]. This is useful when a temporary engine shutdown is desired. In this case EPRB must also be held open when moving from [6] back to [4].

### 2.3.2.7 Shutdown

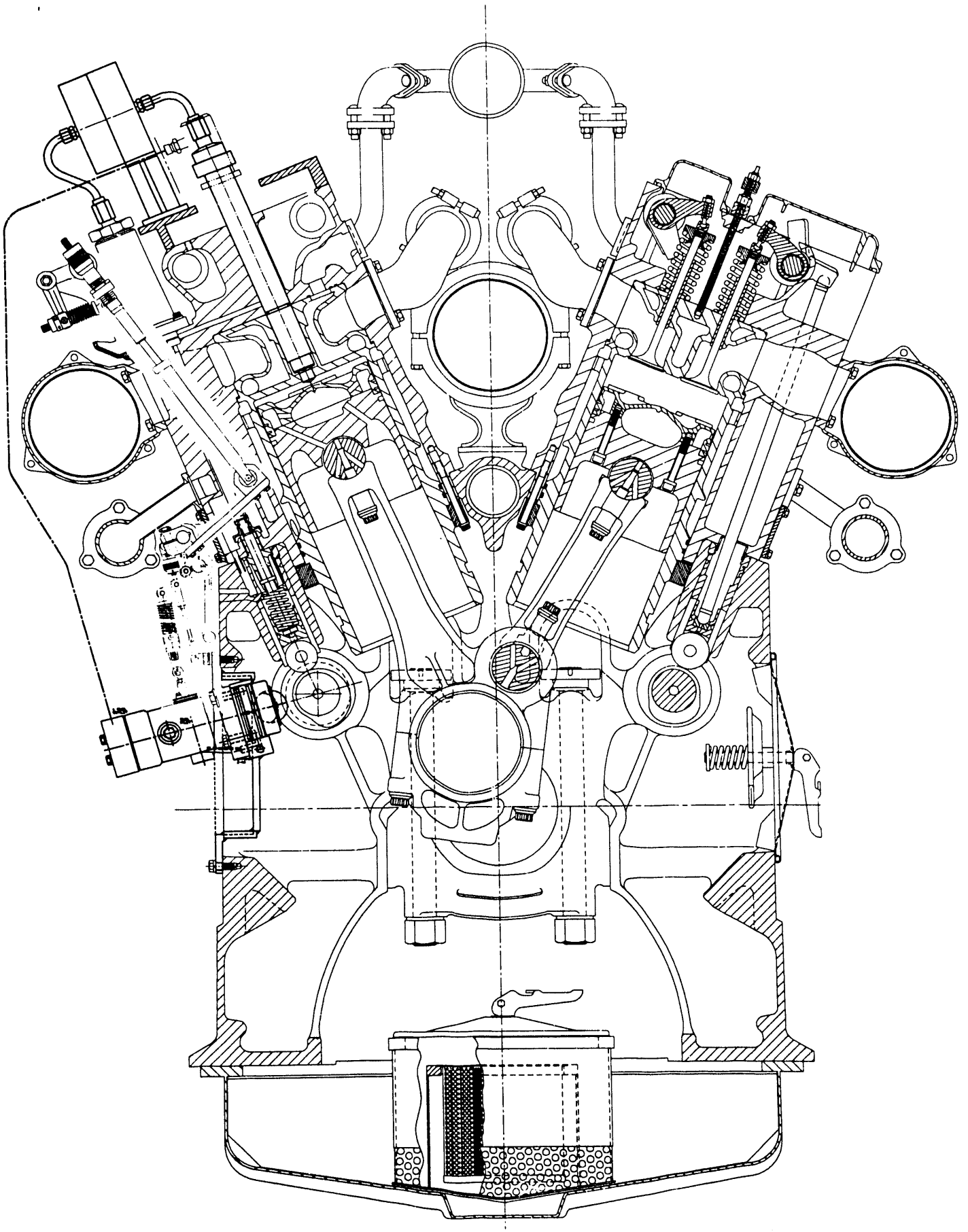
Moving to position [1] with LOR picked up initiates the shutdown sequence. The purge pump is re-started while valve V7 is closed and valve V8 is opened. This pumps water from the clean water tank through the recirculation lines. Prior to complete purging of the CWS, TD11 picks up to open V9 and close V10. This is done to route the purge water into the dirty water tank and not into the CWS tank. When all lines have been purged, TD12 picks up to stop the purge pump and open V4, V7, and V10. The shutdown cycle is now complete. Note that the relay RPR is picked up at the start of the purge cycle causing RCCR to drop out. This prevents running the engine until another full recirculation line charge cycle has been completed. Removing DC power will allow the LOR relay to drop out to avoid another purge cycle on re-start.

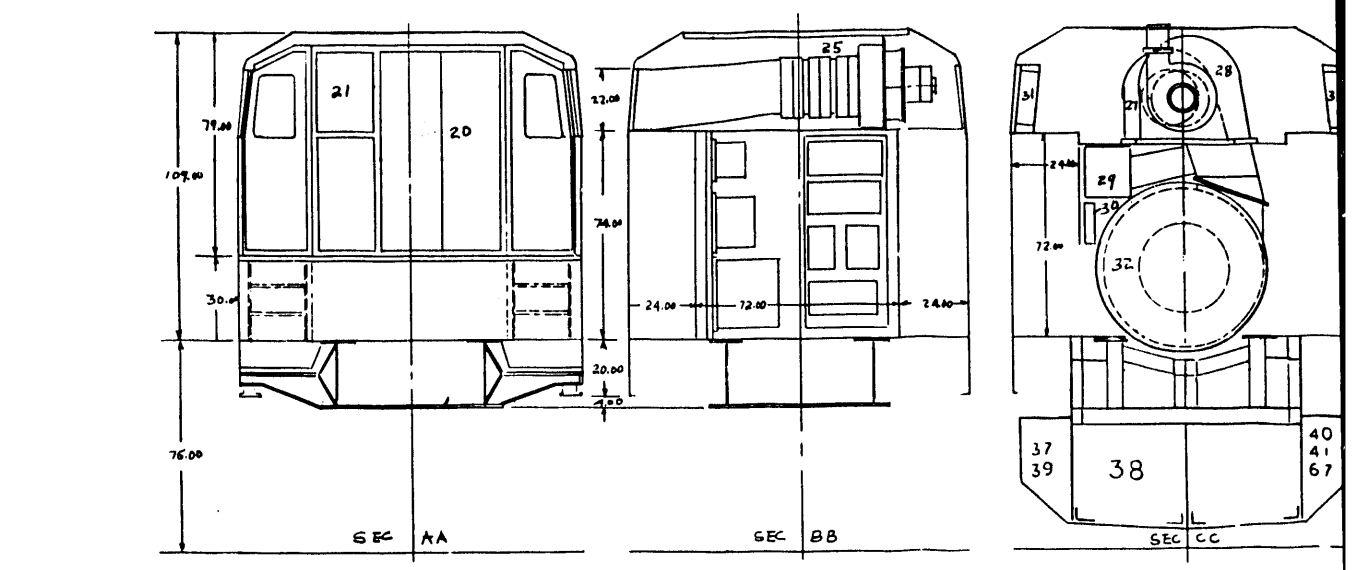
### 2.3.3 Status Indicators

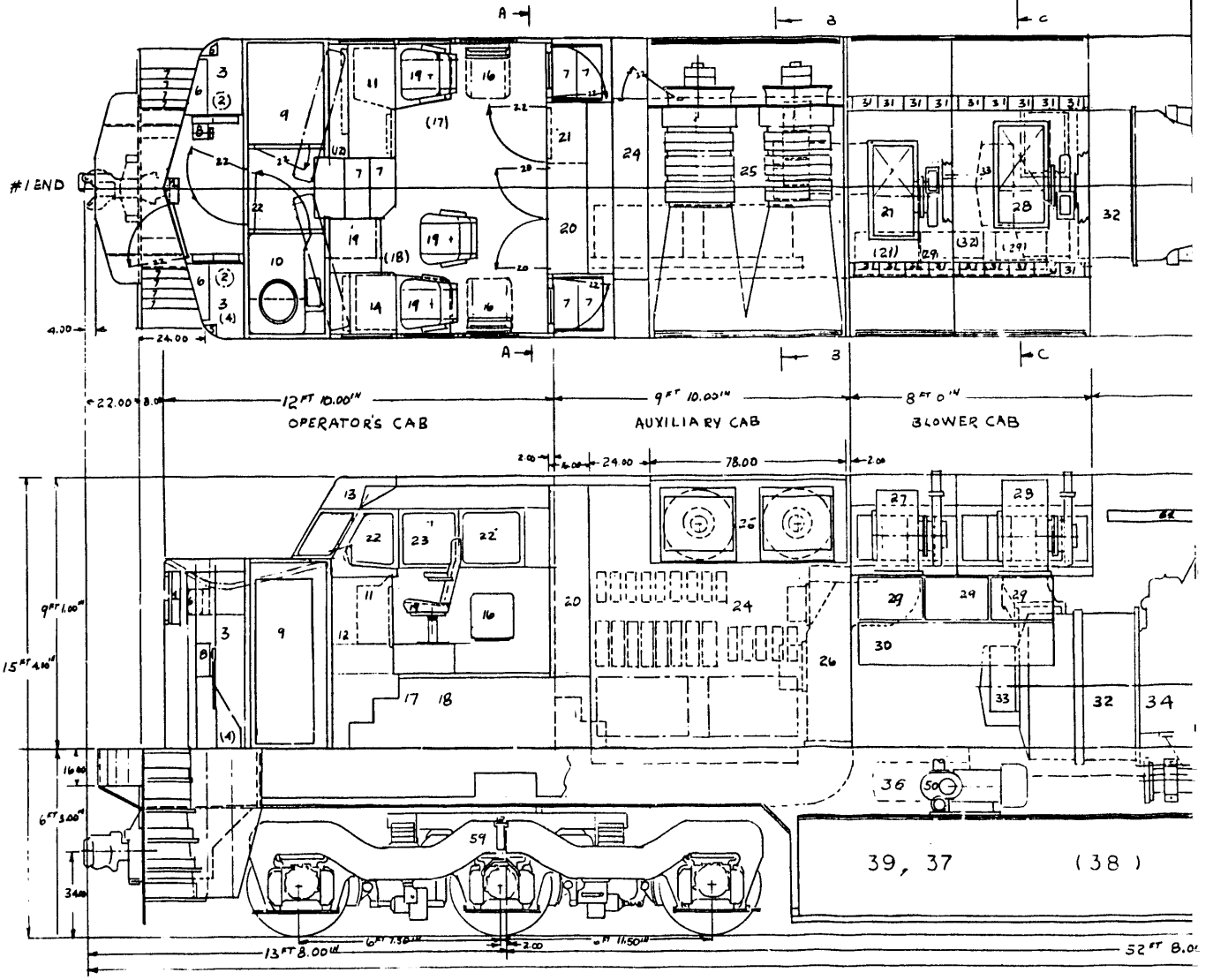
Control Status is displayed by status lamps mounted on the door of the fuel tender control box, as shown on sketch CRC-890106C, sheet 3. Indicator lights are used to shown the following:

Shutdown Complete
Recirculation Charge Complete
Engine Charge Complete
Running
Engine Purge Complete
Standby
V10 Closed
AC Power
DC Power (Wayside)
DC Power (Locomotive)
Water Heater
Recirculating Pump Running
Purge Pump Running
Charge Pump Running
Charge Pump Running Hi Speed
Full Pressure at Orifice

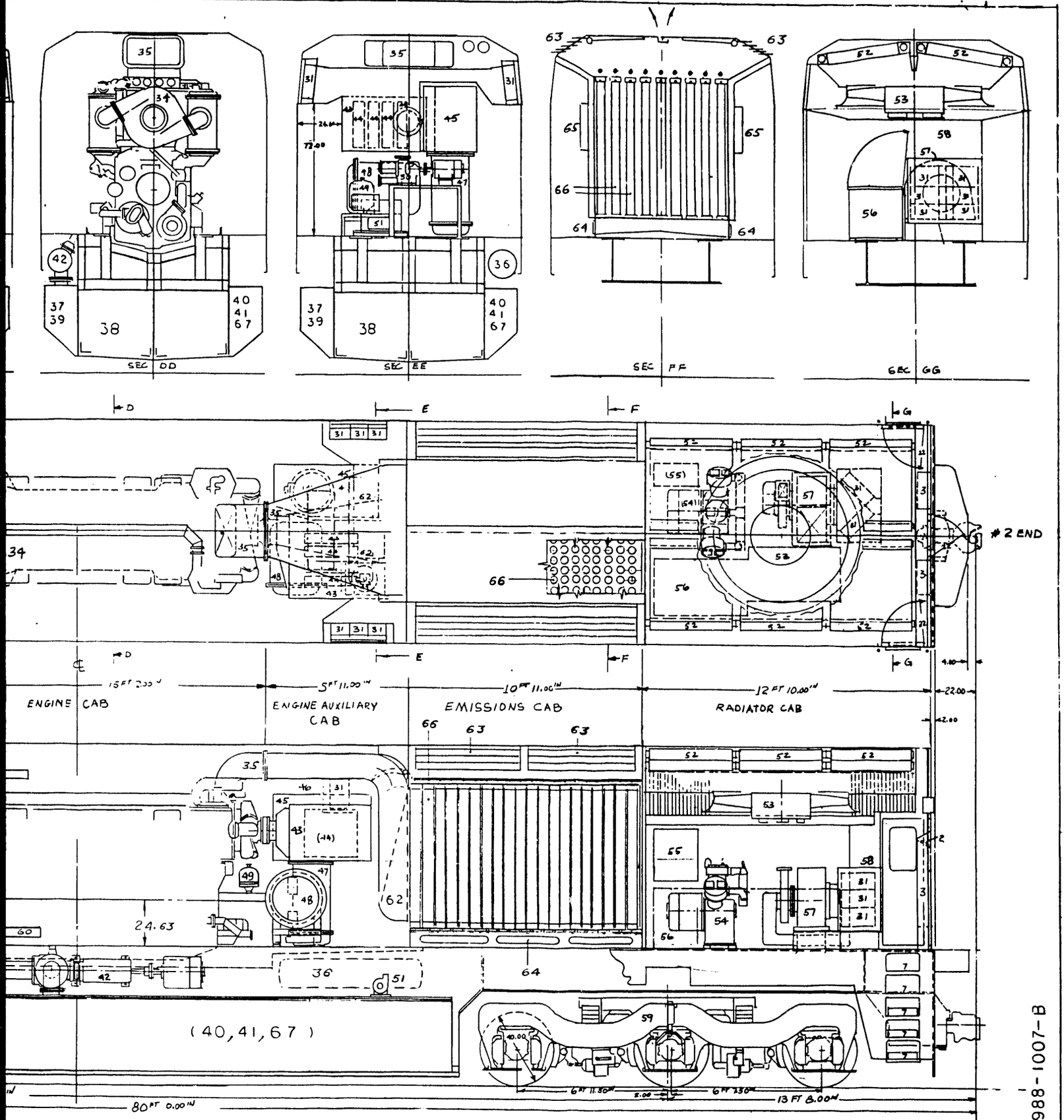
Control Air
V3 Closed
V4 Closed
V5 Closed
V8 Closed
V9 Closed
Purging Engine
Purging Recirculation Lines
V6 Closed
V7 Closed
V2 Closed






1 HEADLIGHT
2 SAND FILL
3 SAND BOX
4 SAND TRAPS
5 MARKER LIGHTS
6 NUMBER BOX
7 STEP
8 HAND BRAKE
9 CREW LOCKER
10 TOILET
11 OPERATOR CONSOLE
12 EMERGENCY BRAKE VALVE
13 OVERHEAD CONSOLE
14 CONDUCTOR CONSOLE
15 ROTATING PEDISTAL SEAT
16 SPRING UP DROP SEAT
17 AIR BRAKE COMPARTMENT
18 HEATER-AIR CONDITIONER
19 REFRIGERATOR
20 CC-1 LOW VOLTAGE CONTROL
21 EC PANEL
22 FIXED WINDOW
23 SLIDING WINDOW
24 CC-2 HIGH VOLTAGE CONTROL
25 DYNAMIC BRAKING BOX
26 #1 END TRACTION MOTOR DUCT
27 #1 END TRACTION BLOWER-MOTOR-EDUCTOR
28 ALTERNATOR-RECTIFIER-BLOWER MOTOR
29 RECTIFIER
30 FUSES + BUG BAR
31 PRIMARY AIR FILTER
32 ALTERNATOR
33 AUXILIARY ALTERNATOR
34 ENGINE
35 EXHAUST STACK SECTION
36 AIR RESERVOIR
37 500 GAL DIESEL FUEL TANK
38 8500 GAL CWS STRUCTURAL TA
39 RETENSION TANK 150 GAL.
40 250 GAL PURGE WATER TANK




41 250 GAL WASTE PURGE WATER TANK
42 MYNO PUMP-MOTOR
43 ENGINE AIR FILTER COMPARTMENT
44 SECONDARY FILTER
45 ENGINE WATER TANK
46 FLOW CONTROL VALVE
47 LUBE OIL COOLER
48 LUBE OIL FILTER
49 LUBE OIL CENTRIFUGE
50 TUTHILL LOBE PUMP-MOTOR
51 PURGE WATER PUMP-MOTOR
52 RADIATOR
53 RADIATOR FAN-MOTOR
54 AIR COMPRESSOR-MOTOR
55 AIR COMPRESSOR CONTROL
56 BATTERY BOX
57 #2 END TRACTION BLOWER-MOTOR-EDUCTOR
58 #2 END TRACTION FILTER-DUCT
59 "C" 3 MOTOR TRUCK
60 CWS HEAT EXCHANGER
61 HYDRAULIC CONTROL UNIT
62 DIFFUSOR INLET
63 AUTOMATIC LOUVERS
64 PARTICULATE VACUUM EXTRACTION
65 INSPECTION HATCHES
66 STAINLESS STEEL BAG FILTERS
67 500 GAL. SORBENT TANK

SCALE 3/8" = 1'0"

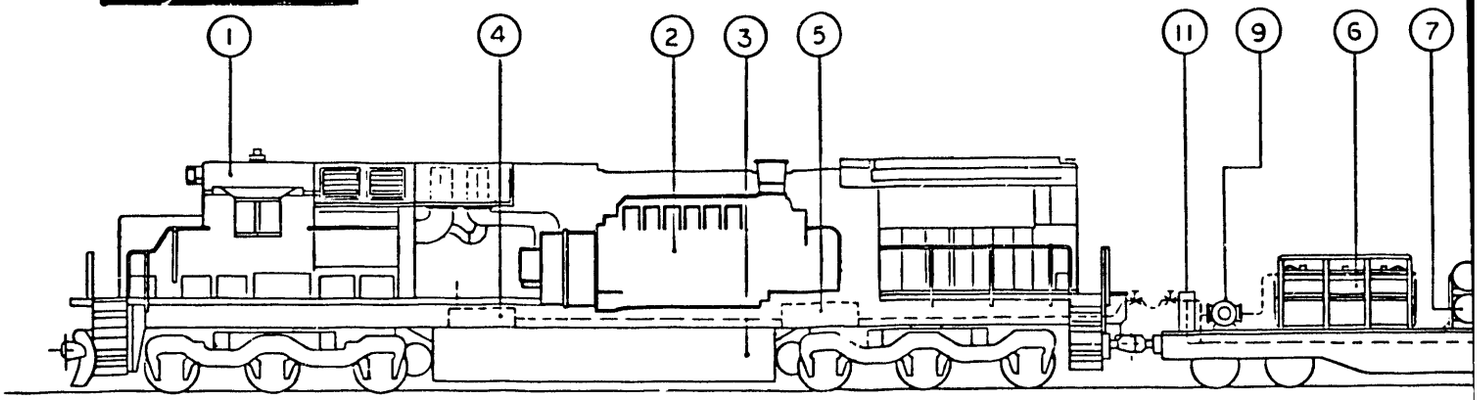
4000 HP CWS FUELED CONCEPT LOCOMOTIVE — PRELIMINARY LOCATION OF APPARATUS

MADE J.R. CHAMP ISSUED 10/7/88
ISSUED 10/8/88 "A" ADDED ITEMS 11/1/88 "B"

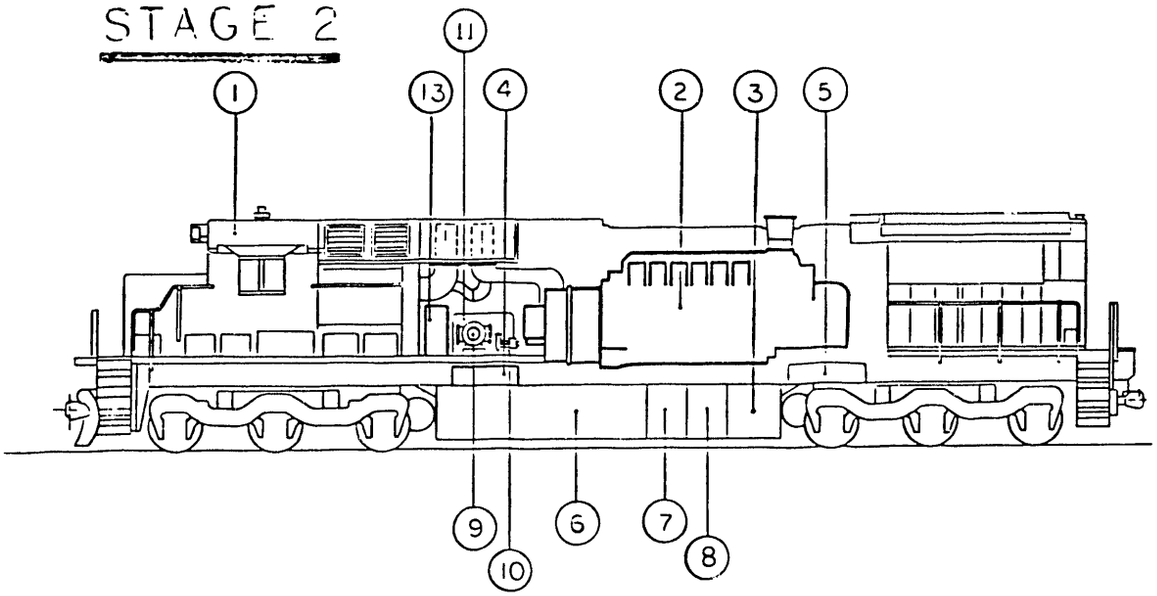
41D715543

SK-1988-1007-B

STAGE 1

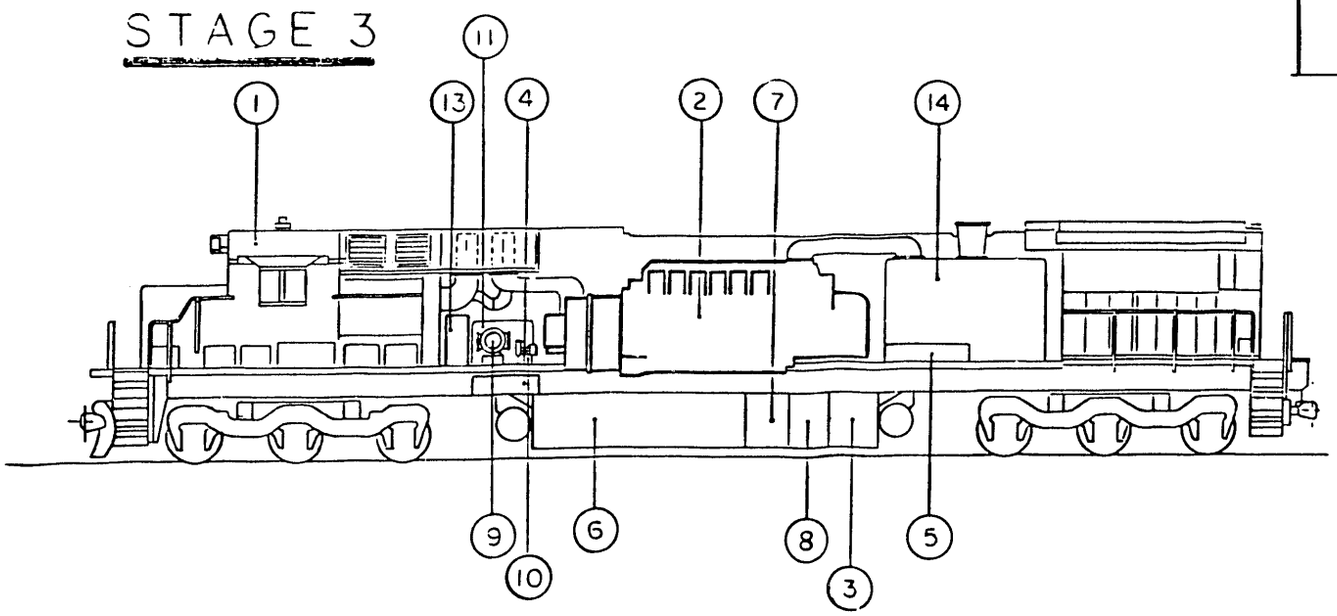


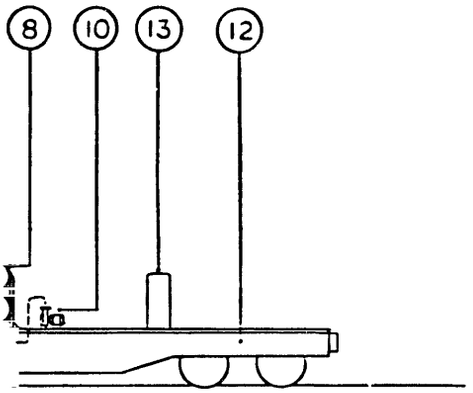

STAGE 2




| | |
|---|---|
| 14 | EMISSION |
| 13 | ELECTRIC |
| 12 | FLAT CAR |
| 11 | ELECTRIC |
| 10 | WATER PU |
| 9 | RECIRCUL |
| 8 | DIRTY WA |
| 7 | CLEAN WA |
| 6 | CWS EXPE |
| 5 | WATER/CW |
| 4 | ENGINE CH |
| 3 | DIESEL FU |
| 2 | 12 CYLIND |
| 1 | MODIFIED |

STAGE 3






| |
|---|
| CONTROL |
| CONTROLS |
| |
| HEATER & THERMOSTAT |
| GE PUMP |
| TING PUMP |
| TER TANK |
| ER TANK |
| RIMENTAL FUEL TANK |
| S HEAT EXHANGER |
| ARGE PUMP. |
| EL TANK |
| R DIESEL ENGINE |
| 07 LOCOMOTIVE |

| SIGNATURES | DATE |
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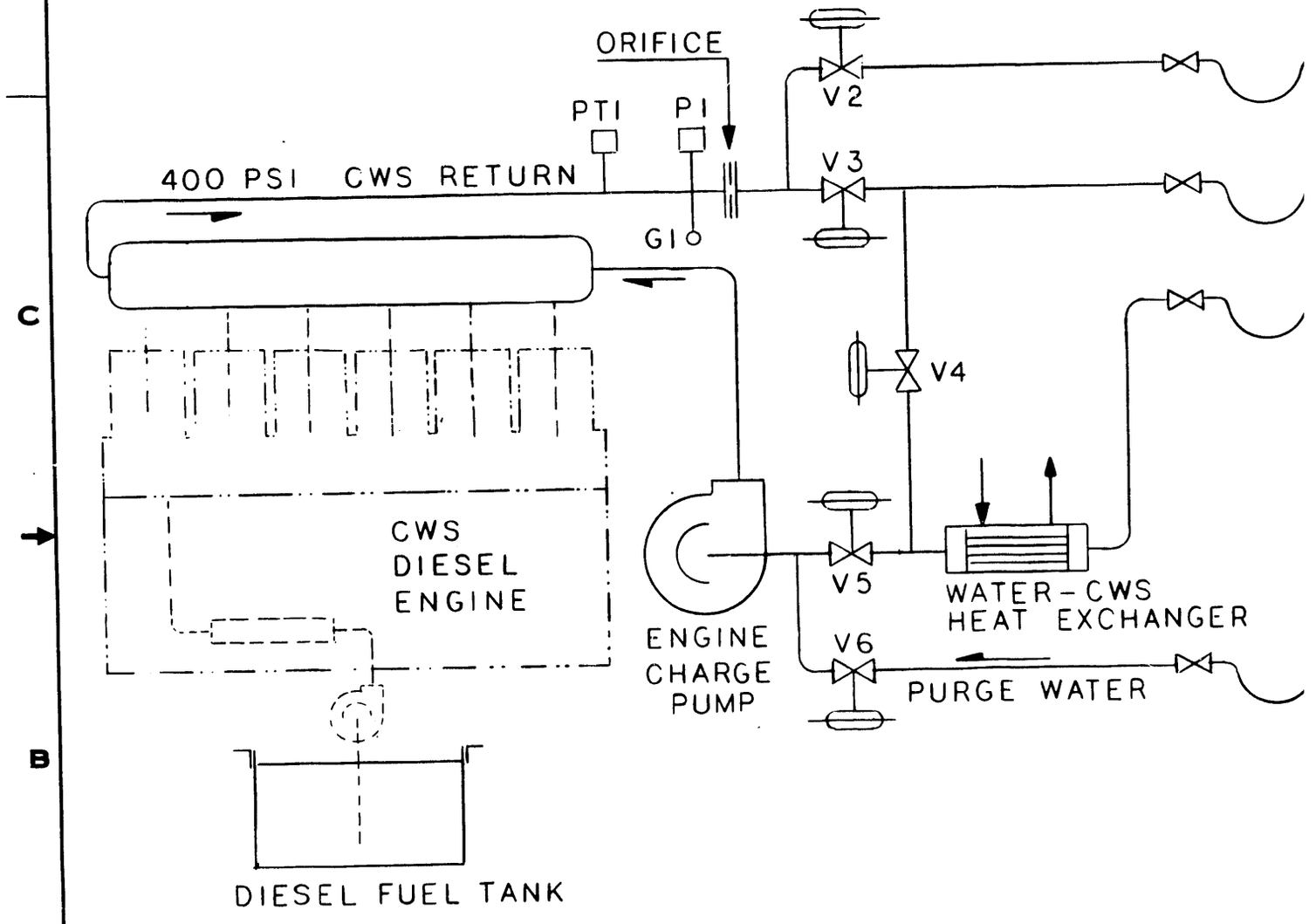
GENERAL ELECTRIC

CWS DIESEL
LOCOMOTIVE
STAGES 1, 2 & 3

SIZE D | FSCM NO. | DWG. NO. 41D715472

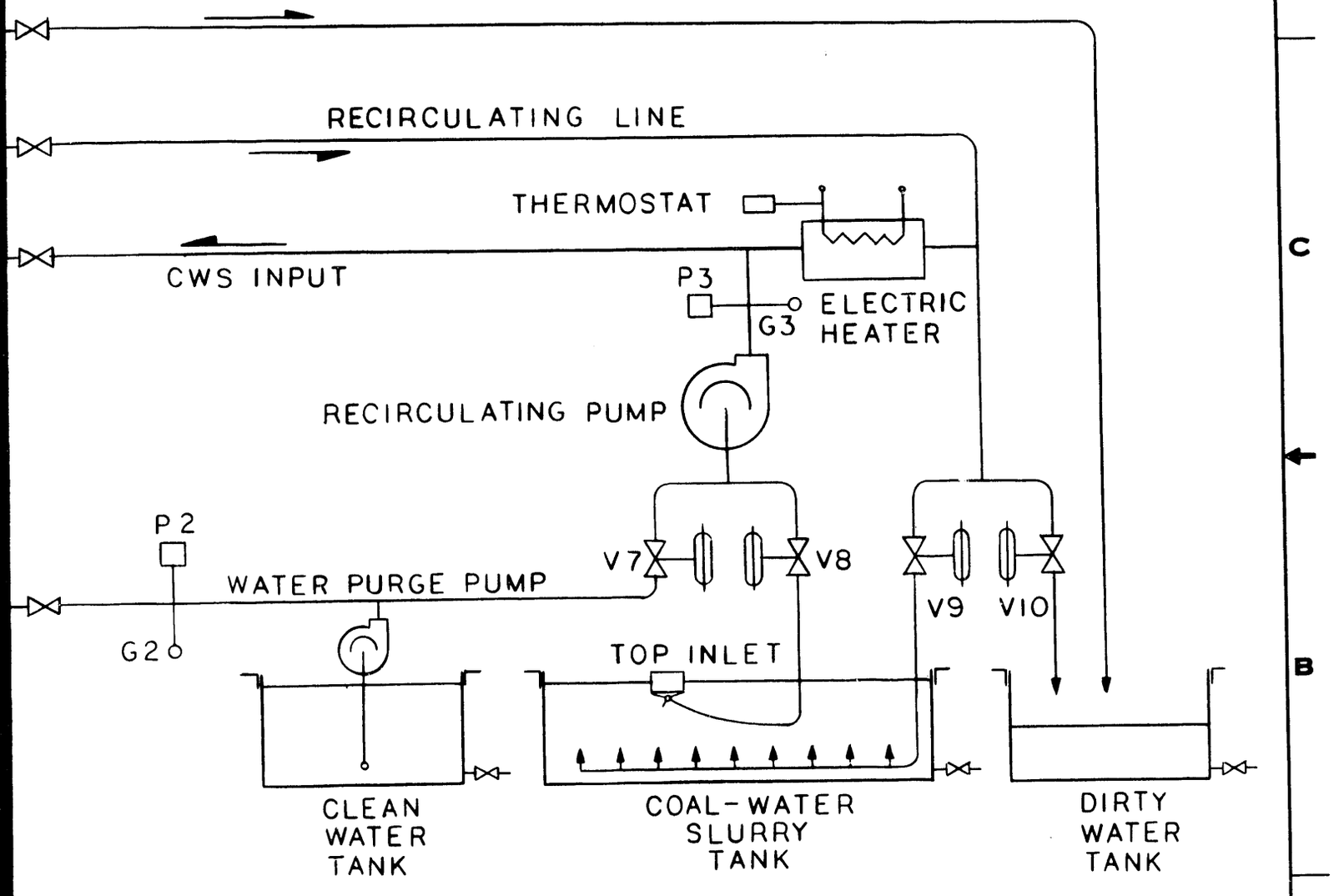
SCALE | SHEET




THIRD ANGLE PROJECTION

FN 1148-F (0)
1-84

| REVISIONS | | | |
|---|---|---|---|
| REV | DESCRIPTION | DATE | APPROVED |




| UNLESS OTHERWISE SPECIFIED | SIGNATURES | DATE |
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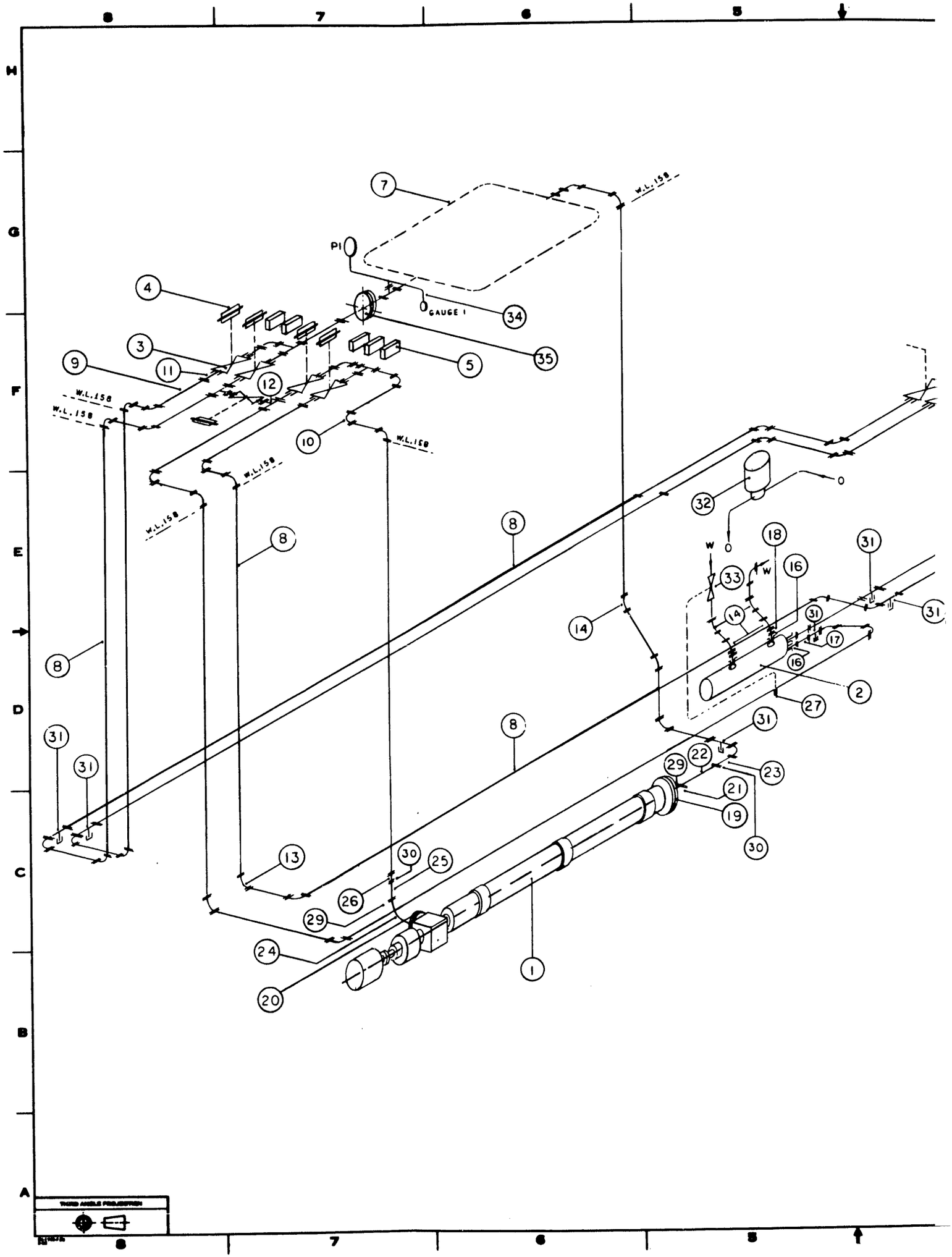
| TOLERANCES ON: | CHECKED | |
| 2 PL DECIMALS ± | ENGRG | |
| 3 PL DECIMALS ± | ISSUED | |
| ANGLES ± | | |
| FRACTIONS ± ✓ | | |

GENERAL ELECTRIC
DEPT LOC

COAL-WATER SLURRY
DIESEL ENGINE
HYDRAULIC SCHEMATIC

SIZE D | FSCM NO | DWG NO 41D715526 | DISTR TO

SCALE — | SHEET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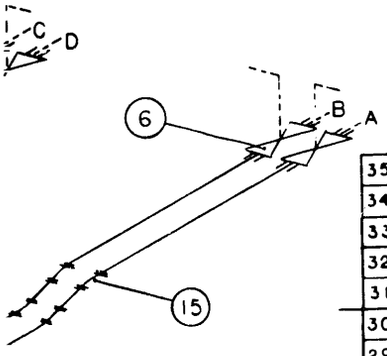


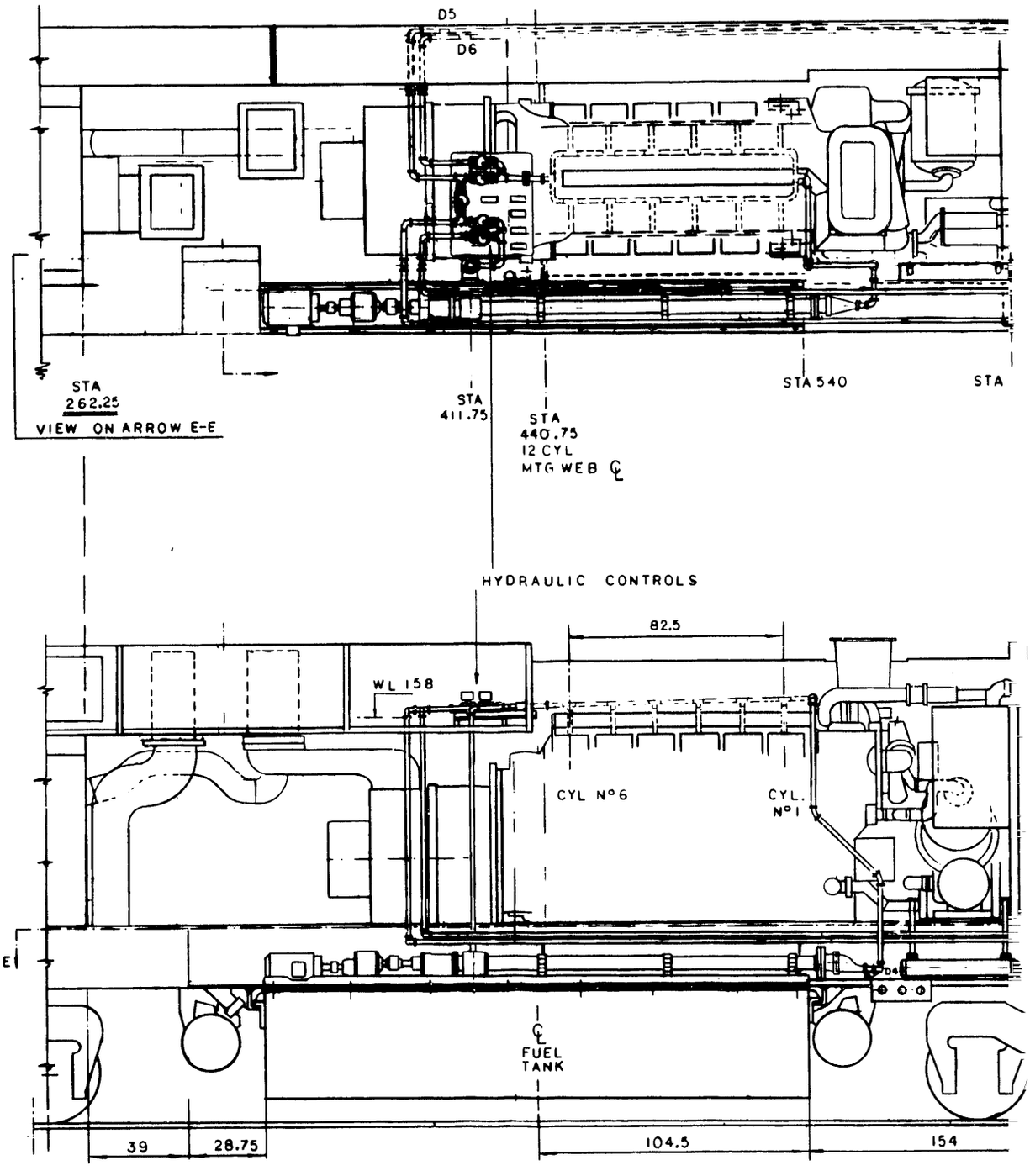

| ITEM | QTY | VENDOR | DESCRIPTION |
|---|---|---|---|
| 35 | 1 | TUBE LINE | ORIFICE FLANGES 1.5" WELDING NECK 300 LB |
| 34 | 1 | RED VALVE COMPANY | PRESSURE SWITCH AND GAUGE COMBINATION |
| 33 | 1 | | 1.5" THERMOSTATIC VALVE |
| 32 | 1 | SPINNER II | OIL CLEANING CENTRIFUGE MODEL 600 |
| 31 | 6 | GENERAL ELECTRIC | DRAWING Nº 41D 715 494 |
| 30 | 2 | VICTAULIC COMPANY OF AMERICA | 2" STYLE HP 70 ES END SEAL COUPLING H.D.G. |
| 29 | 2 | —II— | 6" STYLE HP 70 ES END SEAL COUPLING H.D.G. |
| 28 | 131 | —II— | 1.5" STYLE HP 70 ES END SEAL COUPLING H.D.G. |
| 27 | 1 | —II— | VIC-O-WELL STYLE 924 |
| 26 | 1 | —II— | 2"x1.5" CONCENTRIC REDUCER Nº 50 |
| 25 | 1 | —II— | 6"x2" ECCENTRIC REDUCER Nº 51 H.D.G. |
| 24 | 1 | —II— | 6" 90° ELBOW Nº 10 H.D.G. |
| 23 | 1 | —II— | 2"x1.5" ECCENTRIC REDUCER Nº 51 H.D.G. |
| 22 | 1 | —II— | 6"x2" ECCENTRIC REDUCER Nº 51 H.D.G. |
| 21 | 1 | —II— | 5"x6" CONCENTRIC REDUCER Nº 50 (DIVERGING) H.D.G. |
| 20 | 1 | —II— | 6" STYLE 742 VIC FLANGE ADAPTER 125 LB H.D.G. |
| 19 | 1 | —II— | 5" STYLE 743 VIC FLANGE ADAPTER 300 LB H.D.G. |
| 18 | 2 | —II— | 2"x 1.5" CONCENTRIC REDUCER Nº 50 H.D.G. |
| 17 | 2 | —II— | 2"x 1.5" ECCENTRIC REDUCER Nº 51 H.D.G. |
| 16 | 4 | —II— | 2" THREADED ADAPTER NIPPLE Nº 40 H.D.G. |
| 15 | 4 | —II— | 1.5" 22° ELBOW Nº 12 H.D.G. |
| 14 | 6 | —II— | 1.5" 45° ELBOW Nº 11 H.D.G. |
| 13 | 22 | —II— | 1.5" 90° ELBOW Nº 10 HOT-DIP GALVANISED (HDG) |
| 12 | 4 | —II— | 1.5" TEE Nº 20 SST 304 , OR , 314 |
| 11 | 10 | —II— | 1.5" THREADED ADAPTER NIPPLE Nº 40 SST 304 & 16 |
| 10 | 15 | —II— | 1.5" 90° ELBOW Nº 10, SST 304 OR 316 |
| 9 | 20 FT | —II— | 1.5" I.D. 0.2" WALL STAINLESS STEEL TUBE ABOVE W.L. 158 304 SST CUT GROOVED |
| 8 | 250 FT | —II— | 1.5" I.D. 0.2" WALL GALVANISD CUT GROOVED STEEL TUBE BELOW W.L. 158 |
| 7 | 1 | GENERAL ELECTRIC | DIESEL ENGINE FUEL DISTRIBUTION LINKAGE |
| 6 | 4 | JAMESBURY Co | 1.5" FULL PORT SERIES 4000 BALL VALVE |
| 5 | 5 | MAC VALVES INC | SOLENOID VALVE MAC 82 INDIVIDUAL BASE |
| 4 | 5 | JAMESBURY Co | DOUBLE ACTING PNEUMATIC VANE ACTUATOR 105-1 |
| 3 | 5 | —II— | 1.5" FULL PORT SERIES 4000 BALL VALVE |
| 2 | 1 | YOUNG | WATER CWS HEAT EXCHANGER 604-ER-2P-CNTB PART NUMBER 267382 |
| 1 | 1 | ROBBINS MYERS | MOYNO PUMP DWG 385 039480 |

| | SIGNATURES | DATE |
|---|---|---|
| | S.L.O. | 1.16.89 |

GENERAL ELECTRIC

CWS FUELED LOCOMOTIVE
MODIFIED 607 PROTOTYPE
PIPING LAYOUT OVERLAY
AND MATERIALS LIST

E 41E914 188




NOTE 1
EVRY PIPE JOINT IS AN VICTAULIC STYLE HP70ES END SEAL UNION

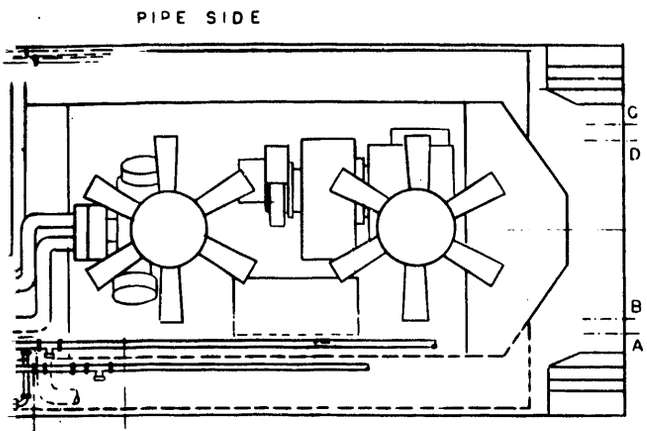
NOTE 2
1.5" EXTRA STRONG 0.2"WALL, 304 STAINLESS STEEL, CUT GROOVED PIPING A

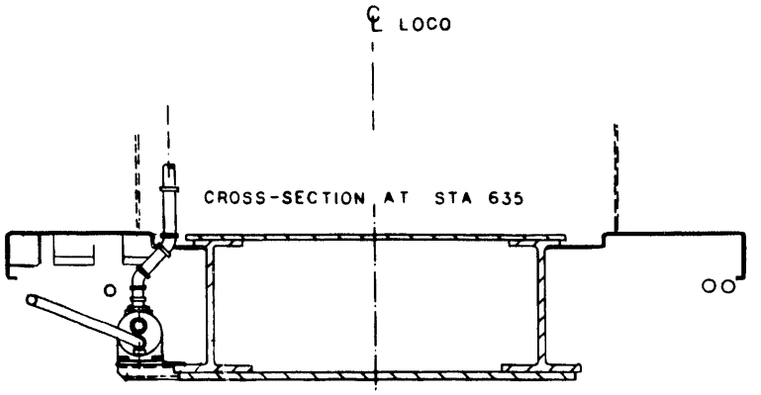
NOTE 3
ALL FITTINGS ARE GROOVED VICTAULIC 316 OR 304 STAINLESS STEEL ABOVE

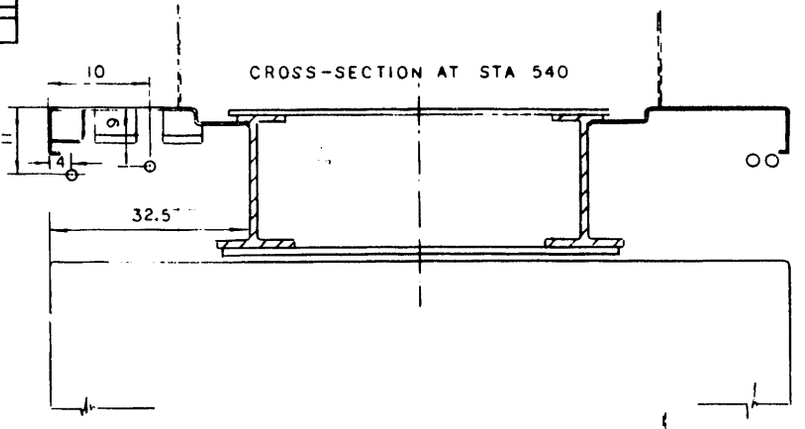
NOTE 4
1.5" EXTRA STRONG 0.2" WALL GALVANISED STEEL, CUT GROOVED PIPING BEL

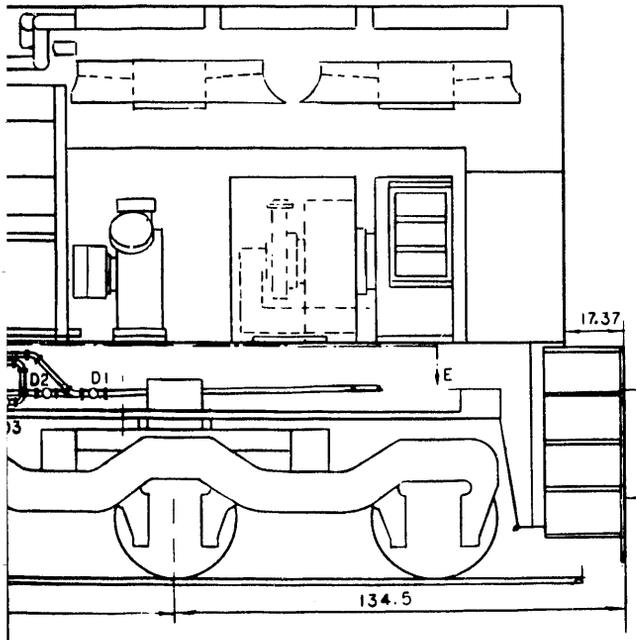
NOTE 5
D1, D2, D3, D4, D5 AND D6 ARE SHOWN IN DRAWING N° 410 715 494

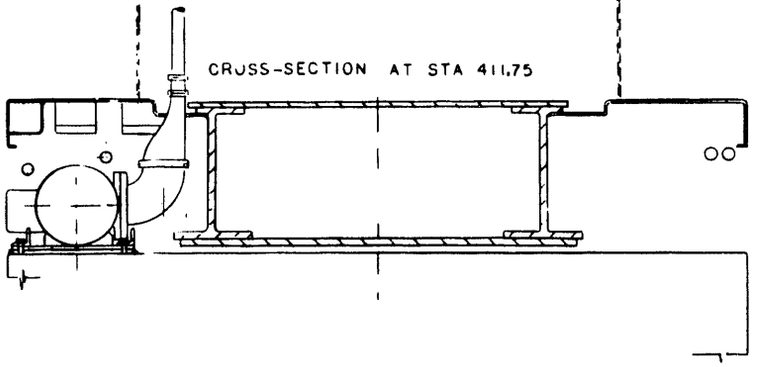
NOTE 6
ENTIRE SYSTEM HAS TO BE SELF DRAINING INTO AUXILIARY VALVES D1, D2, D3, D4,

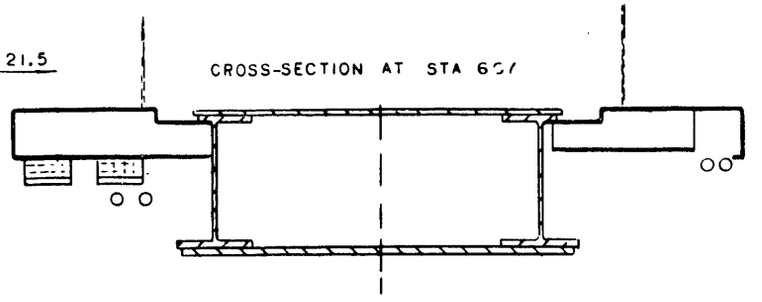


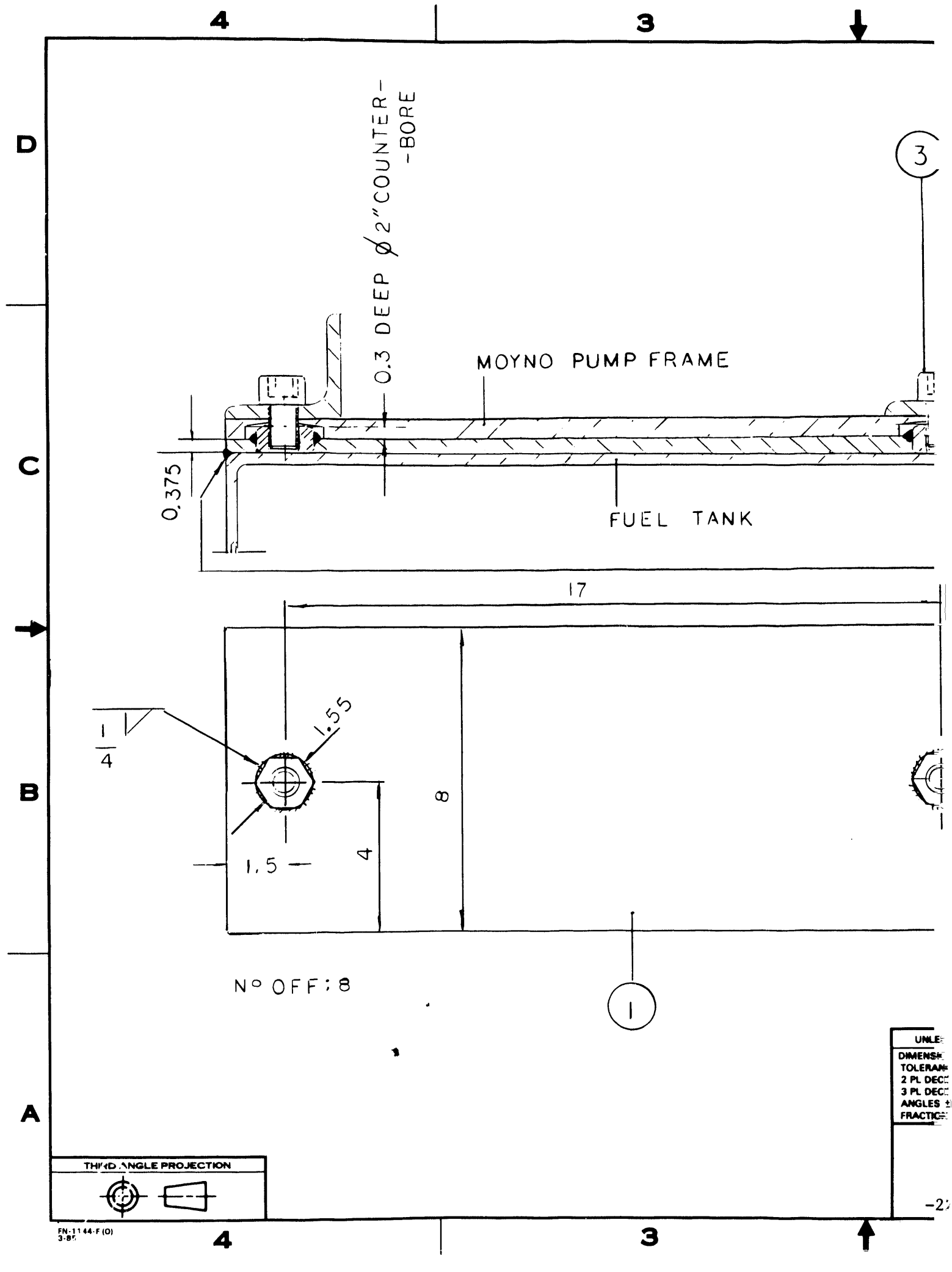

VE W.L. 158

.L. 158 AND GALVANISED BELOW W.L. 158

W W.L. 158

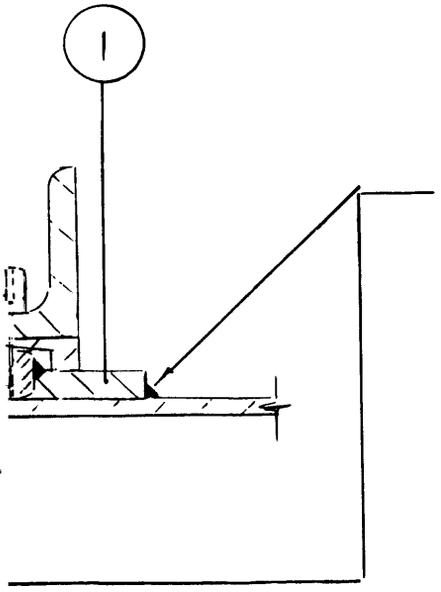
D5 AND D6

| | | | |
|---|---|---|---|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: 2 PL DECIMALS ± 3 PL DECIMALS ± ANGLES ± FRACTIONS ± | SIGNATURES DRAWN SLO CHECKED ENGR MFG QUALITY | DATE 10/27/66 | GENERAL ELECTRIC DEPT LOCO<br>CWS FUELED LOCOMOTIVE<br>MODIFIED 607<br>STAGE 1 LAYOUT<br>SIZE E FSCM NO 41E914186<br>SCALE 1:20 AND 1:10 AND 1:1 SHEET |


4
3
D
C
B
A
0.3 DEEP Ø2" COUNTER-BORE
3
MOYNO PUMP FRAME
0.375
FUEL TANK
17
1.55
1
4
8
1.5
4
Nº OFF: 8
1
THIRD ANGLE PROJECTION
FN-1144-F (0)
3-85
4
3

| REVISIONS | | | |
|---|---|---|---|
| REV | DESCRIPTION | DATE | APPROVED |

UNC STANDARD OR ALTERNATEVLY
ALLAN $\frac{7}{8}$" x 1.5"




SPOT WELD IN ASSEMBLY WITH THE MOYNO PUMP FRAME THEN REMOVE THE MOYNO PUMP FOR A BETTER ACCESS DURING FINAL INTERMITTENT WELDING OF THE PLATE (1) TO THE FUEL TANK

(2) UNC STANDARD HEXAGONAL NUT $\frac{7}{8}$

REMOVE SHARP EDGES

| UNLESS OTHERWISE SPECIFIED | SIGNATURES | DATE |
|---|---|---|
| DIMENSIONS ARE IN INCHES | DRAWN S.L.O. | 2.24. |
| TOLERANCES ON: | CHECKED | 89 |
| FRACTIONALS ± | ENGRG | |
| ANGULARS ± | ISSUED | |

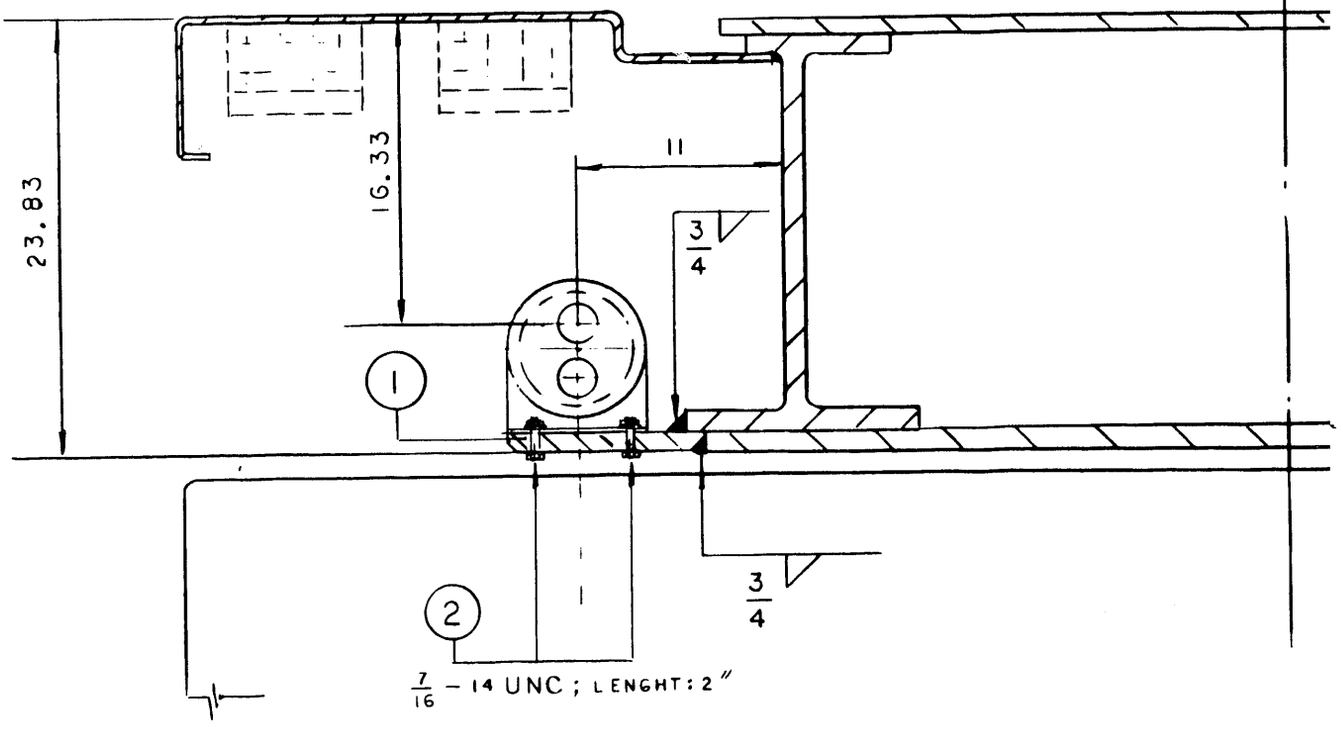
GENERAL ELECTRIC
DEPT LOC

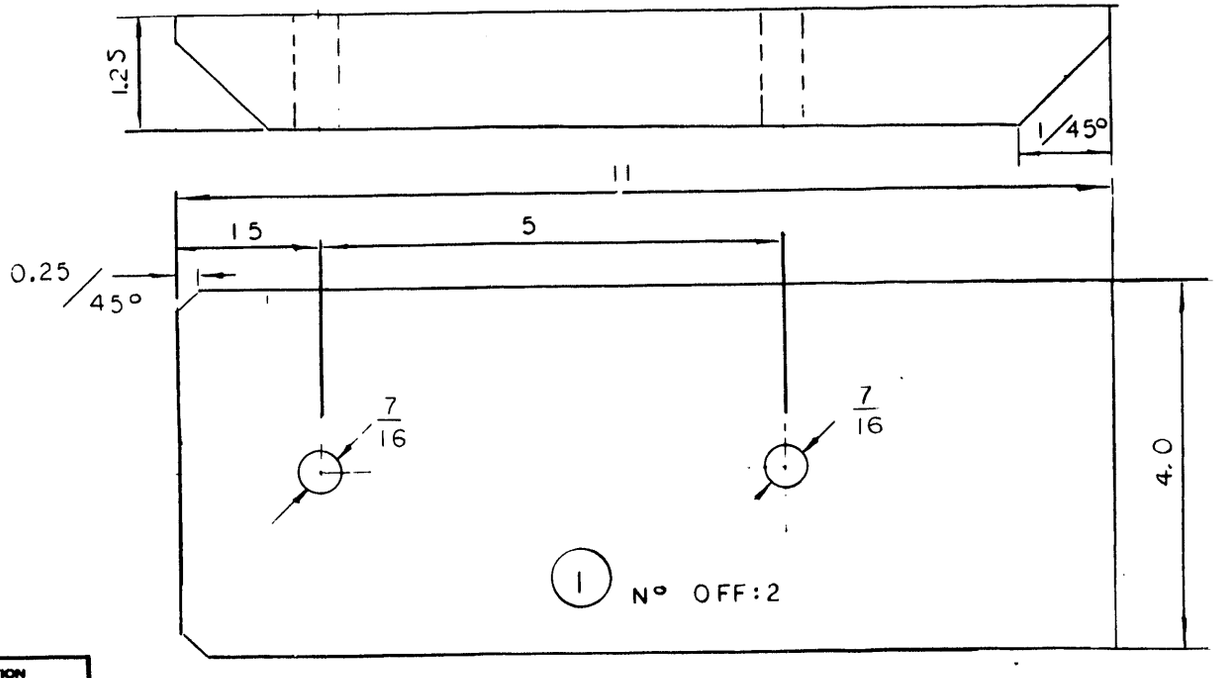
MODIFIED LOCO 607
MOYNO PUMP ATTACHMENT
DETAIL

| SIZE | FSCM NO | DWG NO | DISTR TO |
|---|---|---|---|
| C | | 41C640505 | |
| SCALE 1:2 | | SHEET | |

CROSS-SECTION AT STA 640

$f_{NAT}$ = 122 Hz

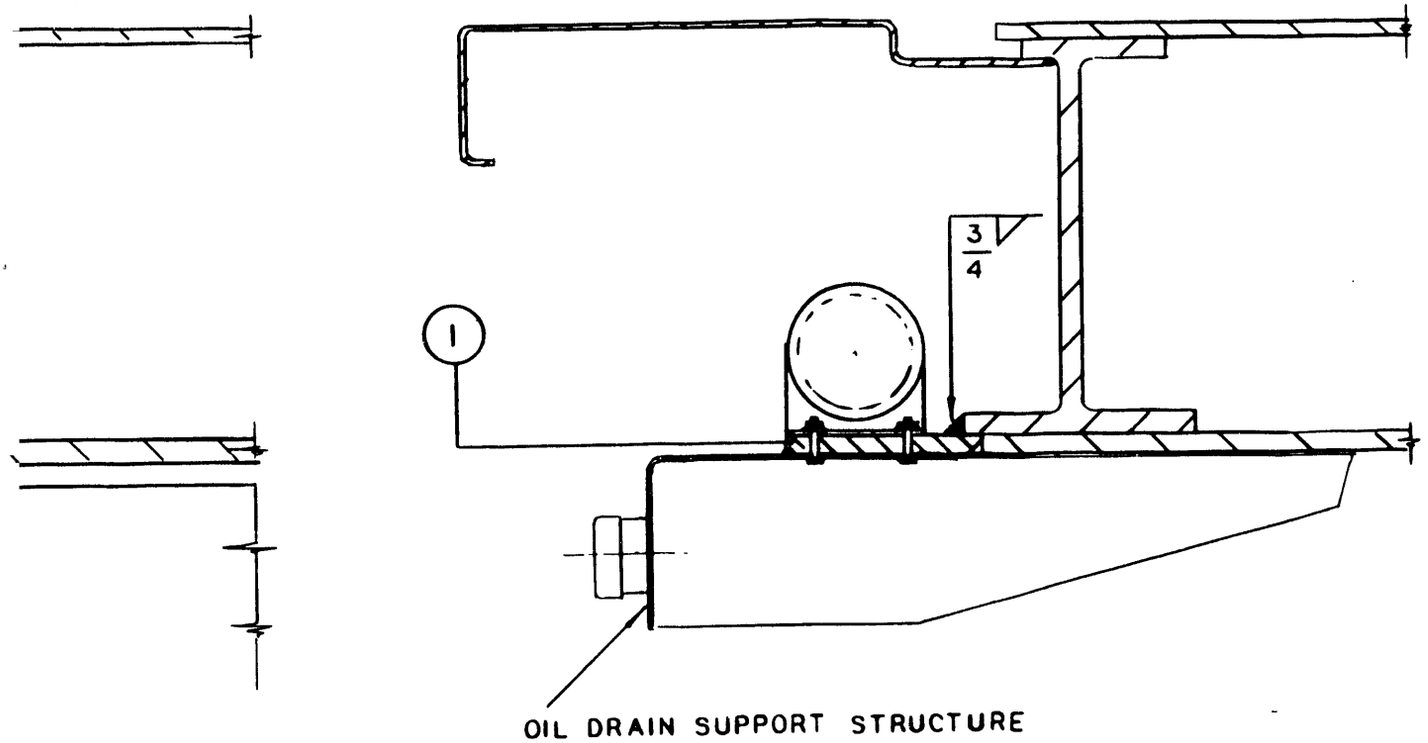



THIRD ANGLE PROJECTION

| REVISIONS | | | |
|---|---|---|---|
| REV | DESCRIPTION | DATE | APPROVED |

CROSS-SECTION AT STA 578



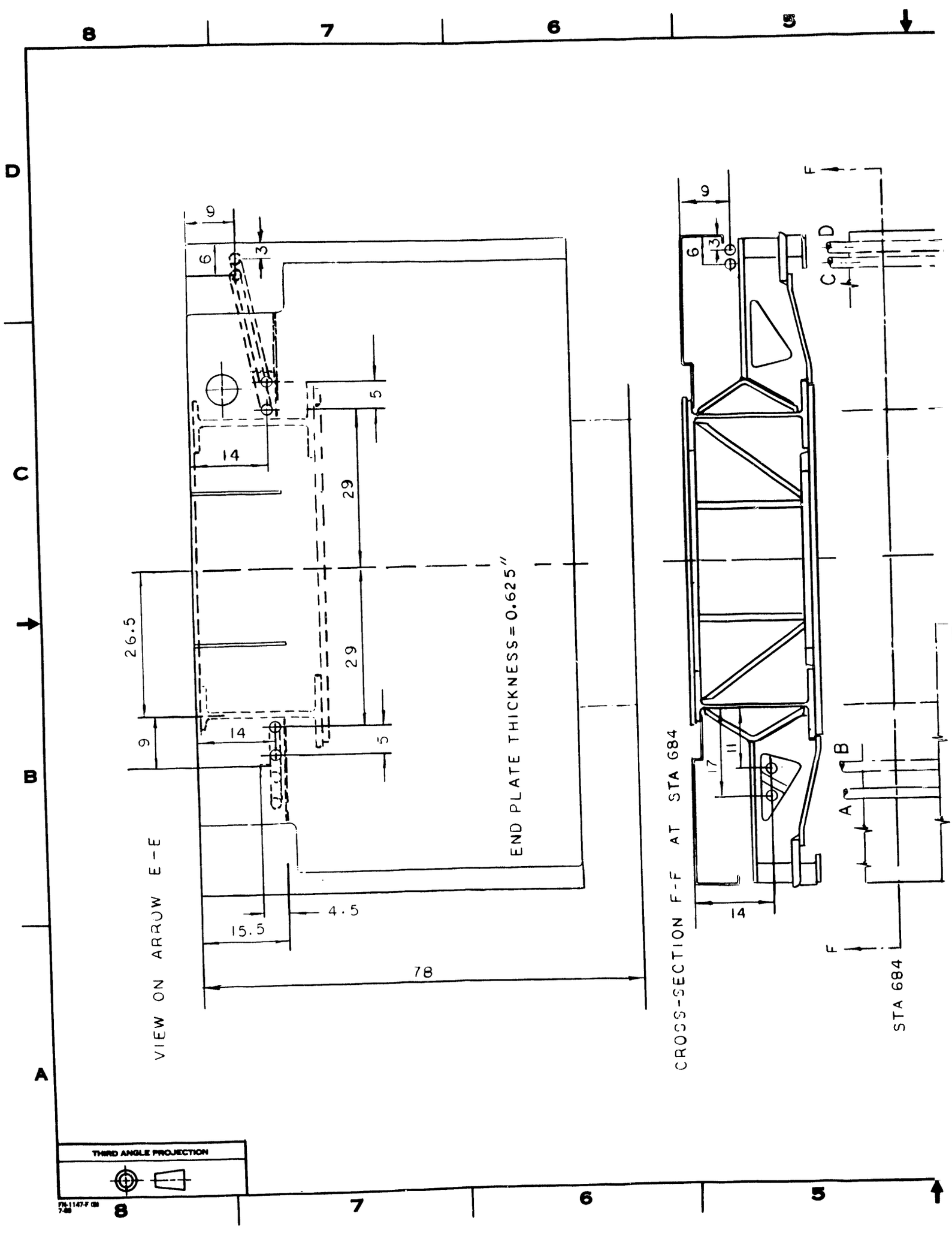

| SIGNATURES | | DATE |
|---|---|---|
| DRAWN | S.L.O. | 2,9, |
| CHECKED | | 89 |
| ENGR. | | |
| ISSUED | | |

GENERAL ELECTRIC
DEPT LOC

MODIFIED LOCO 607
WATER CWS HEAT EXHANGER
ATTACHMENTS

SIZE D | FSCM NO. | DWG NO. 41D715 508 | REV

SCALE 1:5 AND 1:1 | SHEET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26.5
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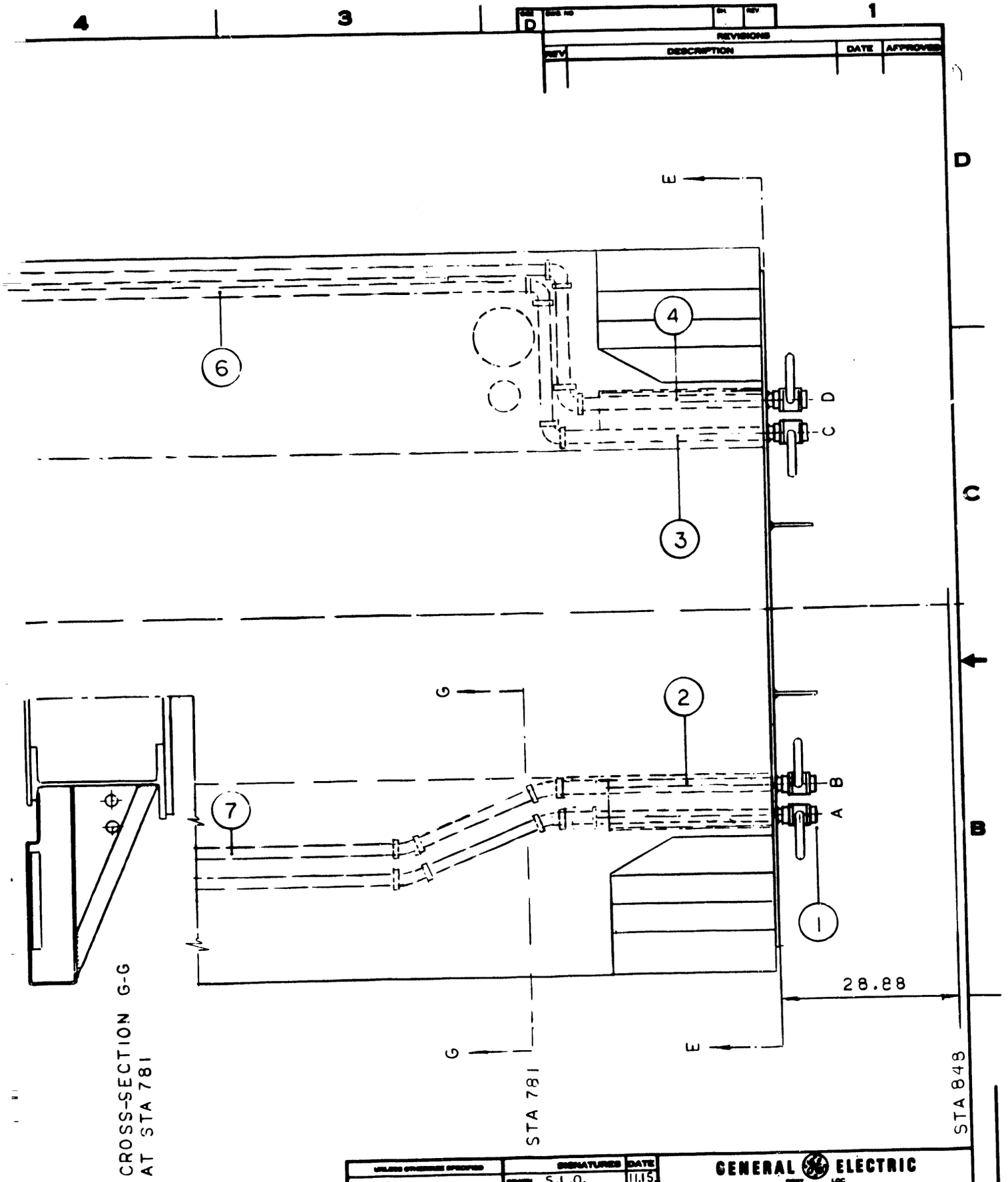
78
END PLATE THICKNESS = 0.625"
VIEW ON ARROW E-E
F
9
6
3
C
D
11
17
B
A
14
F
CROSS-SECTION F-F AT STA 684
STA 684
THIRD ANGLE PROJECTION



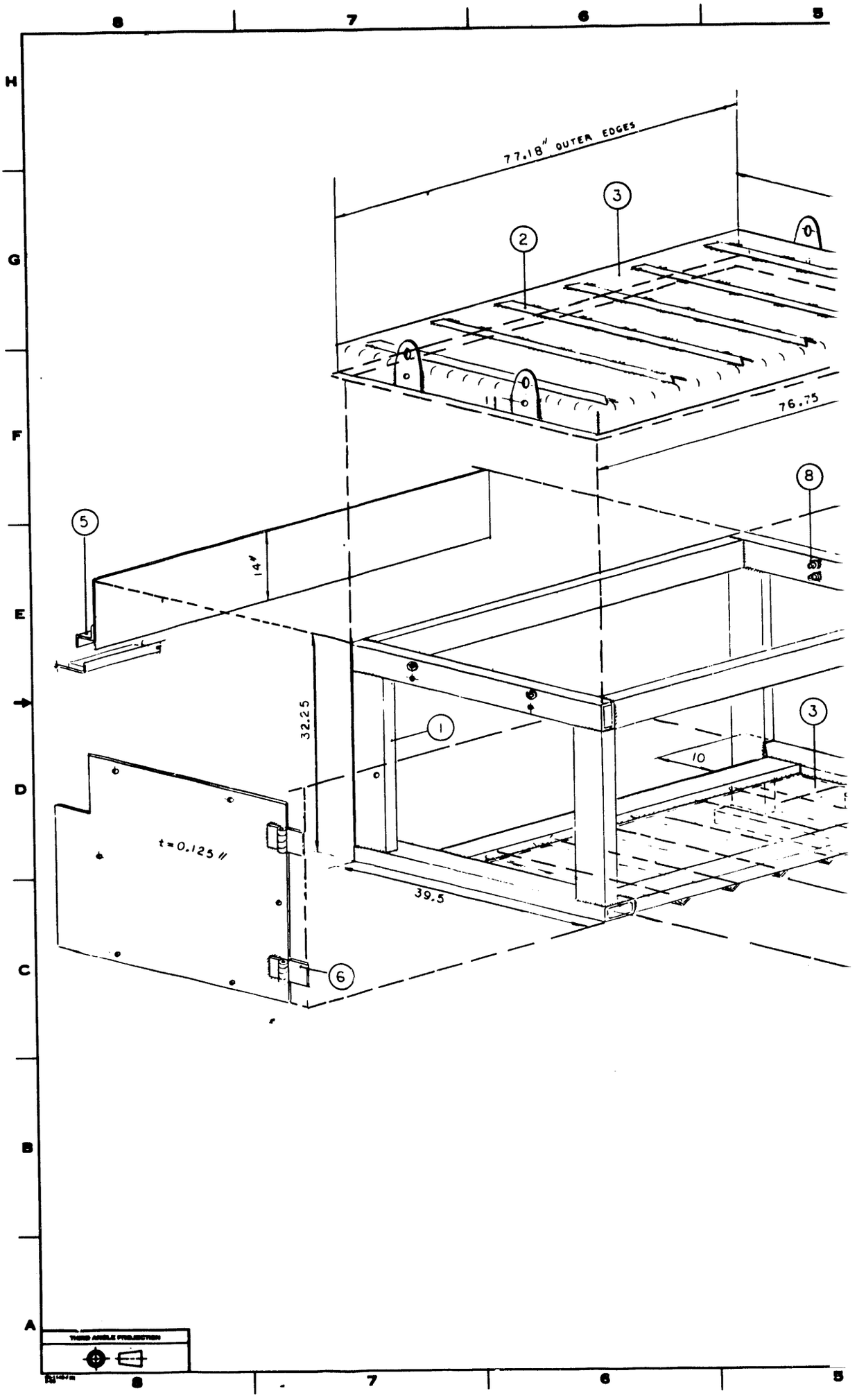

| SIGNATURES | DATE |
|---|---|
| S.L.O. | 11.15.88 |

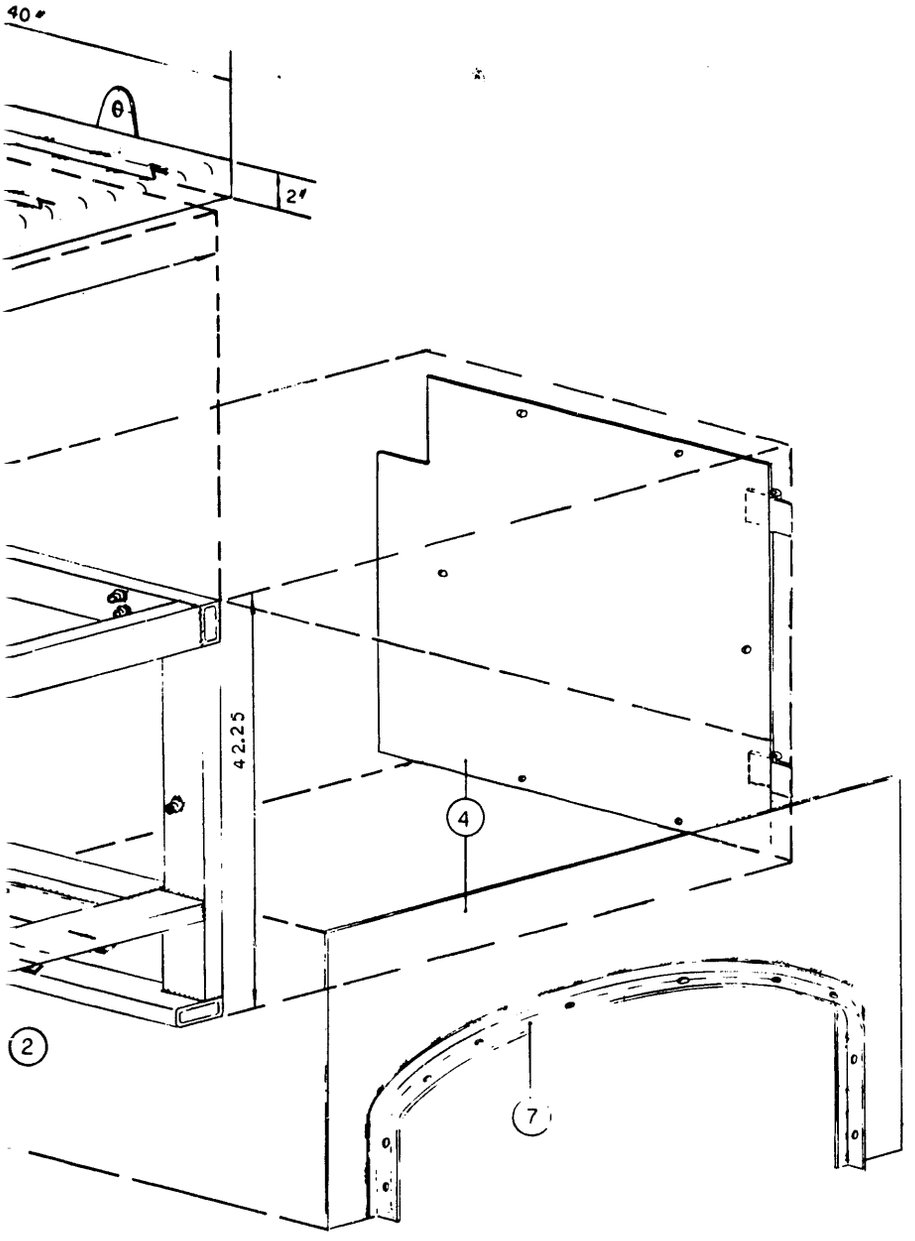
GENERAL ELECTRIC

CWS FUELED DIESEL
LOCOMOTIVE-MODIFIED 607
STAGE 1-LAYOUT OF 1.5" I.D.
LINES BETWEEN STA 848 & 550

DWG. NO. 41D 715 483

SCALE 1:10


77.18" OUTER EDGES
76.75
14"
32.25
39.5
10
t=0.125"
1
2
3
5
6
8



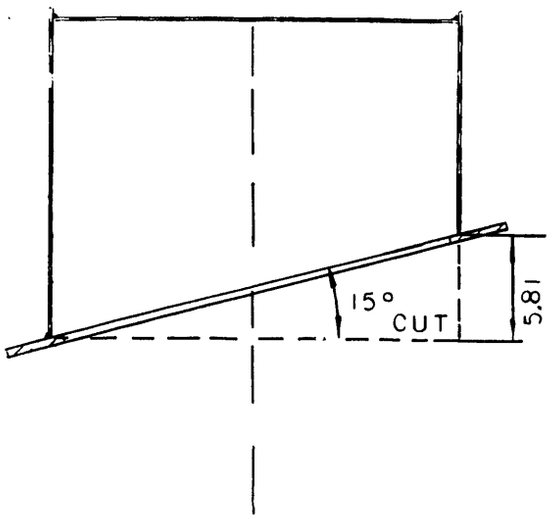

| ITEM | QTY | VENDOR | DESCRIPTION |
|---|---|---|---|
| 9 | 16 | | 0.5" 6"– 12 GALVANISED STEEL BOLTS |
| 8 | 16 | | 0.5" WELD NUTS |
| 7 | 1 | | DASH 8 ENGINE CAB JOINT MEMBER |
| 6 | 4 | | WELDING HINGES |
| 5 | 7 FT | | 1"1.5"1" ZEE |
| 4 | 62 SQFT | | 0.125" WALL ACCESS AND SIDE PLATES |
| 3 | 50 SQFT | | 0.09" WALL ROOF AND DRIP FLOOR PLATE |
| 2 | 44 FT | | 1.5.1.5.0.125 EQAL ANGLE STIFFENERS |
| 1 | 55 FT | | 4"x2"x 3/16" STEEL BOX BEAM |

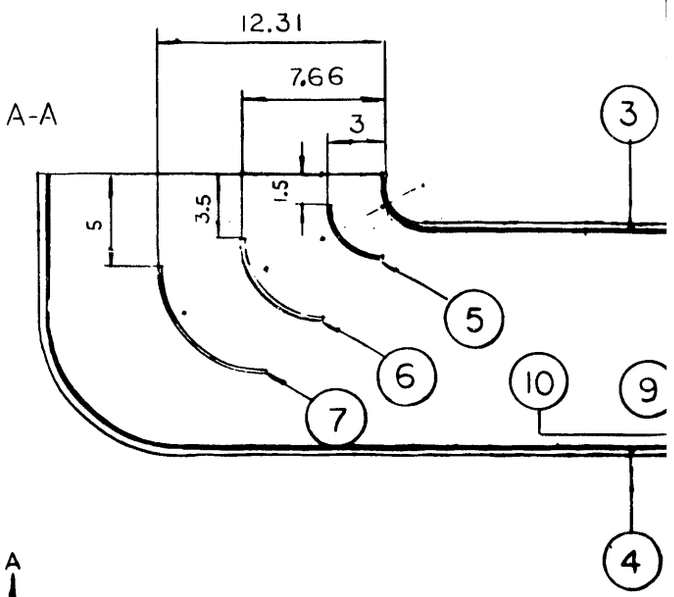
| SIGNATURES | DATE |
|---|---|
| SLO | 1.26. |
| | 89 |

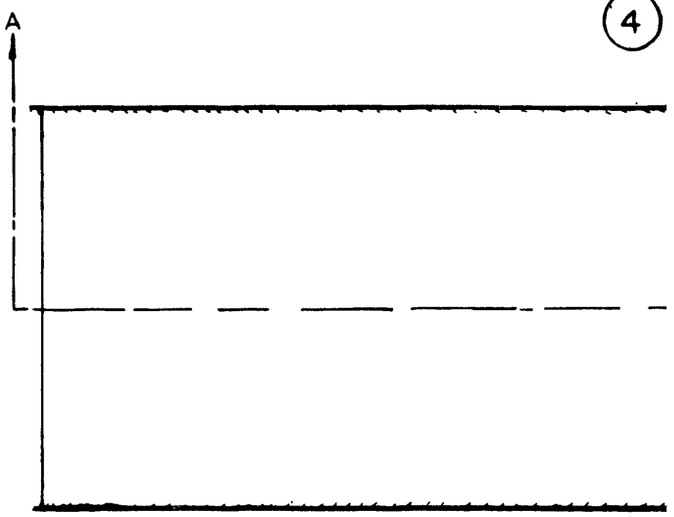
GENERAL ELECTRIC

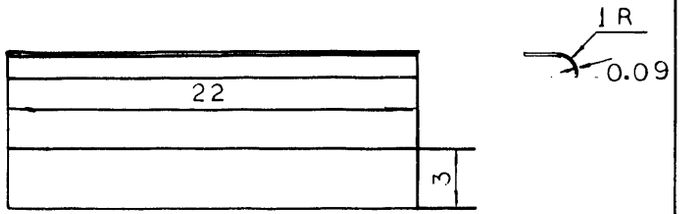
CWS FIRED LOCOMOTIVE
MODIFIED 607
HYDRAULIC CONTROL MODULE

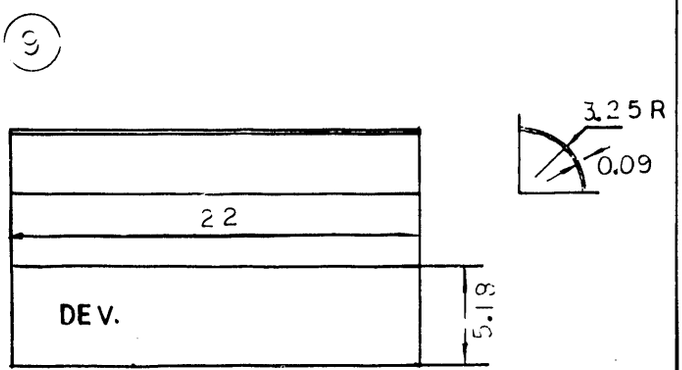
SIZE E | DWG NO 41E914189 | SCALE — | SHEET

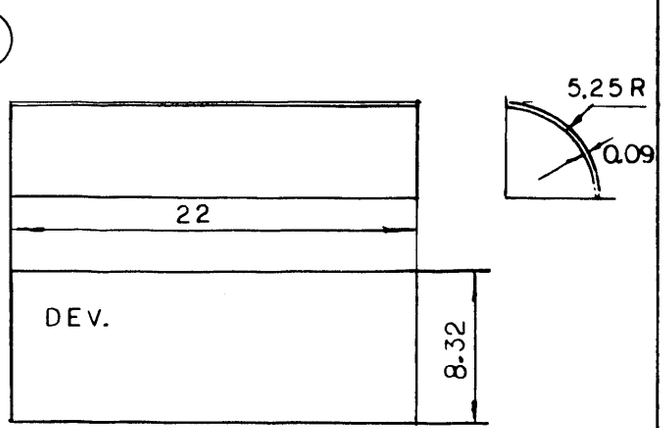


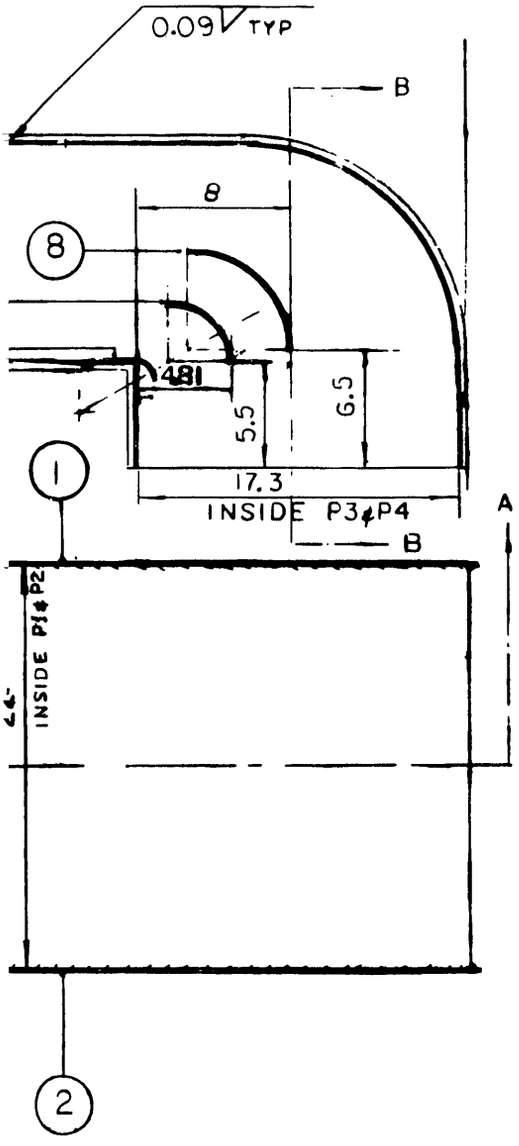

THIRD ANGLE PROJECTION

FN-1147-F (B)
7-83

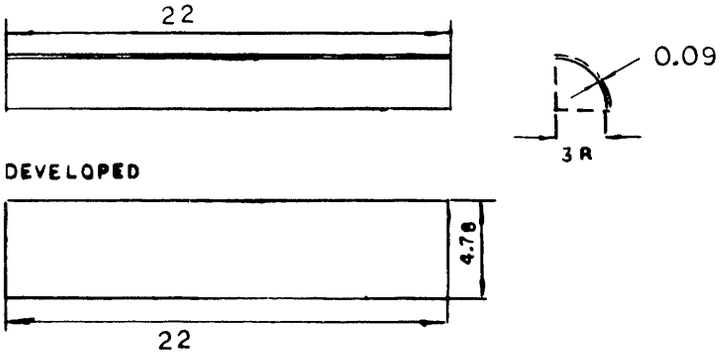
| SIZE | DRG NO | SH | REV |
|---|---|---|---|
| D | | | |

REVISIONS

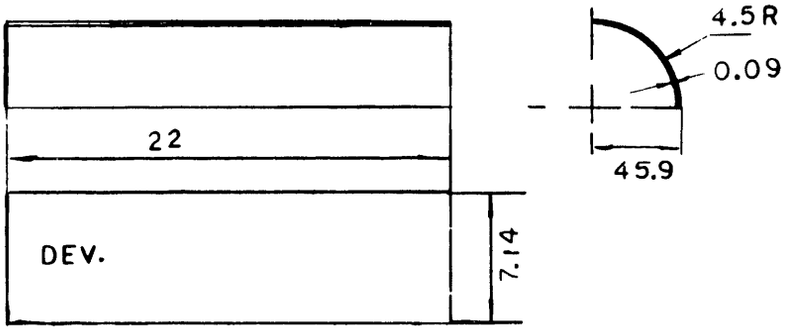
| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|



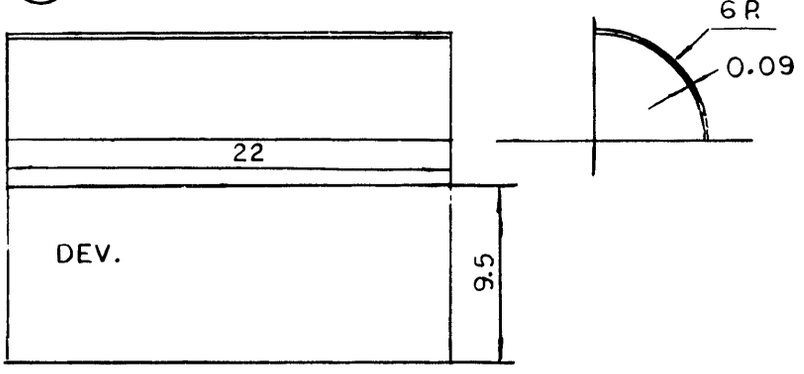

5




6




7




| UNLESS OTHERWISE SPECIFIED | SIGNATURES | DATE |
|---|---|---|
| DIMENSIONS ARE IN INCHES. TOLERANCES ON: 2 PL. DECIMALS ± 3 PL. DECIMALS ± ANGLES ± FRACTIONS ± ✓ | DRAWN | |
| | CHECKED S.L.O. | 1.31.89 |
| | ENGR. | |
| | MFGR. | |

GENERAL ELECTRIC
DEPT LOC

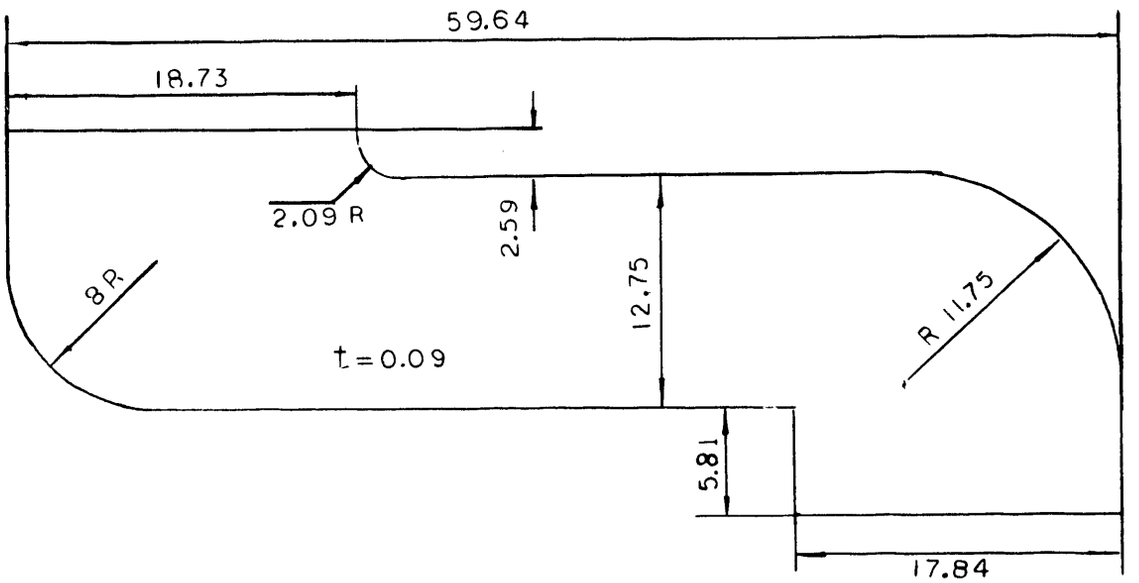
MODIFIED LOCOMOTIVE 607
ALTERNATOR COOLING DUCT
MODIFICATION; DETAILS 5 TO 10

| SIZE | FSCM NO. | DWG NO. | REV |
|---|---|---|---|
| D | | 41D715502 | |
| SCALE | | SHEET | |

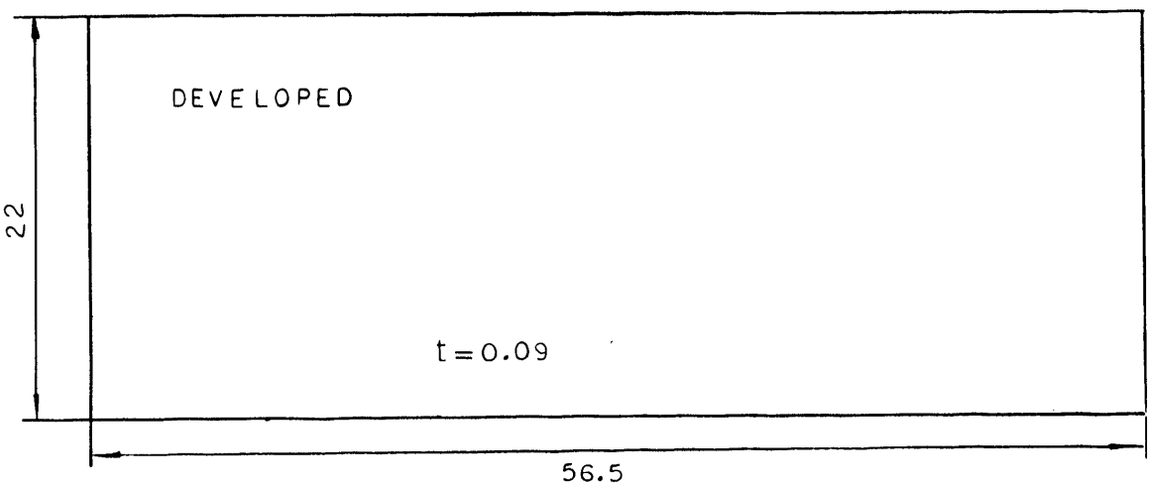
8 7 6 5

D C B A

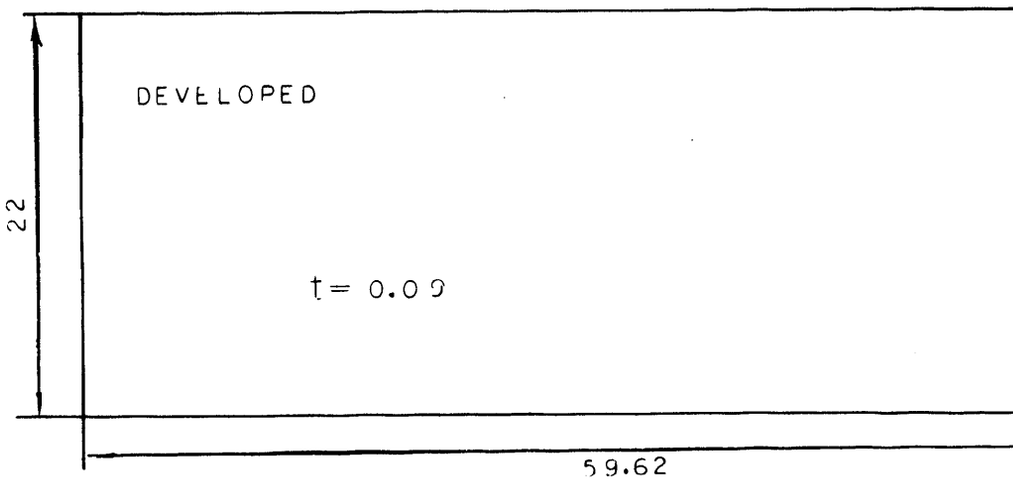
(1) AND (2) N° OFF : 2



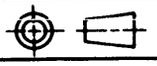

(3)




(4)




THIRD ANGLE PROJECTION



FN-1147-F (B)
7-83

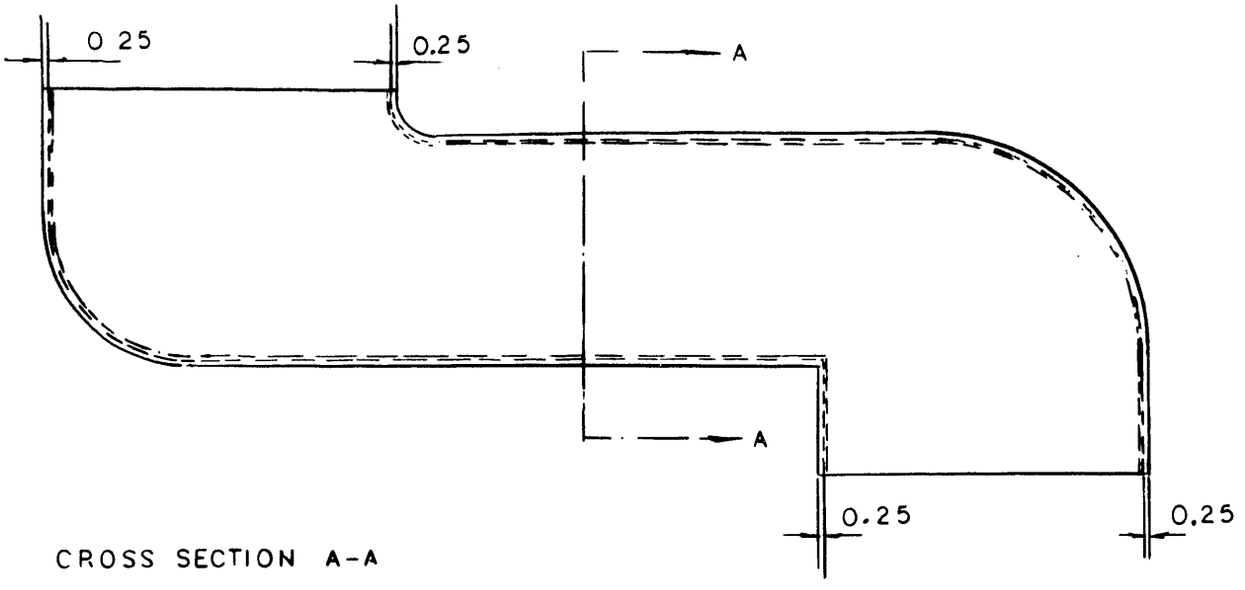
8 7 6 5

| SIZE | DWG NO | SH | REV |
|---|---|---|---|
| D | | | |

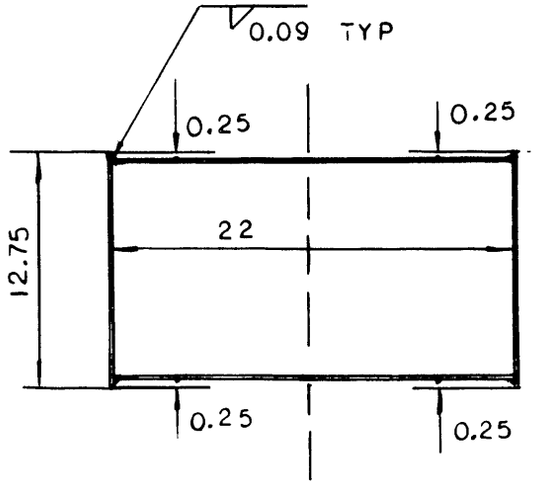
REVISIONS

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| | | | |

SIDE VIEW (VANES NOT SHOWN)




CROSS SECTION A-A



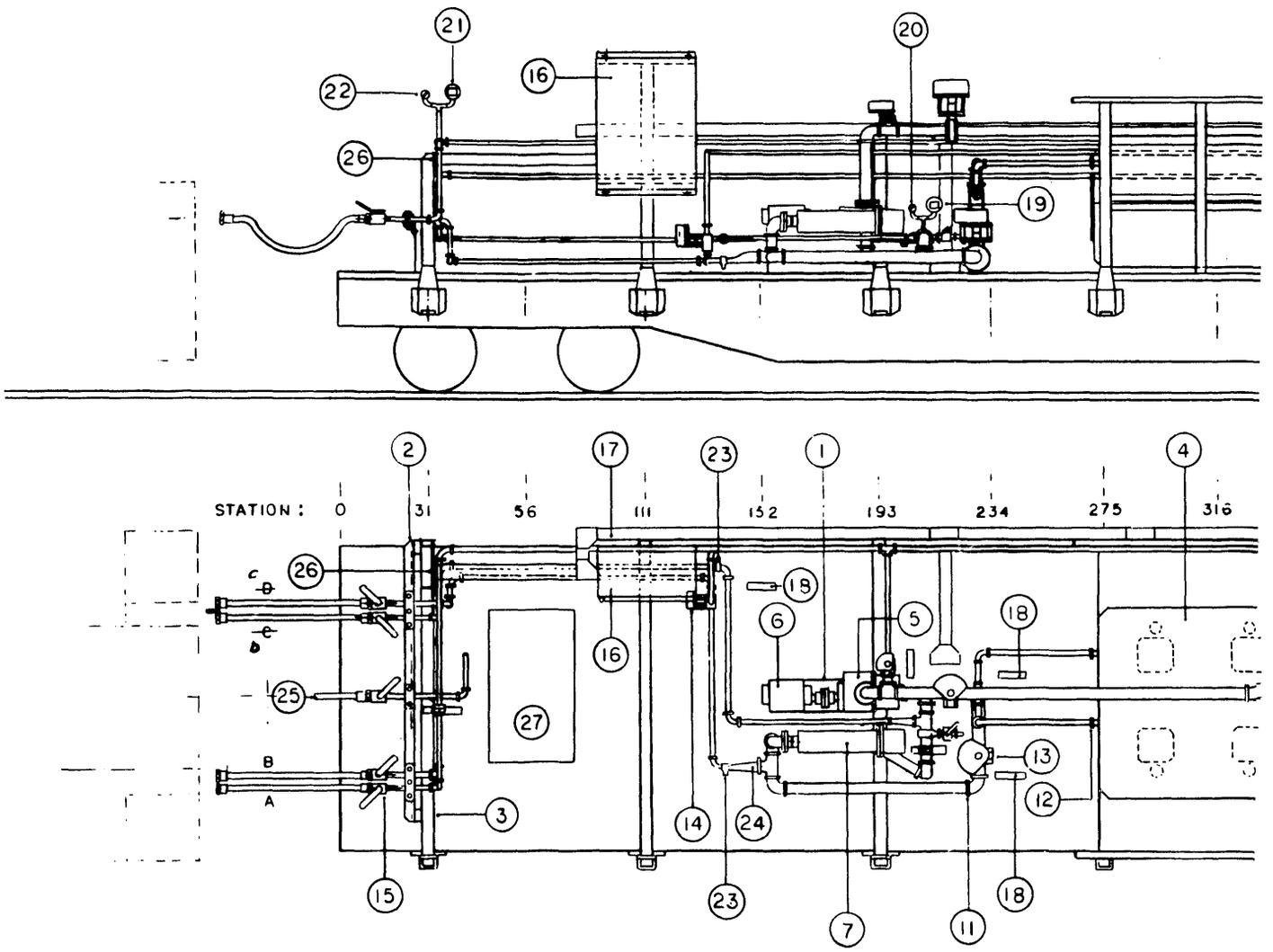

| UNLESS OTHERWISE SPECIFIED | SIGNATURES | DATE |
|---|---|---|
| DIMENSIONS ARE IN INCHES. TOLERANCES ON: 2 PL. DECIMALS ±; 3 PL. DECIMALS ±; ANGLES ±; FRACTIONS ± ✓ | DRAWN S.L.O. | 1.31.89 |
| | CHECKED | |
| | ENGR. | |
| | ISSUED | |

GENERAL ELECTRIC DEPT LOC

MODIFIED LOCOMOTIVE 607 ALTERNATOR COOLING DUCT MODIFICATION; DETAILS 1 TO 4

| SIZE | FSCM NO. | DWG. NO. | REV |
|---|---|---|---|
| D | | 41D715501 | |

SCALE 1:5 SHEET


21
20
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19
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17
23
1
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STATION :
0
31
56
111
152
193
234
275
316
26
18
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18
16
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27
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B
A
12
3
14
24
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23
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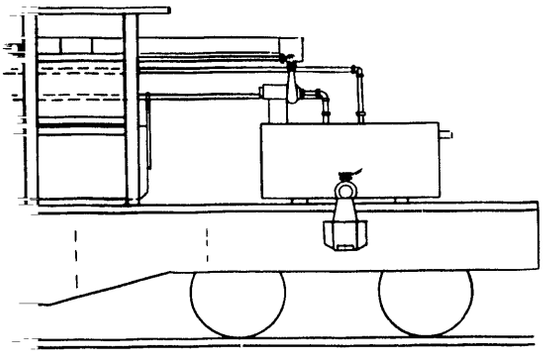
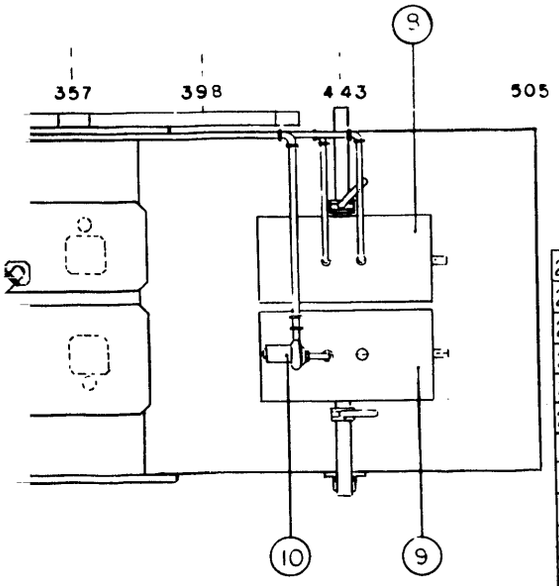
11
18

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| 1 | VICTAULIC COUPLINGS AND FITTINGS INCORPORATED, PIPING LAYOUT MOD. ELECTRIC HEATER (ITEM 7) REPLACED | 01.20.89 | |
| 2 | DETALS OF ELECTRIC CONTROLS AND WIREWAYS INCLUDED | 01.25.89 | |






| | |
|---|---|
| 27 | DIESEL ENGINE POWERED AUXILIARY GENERATOR |
| 26 | ELECTRIC CONECTIONS TO LOCOMOTIVE |
| 25 | COMPRESSED AIR |
| 24 | ECCENTRIC REDUCER |
| 23 | VICTAULIC OUTLET COUPLING |
| 22 | PRESSURE GAUGE |
| 21 | PRESSURE SWITCH P2 |
| 20 | PRESSURE GAUGE |
| 19 | PRESSURE SWITCH P3 |
| 18 | SOLENOID PILOT VALVE |
| 17 | CABLE WAY BOX |
| 16 | ELECTRIC CONTROLS |
| 15 | 1.5" FULL PORT VALVES |
| 14 | 1.5"FULL PORT BALL VALVE WITH PNEUMATIC ACTUATOR |
| 13 | 4" BUTTERFLY VALVE WITH PNEUMATIC ACTUATOR |
| 12 | 1.5" VICTAULIC COUPLING |
| 11 | 4" VICTAULIC COUPLING |
| 10 | WATER PURGE PUMP |
| 9 | CLEAN WATER TANK |
| 8 | DIRTY WATER TANK |
| 7 | ELECTRIC HEATER AND THERMOSTAT |
| 6 | ELECTROMOTOR |
| 5 | RECIRCULATING PUMP GEAR BOX |
| 4 | EXPERIMENTAL CWS FUEL TANK |
| 3 | FLOOR AND FENCE BEAMS |
| 2 | VALVE AND TUBING 'SUPPORT PORTAL FRAME |
| 1 | RECIRCULATING PUMP TUTHILL 330 H700-3 |

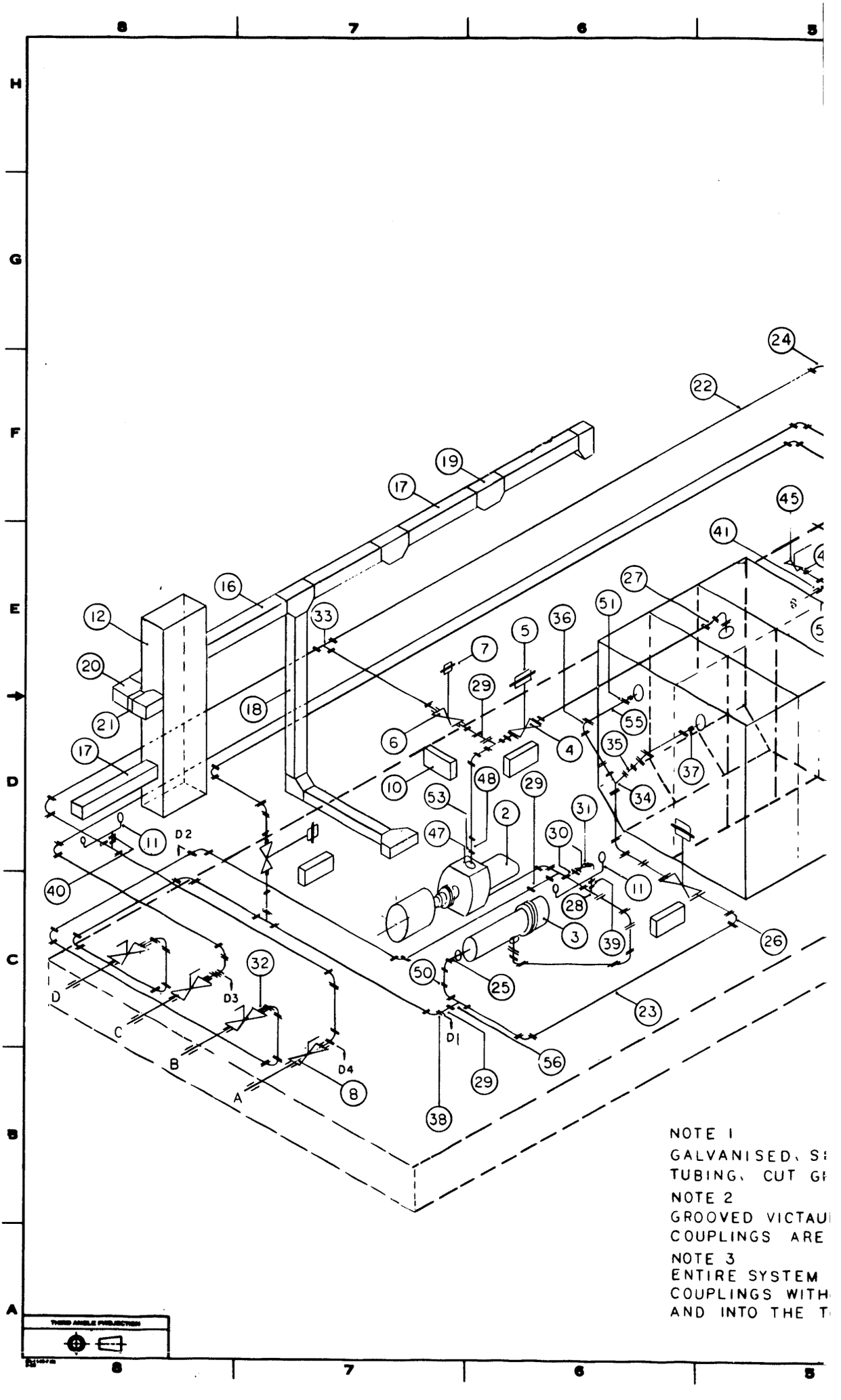
| UNLESS OTHERWISE SPECIFIED | SIGNATURES | DATE |
|---|---|---|
| DIMENSIONS ARE IN INCHES | SLO | 10,21,86 |
| TOLERANCES ON: | | |
| 2 PL. DECIMALS ± | | |
| 3 PL. DECIMALS ± | | |
| ANGLES ± | | |
| FRACTIONS ± | | |

GENERAL ELECTRIC

FLAT CAR
LAY OUT

DRAW NO 41E914197

SCALE 1:20


8
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48
29
37
34
53
2
31
47
30
11
D2
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28
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39
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D3
D
C
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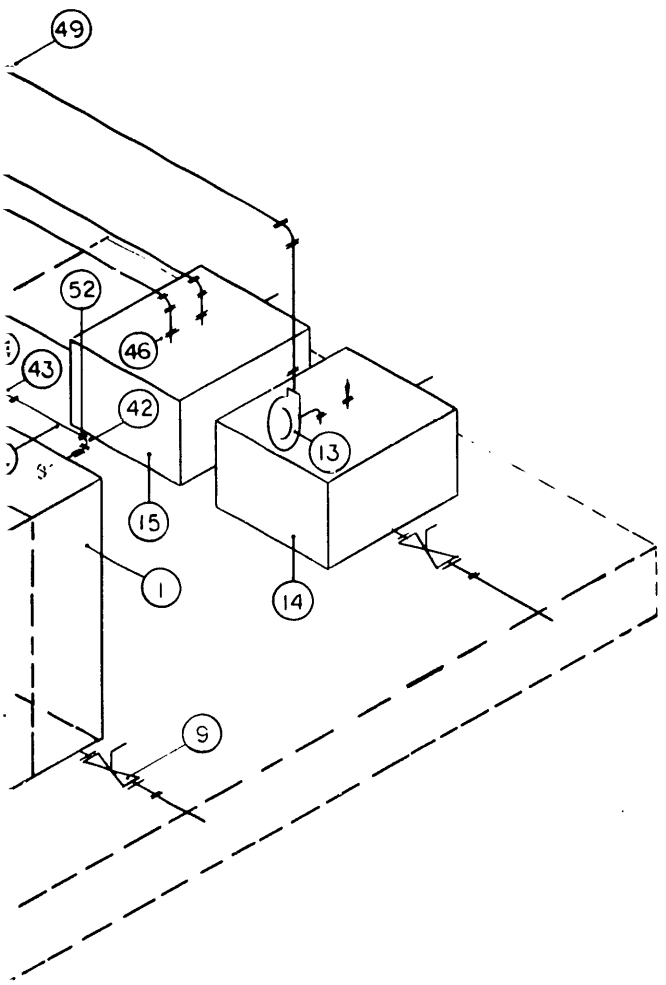
D1
23
56
29
D4
8
38
NOTE 1
GALVANISED, S
TUBING, CUT G
NOTE 2
GROOVED VICTAU
COUPLINGS ARE
NOTE 3
ENTIRE SYSTEM
COUPLINGS WITH
AND INTO THE T
THIRD ANGLE PROJECTION




| ITEM | QTY | VENDOR | DESCRIPTION |
|---|---|---|---|
| 56 | 3 | VICTAULIC COMPANY OF AMERICA | 4" TEE N° 20 H.D.G. |
| 55 | 12 FT | | 2" I.D. 0.1875 WALL GALVANISED STEEL PIPE |
| 54 | 18 FT | | 1" I.D. 0.1575 WALL GALVANISED STEEL PIPE |
| 53 | 1 | VICTAULIC COMPANY OF AMERICA | 5" STYLE HP-70 ES END SEAL COUPLING H.D.G. |
| 52 | 8 | —II— | 1" STYLE 77 STANDARD COUPLING H.D.G. |
| 51 | 10 | —II— | 2" STYLE HP 70 ES END SEAL COUPLING H.D.G. |
| 50 | 33 | —II— | 4" STYLE HP-70 ES END SEAL COUPLING H.D.G. |
| 49 | 77 | —II— | 1.5" STYLE HP-70 ES ENDSEAL COUPLING H.D.G. |
| 48 | 1 | —II— | 5"x 4" CONCENTRIC REDUCER N° 50 H.D.G. |
| 47 | 1 | —II— | 5" FLANGED ADAPTOR NIPLE N° 41 H.D.G. |
| 46 | 4 | —II— | 1.5" FEMALE THREADED ADAPTER N° 80 H.D.G. |
| 45 | 1 | —II— | 1" GAS VALVE |
| 44 | 1 | —II— | 1" NIPPLE N° 40 H.D.G. |
| 43 | 1 | —II— | 1" TEE N° 20 H.D.G. |
| 42 | 1 | —II— | 1" 90° ELBOW N° 10 H.D.G. |
| 41 | 2 | —II— | 1" FEMALE THREADED ADAPTERS N° 80 H.D.G. |
| 40 | 1 | —II— | 1.5"x 3/4" REDUCER THREADED SMALL END N° 52 H.D.G. |
| 39 | 1 | —II— | 2"x 3/4" REDUCER THREADED SMALL END N° 52 H.D.G. |
| 38 | 4 | —II— | 1.5"x 3/4" STYLE 72 WITH F THREADED OUTLET H.D.G. |
| 37 | 2 | —II— | 2" FEMALE THREADED ADAPTER N° 80 H.D.G. |
| 36 | 2 | —II— | 2" 90° ELBOW N° 10 H.D.G. |
| 35 | 2 | —II— | 4"x 2" CONCENTRIC REDUCER N° 50 H.D.G. |
| 34 | 1 | —II— | 4" TRUE "Y" N° 33 H.D.G. |
| 33 | 2 | —II— | 1.5" TEE N° 20 H.D.G. |
| 32 | 8 | —II— | 1.5" NIPPLE N° 40 H.D.G. |
| 31 | 1 | —II— | 1.5" STYLE 700 BUTTERFLY VALVE |
| 30 | 1 | —II— | 4"x 1.5" STYLE 72 GROOVED OUTLET COUPLING H.D.G. |
| 29 | 3 | —II— | 4"x 1.5" ECCENTRIC REDUCER N°51 H.D.G. |
| 28 | 1 | —II— | 4"x 4"x 2" REDUCING TEE N° 25 H.D.G. |
| 27 | 1 | —II— | 4" 45° ELBOW N° 11 H.D.G. |
| 26 | 10 | —II— | 4" 90° ELBOW N° 10 H.D.G. |
| 25 | 11 | —II— | FLANGED ADAPTER NIPPLE N° 41 H.D.G.; 4" |
| 24 | 24 | —II— | 1.5" 90° ELBOW N° 10 HOT DIP GALVANISED |
| 23 | 50 FT | | 4" I.D. 0.25" GALVANISED STEEL PIPE |
| 22 | 200 FT | | 1.5" I.D. 0.2" WALL GALVANISED STEEL PIPE |
| 21 | 1 | HOFFMAN ENGINEERING COMPANY | F-44WN4 NIPPLE |
| 20 | 4 | —II— | F-44WE 90° ELBOW |
| 19 | 4 | —II— | F-44WT TEE |
| 18 | 2 | —II— | F-44W36" STRAIGHT SECTION |
| 17 | 4 | —II— | F-44W60" STRAIGHT SECTION |
| 16 | 1 | HOFFMAN ENGINEERING COMPANY | F-44W120" STRAIGHT SECTION |
| 15 | 1 | GENERAL ELECTRIC | DIRTY WATER TANK DWG N°41D 715 481 |
| 14 | 1 | —II— | CLEAN WATER TANK DWG N°41D 715 481 |
| 13 | 1 | POWER DRIVES INC | WATER PURGE PUMP SERIES 80 STRAIGHT CENTRIFUGAL |
| 12 | 1 | HOFFMAN ENGINEERING COMPANY | A-48H36FLP ENCLOSURE A48P36 ELECTRICAL CONTROLS PANEL |
| 11 | 2 | RED VALVE COMPANY INC | PRESSURE SWITCH AND GAUGE COMBINATION |
| 10 | 4 | MAC VALVES INC | SOLENOID VALVE MAC 82-INDIVIDUAL BASE |
| 9 | 3 | JAMESBURY CO | 4" BUTTERFLY VALVE TYPE 815 W |
| 8 | 4 | —II— | 1.5" FULL PORT SERIES 4000 BALL VALVE |
| 7 | 2 | —II— | 1.5" DOUBLE ACTING PNEUMATIC ACTUATOR 105-I |
| 6 | 2 | —II— | 1.5" FULL PORT SERIES 4000 BALL VALVE |
| 5 | 2 | —II— | ." DOUBLE ACTING PNEUMATIC ACTUATOR 105-I |
| 4 | 2 | —II— | 4" BUTTERFLY VALVE TYPE 815 W |
| 3 | 1 | HY-TECH SALES INC | ELECTRIC HEATER WITH THERMOSTAT, 4" FLANGES |
| 2 | 1 | TUTHILL PUMP COMPANY | RECIRCULATING AND FEED PUMP TUTHILL 330 H70J-3 |
| 1 | 1 | GENERAL ELECTRIC | CWS EXPERIMENTAL FUEL TANK DWG N°41E914098 |

AMLESS, CARBON STEEL, PRESSURE
OOVED, SCHEDULE 40

IC FITTINGS AND
HOT-DIP GALVANISED

HAS TO BE SELF-DRAINING INTO VICTAULIC
THREADED OUTLETS D1, D2, D3, D4
ANKS (1), (14), (15)

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PL DECIMALS ±
3 PL DECIMALS ±
ANGLES ±
FRACTIONS ±

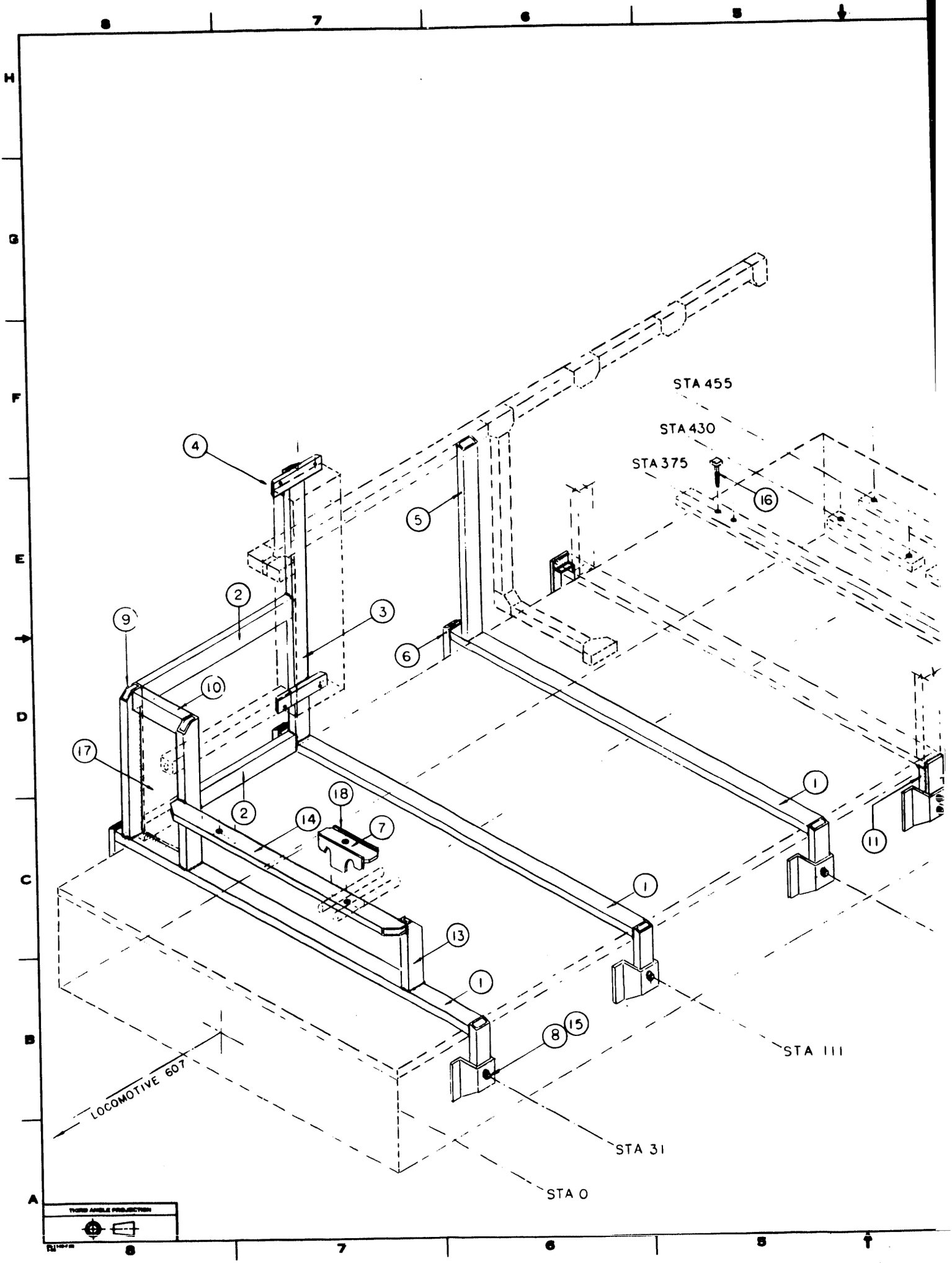
| SIGNATURES | DATE |
|---|---|
| SLO | 01.23. |
| | 89 |

GENERAL ELECTRIC

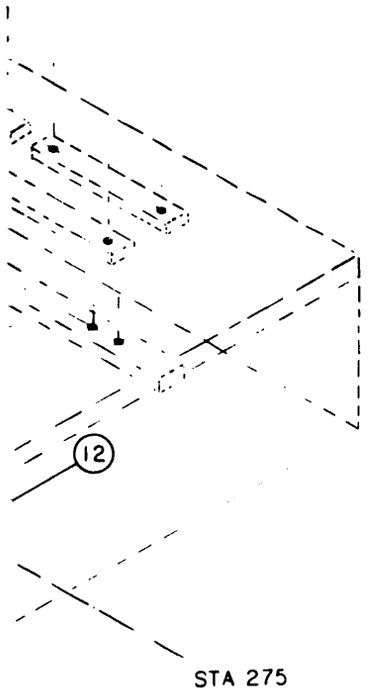
FLAT CAR
PIPING LAYOUT OVERLAY & MATERIALS LIST

SIZE E | DWG NO 41E914191 | REV

SCALE — | SHEET


STA 455
STA 430
STA 375
STA 111
STA 31
STA 0
LOCOMOTIVE 607
THIRD ANGLE PROJECTION

| REVISIONS | | | |
|---|---|---|---|
| REV. | DESCRIPTION | DATE | APPROVED |
| 1 | HEGHT OF ITEM 3 HAS BEEN REDUCED SIMPLIFICATION AND IMPROVEMENT OF ITEMS 10, 17 ITEM 18 INCLUDED | 02.08 | 89 |




| ITEM | QTY | VENDOR | DESCRIPTION |
|---|---|---|---|
| 18 | 4 | | PIPE GRIP PLATE |
| 17 | 1 | | 0.125" WALL WEB PLATE 38" x 15" |
| 16 | 12 | | 1/2" SQARE HEAD WOOD SCREW ; LENGHT 5" |
| 15 | 20 | | 5/8" - 11 WELD NUT |
| 14 | 1 | | BOX BEAM - PIPE SUPPORT |
| 13 | 1 | | STRUT |
| 12 | 2 | | REINFORCEMENT WELD PLATE |
| 11 | 2 | | THE MAIN STAKE POST LUG LINK |
| 9/10 | 2/1 | | END LOAD MEMBERS 9: 4"x2" 0.19" WALL LENGHT 42" 2/45° TOP 10 4"x2" 0.19 WALL LENGTH 15" |
| 8 | 10 | | 5/8" - 11 BOLT |
| 7 | 2 | | PIPE CLAMP PLATE |
| 6 | 6 | | STAKE POST LUG LINK |
| 5 | 1 | | WIREWAY POST 4"x2" 0.19" WALL ; LENGHT : 55" ; 30° SH.TOP |
| 4 | 2 | | CROSS BEAM |
| 3 | 1 | | ELECTRICAL CONTROL UNIT POST BOX BEAM 4"x2" 0.1875" WALL ; LENGTH 70" |
| 2 | 2 | | LONGITUDINAL BOX TIES 4"x2"x0.1875 WALL ; LENGTH 76" ; STL |
| 1 | 3 | | TRANSVERSE FLOOR BOX BEAMS 4"x2"x0.1875 WALL ; 116.5" LENGHT ; STEEL A36 |

| UNLESS OTHERWISE SPECIFIED | SIGNATURES | DATE |
|---|---|---|
| DIMENSIONS ARE IN INCHES<br>TOLERANCES ON:<br>2 PL DECIMALS ±<br>3 PL DECIMALS ±<br>ANGLES ±<br>FRACTIONS ± ✓ | DRAWN S.L.D. | 02.01.89 |
| | CHECKED | |
| | ENGR | |
| | MFG | |
| | | |
| | | |

GENERAL ELECTRIC

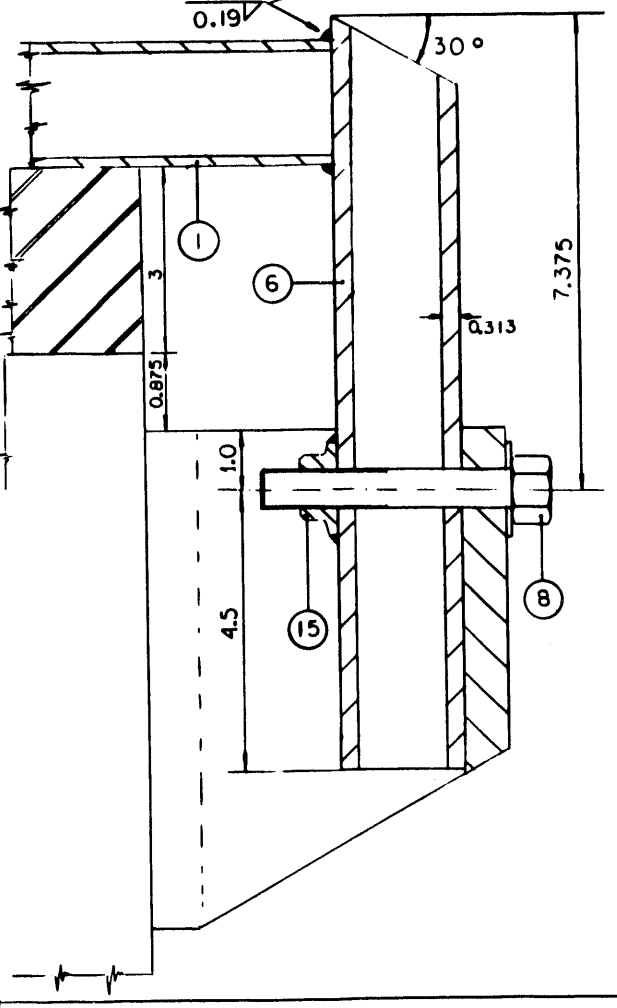
FLAT CAR
CWS EXPERIMENTAL EQIPMENT
SUPPORT STRUCTURE

FSCM NO. | DWG NO. 41E914192

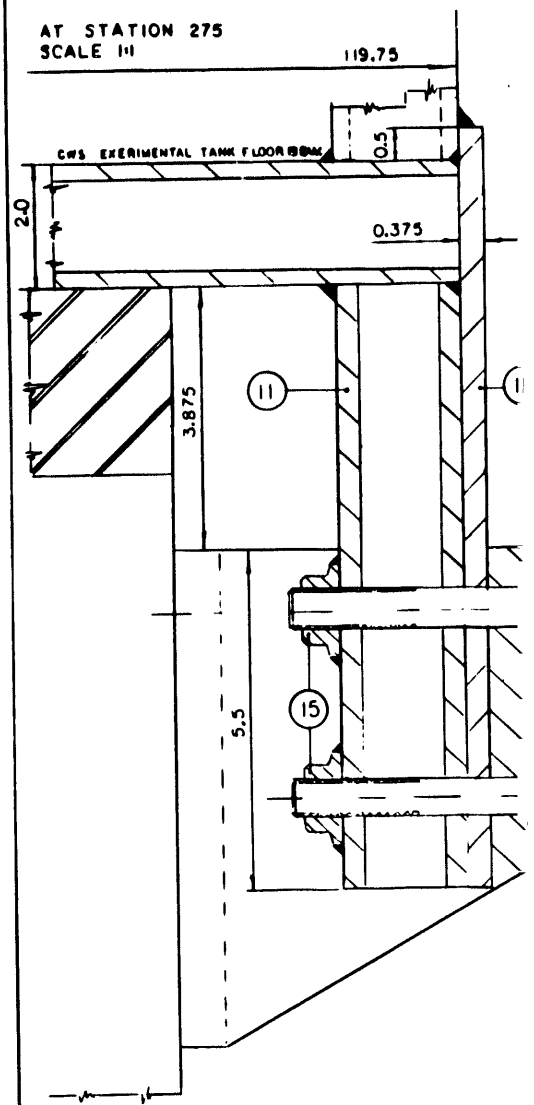
SCALE — | SHEET

FLOOR BEAMS TO THE LUG ATTACMENTS
AT STATIONS 31 ; 111 AND 193
CABLE AND PIPE SIDE
SCALE 1:1
CROSS-SECTION THROUGH SYMMETRY PLANE

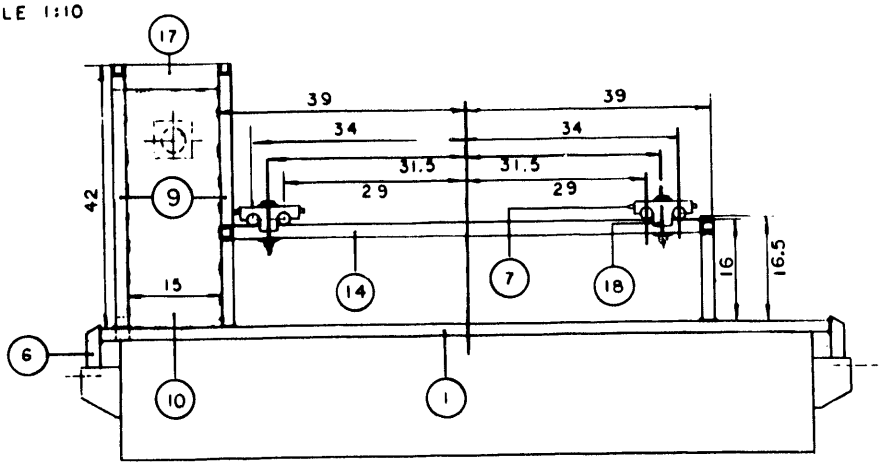
INSTALL 6 AND 8, LOCATE 1 THEN WELD IN ASSEMBLY

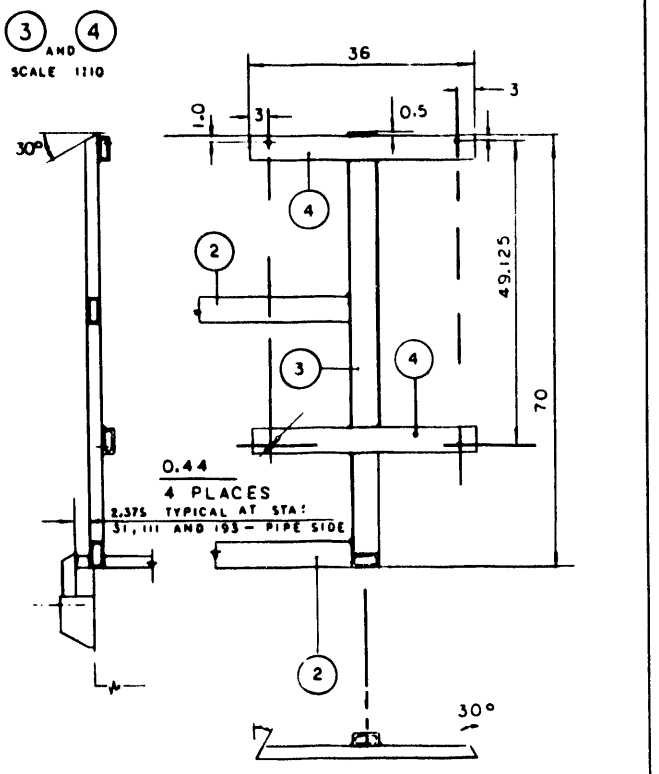


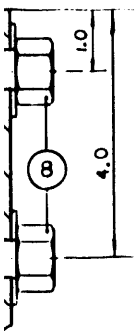

AT STATION 275
SCALE 1:1

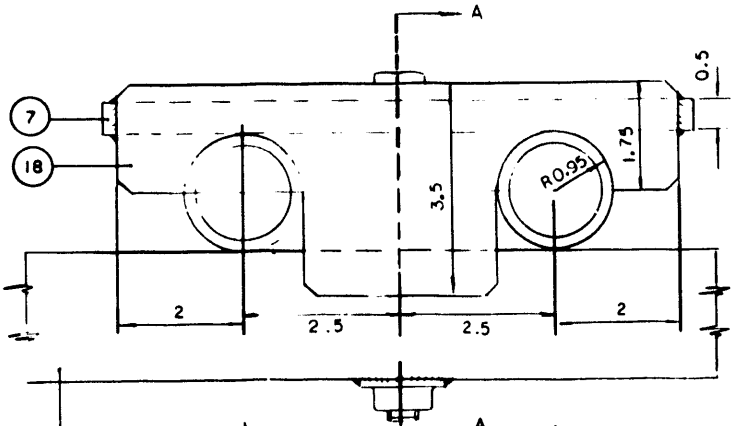


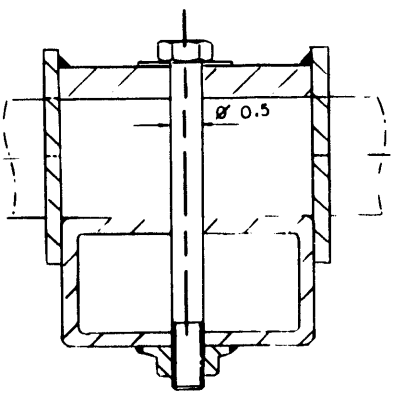

FRONT VIE OF SUBASSEMBLY AT STA 31
SCALE 1:10

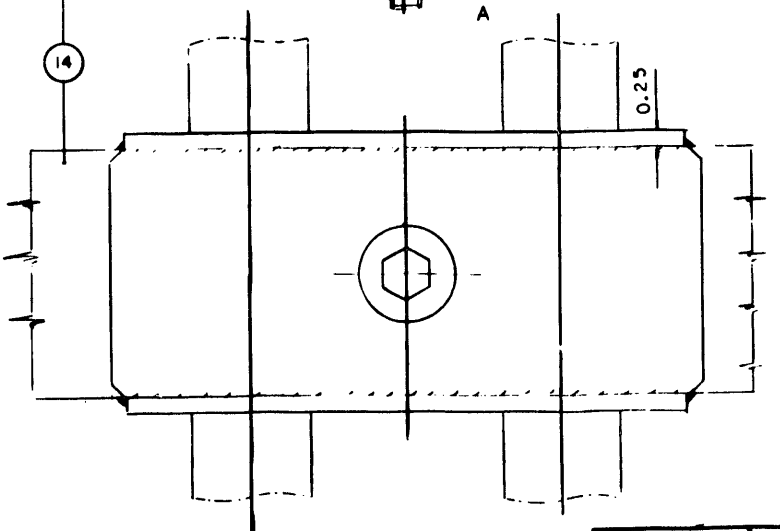




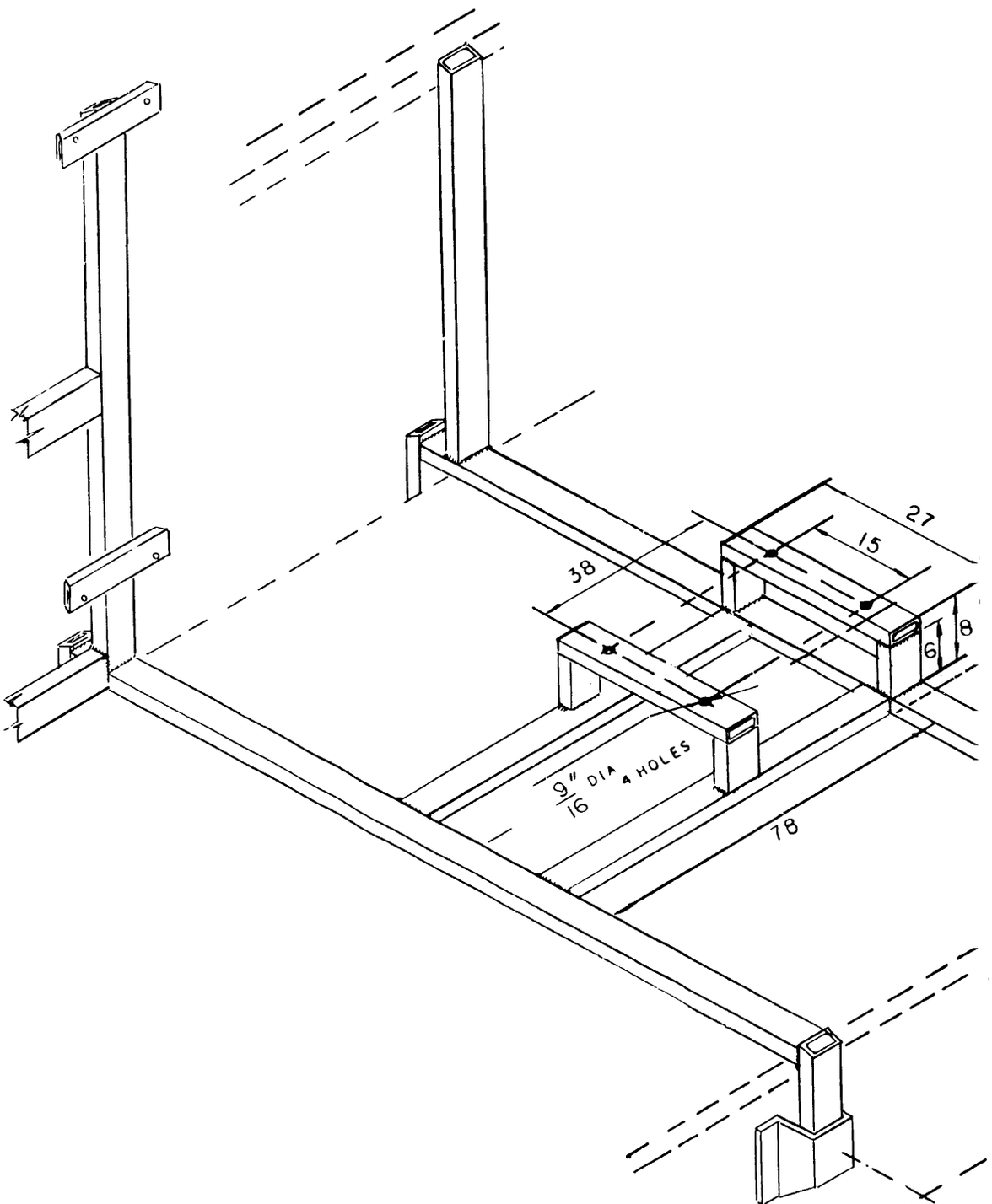

| | | |
|---|---|---|
| | SIGNATURES | DATE |
| | S.L.O. | 02.07 |
| | | 69 |

GENERAL ELECTRIC

FLAT CAR
EQIPMENT SUPPORT
STRUCTURE SUBASSEMBLY

41E 914 193

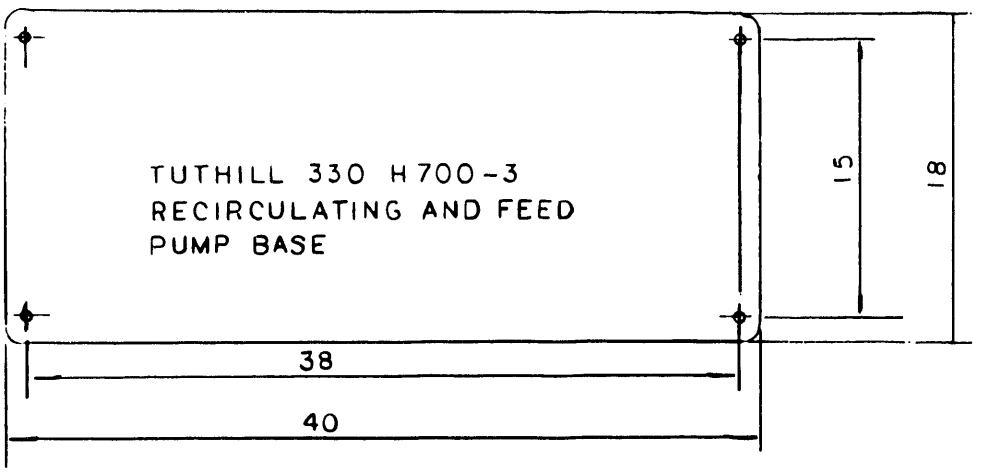
SCALE 1:1 AND 1:10

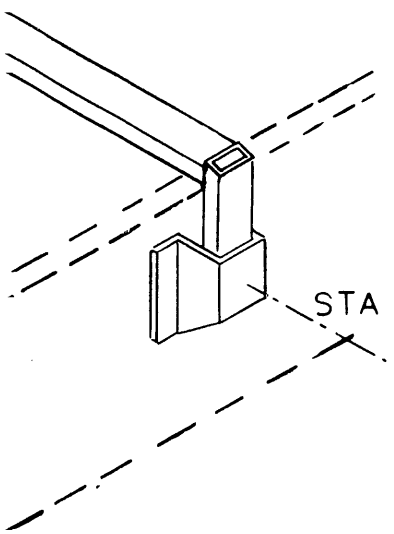



THIRD ANGLE PROJECTION

FN-1147-F (B)
7-83

| REVISIONS | | | |
|---|---|---|---|
| REV | DESCRIPTION | DATE | APPROVED |




| ITEM | QTY | DESCRIPTION |
|---|---|---|
| 3 | 4 | UPRIGTS 4"x2"; 0.19"WALL ; LENGHT 6" |
| 2 | 2 | CROSS BEAMS 4"x2"; 0.19 WALL ; LENGHT 27" |
| 1 | 2 | FLOOR TIES 4"x2"; 0.19"WALL; LENHT 78" |

| SIGNATURES | | DATE |
|---|---|---|
| DRAWN | S.L.O. | 02,9 |
| CHECKED | | 89 |
| ENGR. | | |
| MFGR. | | |

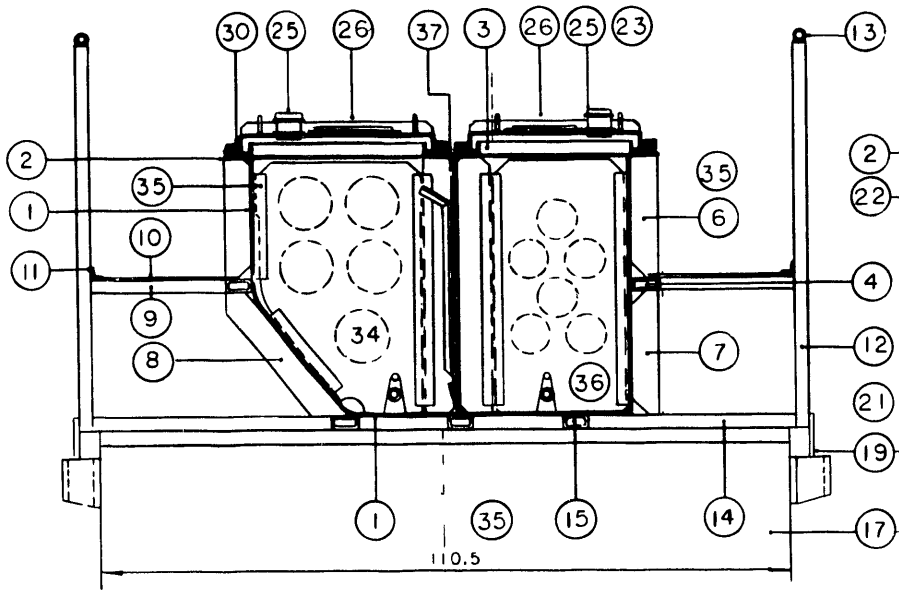
GENERAL ELECTRIC
DEPT LOC

FLAT CAR
RECIRCULATING PUMP
MOUNTING SUBASSEMBLY

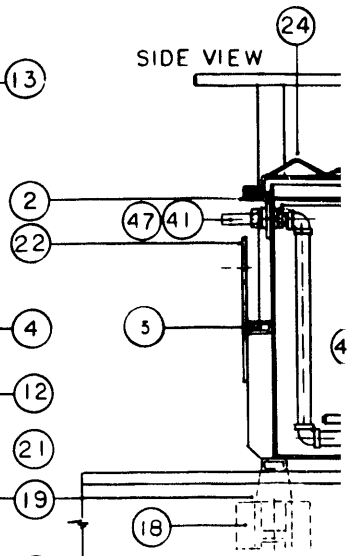
SIZE D | FSCM NO. | DWG. NO. 41D715506 | REV

SCALE — | SHEET

CROSS-SECTION A-A




SIDE VIEW

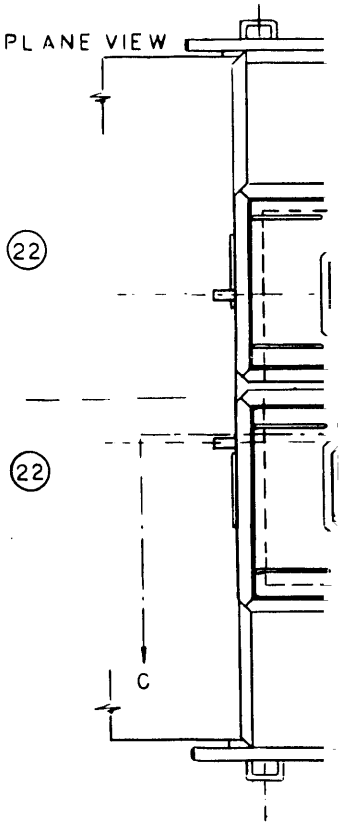


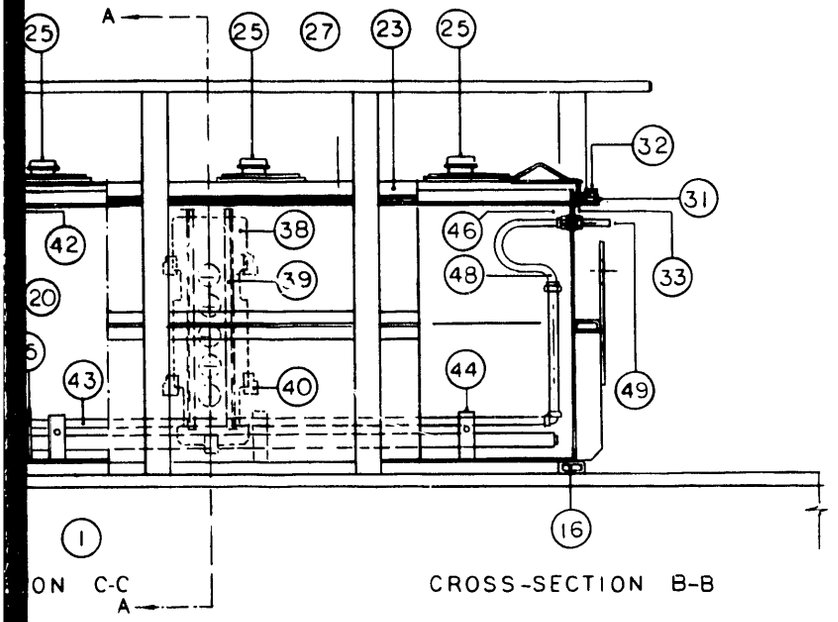

CROSS-SECT

STA
275

NOTE: ELECTRICAL HEATERS ARE INCLUDED IN EXTERNAL PIPING

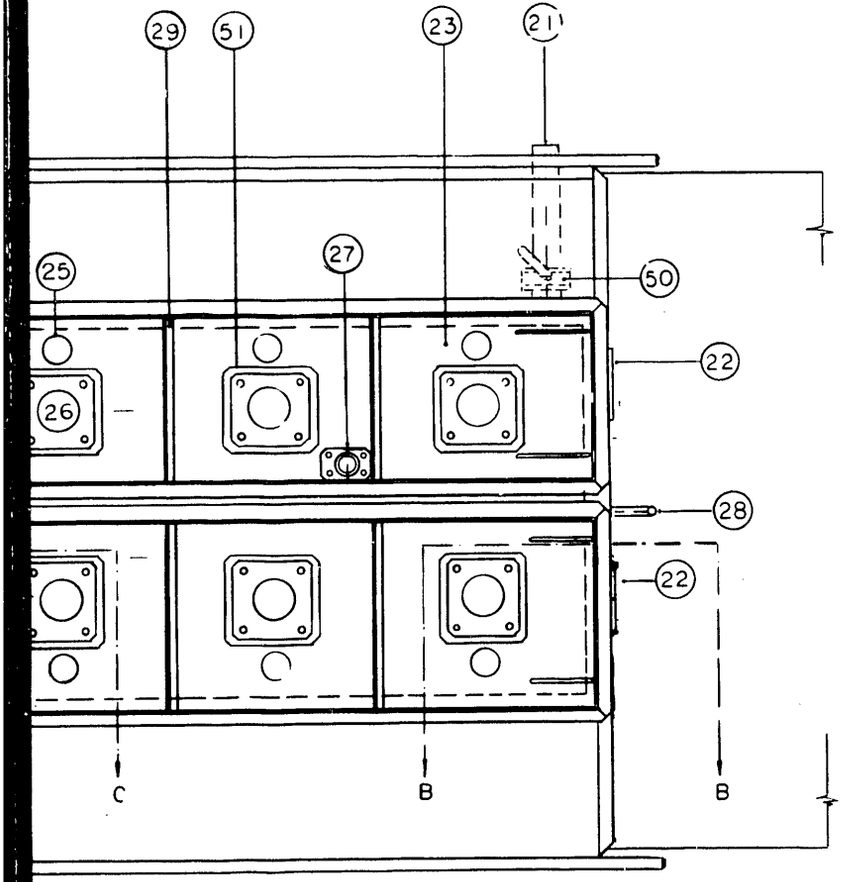
PLANE VIEW






ON C-C
A

CROSS-SECTION B-B




| ITEM | DESCRIPTION |
|---|---|
| 51 | CUT OUT REINFORCEMENT PLATE |
| 50 | 4" BUTTERFLY VALVE TYPE 815 W |
| 49 | COMPRESSED AIR TUBE COUPLING |
| 48 | REINFORCED RUBBER HOSE |
| 47 | FLEXMASTER COUPLING |
| 46 | COMPRESSED AIR INLET FITTING |
| 45 | LOCATION BAR |
| 44 | CLAMP SUPPORT OF 41 & 43 |
| 43 | CMPRESSED AIR TUBE |
| 42 | ADDAPTOR WASHER RUBBER SEAL & ELBOW |
| 41 | RECIRCULATING CWS TUBE |
| 40 | SCREEN SLIPPERS |
| 39 | PLATE STIFFENERS |
| 38 | LONGITUDINAL REMOVABLE SCREEN PLATES |
| 37 | LONGITUDINAL FIXED BUFFLES WITH CUTOUTS |
| 36 | TRANSVERSE REMOVAIBLE BUFFLES – PIPE SIDE |
| 35 | GUIDE ANGLE |
| 34 | TRANSVERSE REMOVABLE BUFFLES- CABLE SIDE |
| 33 | RUBBER SEAL |
| 32 | CLAMP BOLT 5/16 IN. DIA |
| 31 | WELD NUT |
| 30 | FLANGE |
| 29 | COVER STIFFENER |
| 28 | AIR VENT |
| 27 | FUEL SUCTION LINE |
| 26 | STIRRERS |
| 25 | SAMPLE TUBES |
| 24 | COVER LIFT LUGS |
| 23 | REMOVABLE INSPECTION, ACCESS & CLEAN OUT COVERS |
| 22 | CRANE HOOK LUG |
| 21 | TUBE |
| 20 | COAL WATER SLURY |
| 19 | WELDED ATTACHMENT PLATE |
| 18 | STAKE POST LUG |
| 17 | FLAT CAR |
| 16 | TRANSVERSE BEAMS |
| 15 | LONGITUDINAL BEAM |
| 14 | ATTACHMENT BEAM AT STA 275 |
| 13 | RAILING |
| 12 | SUPPORT |
| 11 | EDGE MEMBER |
| 10 | FLOOR PLATE |
| 9 | FLOOR PLATE BEAM |
| 8 | DIGONAL BEAM |
| 7 | BRACE |
| 6 | UPRIGHT |
| 5 | TRANSVERSE STIFFENER |
| 4 | THE MAIN EXTERNAL STIFFENER |
| 3 | EQAL ANGLE |
| 2 | EDGE MEMBER |
| 1 | TANK WALLS, PLATE THICKNESS $t = 0.1875$ " |

REVISIONS

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|

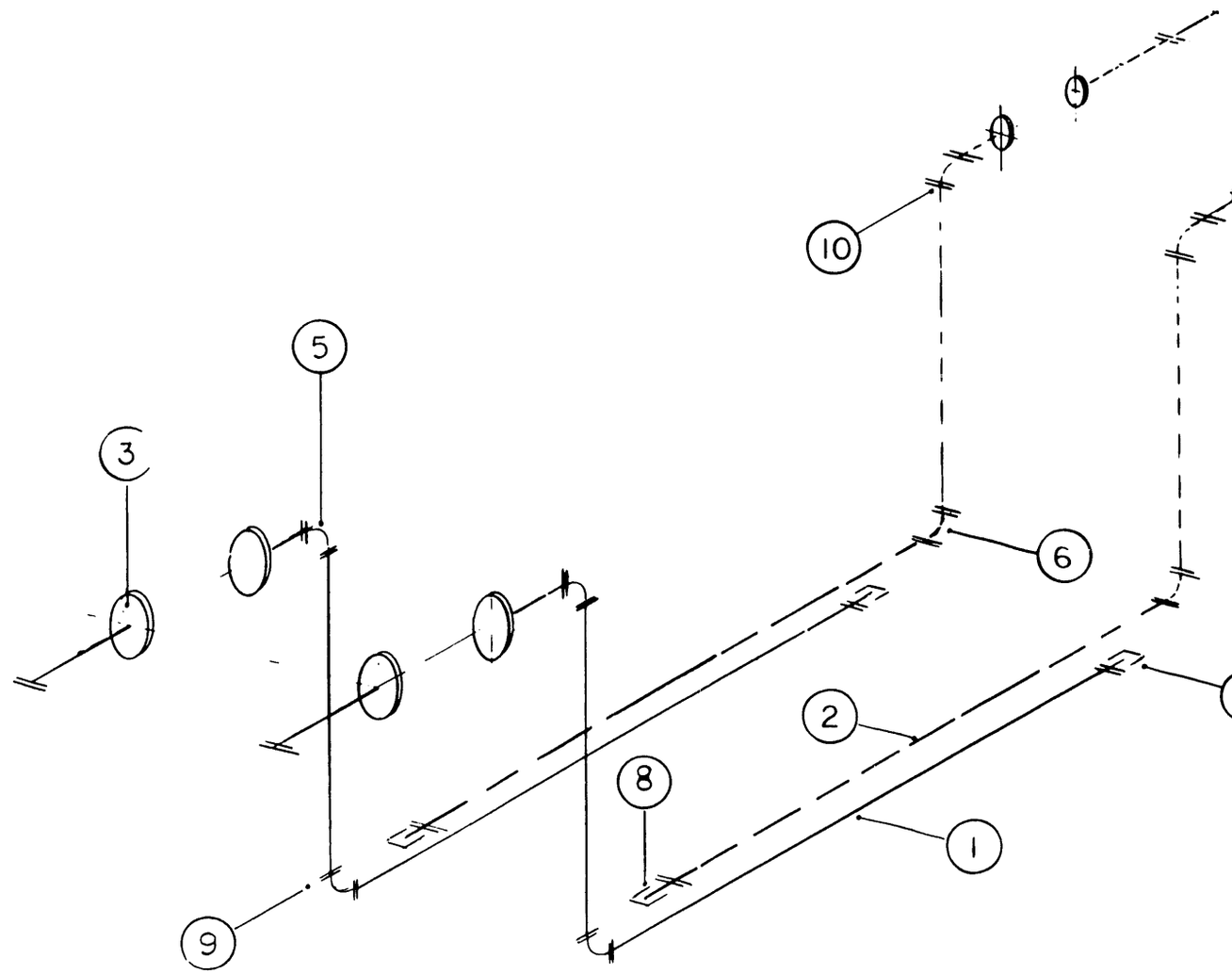
| UNLESS OTHERWISE SPECIFIED | SIGNATURES | DATE |
|---|---|---|
| DIMENSIONS ARE IN INCHES<br>TOLERANCES ON<br>2 PL DECIMALS ±<br>3 PL DECIMALS ±<br>ANGLES ±<br>FRACTIONS ± ✓ | DRAWN S.L.O. | 10 11 88 |
| | CHECKED | |
| | ENGR | |
| | MFG | |
| | APPD | |

GENERAL ELECTRIC
DEPT LOCN

CWS EXPERIMENTAL FUEL TANK

SIZE E | DWG NO 41E914098 | REV

SCALE 1:10 | SHEET



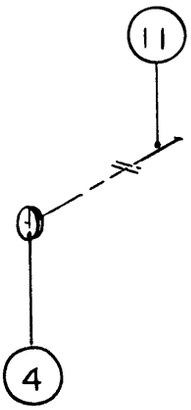

THIRD ANGLE PROJECTION

FN-1147-F (B)
7-83

| SIZE | DWG NO | SH | REV |
|---|---|---|---|
| D | | | |

REVISIONS

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| | | | |




D

C

B

| ITEM | QTY | VENDOR | DESCRIPTION |
|---|---|---|---|
| 11 | 2 | VICTAULIC COMPANY OF AMERICA | 1 ″ NIPPLE N° 40 |
| 10 | 12 | VICTAULIC COMPANY OF AMERICA | 1 ″ STYLE 77 STANDARD COUPLING |
| 9 | 12 | — 11 — | 2″ STYLE HP-70 ES END SEAL COUPLING HOT DIP GALVANISED |
| 8 | 2 | — 11 — | 1″ N° 60 |
| 7 | 2 | — 11 — | 2″ CAP N° 60 |
| 6 | 4 | — 11 — | 1 ″ N° 10 |
| 5 | 4 | — 11 — | 2 ″ 90° ELBOW N° 10 |
| 4 | 4 | — 11 — | 1″ N° 41 |
| 3 | 4 | — 11 — | FLANGED ADAPTER NIPPLE NO 41 ; 2″ I.D. |
| 2 | 25 FT | | 1 ″ I.D. 0.1575 WALL GALVANISED STEEL PIPE |
| 1 | 25 FT | | 2″ I.D. 0.1875 WALL GALVANISED STEEL PIPE |

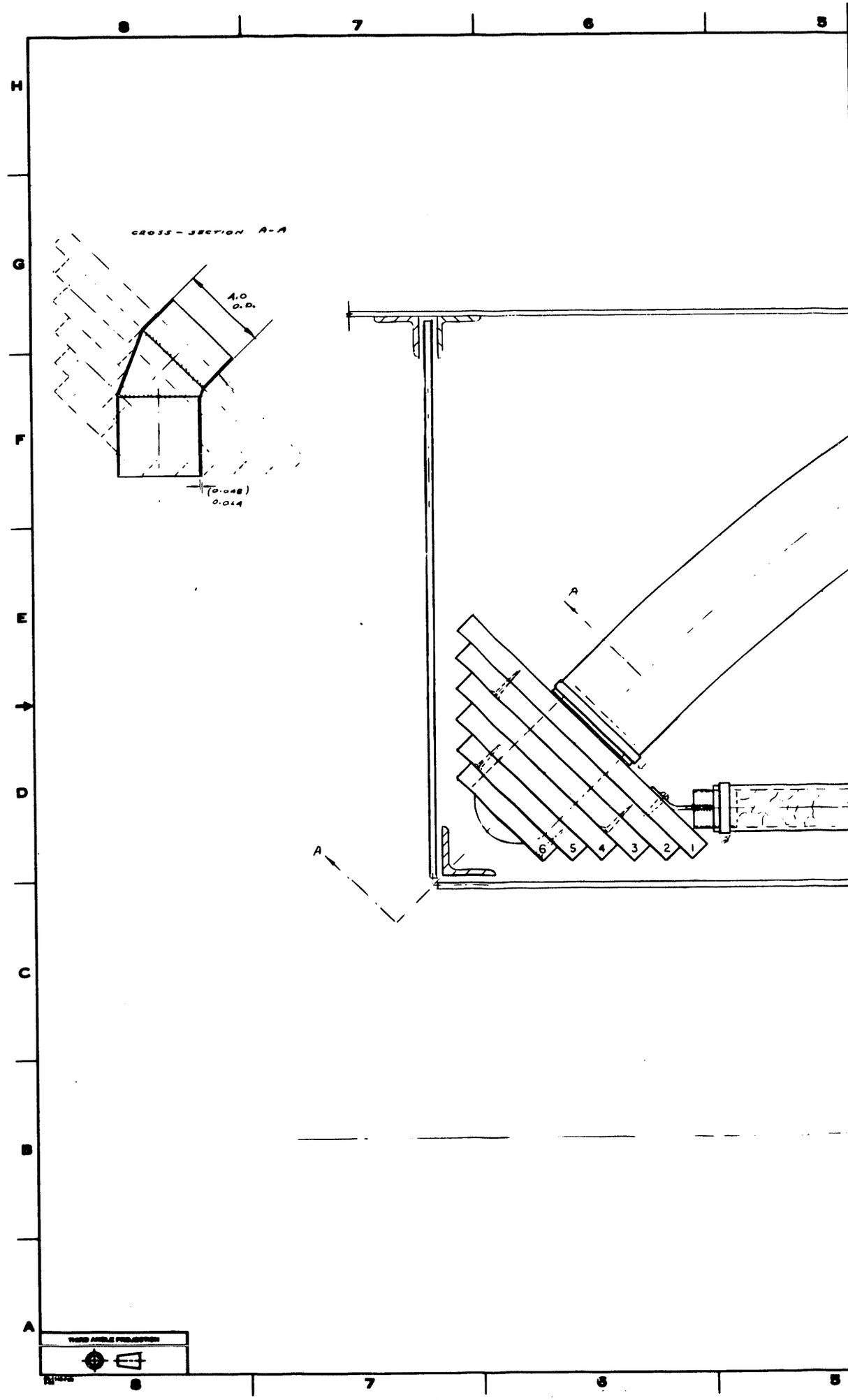
| UNLESS OTHERWISE SPECIFIED | SIGNATURES | DATE |
|---|---|---|
| | S.L.O. | 1.16. |
| | | 89 |

GENERAL ELECTRIC
DEPT LOC

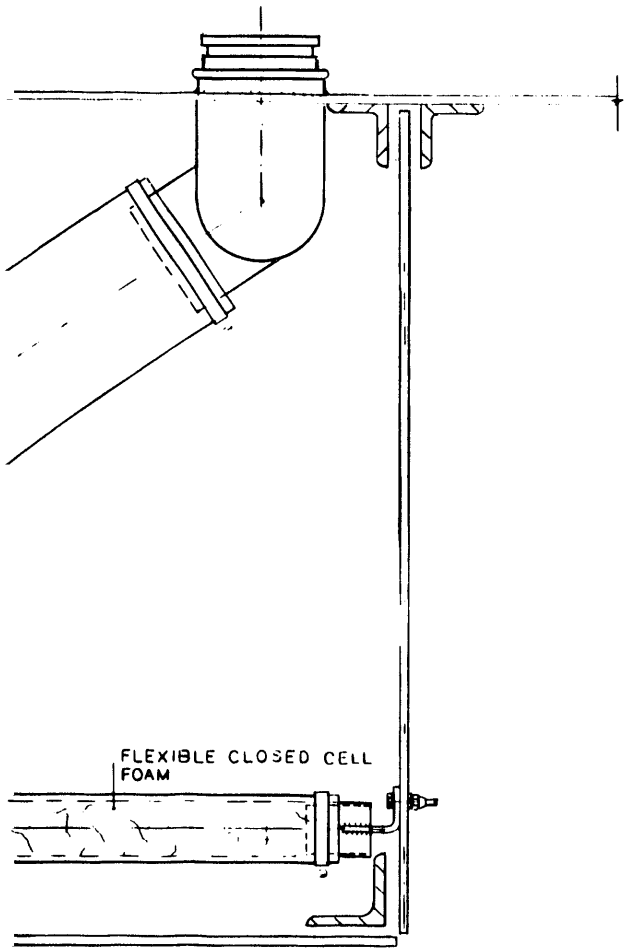
CWS EXPERIMENTAL
FUEL TANK
PIPING LAYOUT

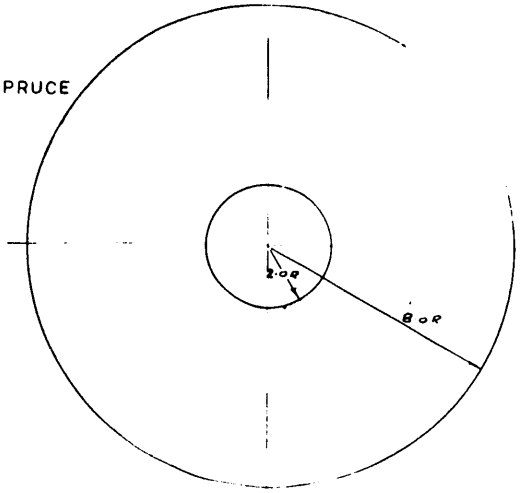
| SIZE | FSCM NO. | DWG NO. | REV |
|---|---|---|---|
| D | | 41D 715 497 | |

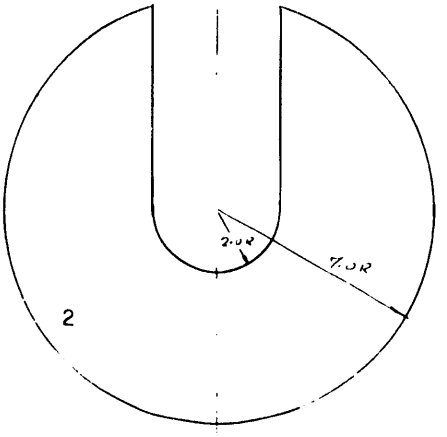
SCALE — SHEET

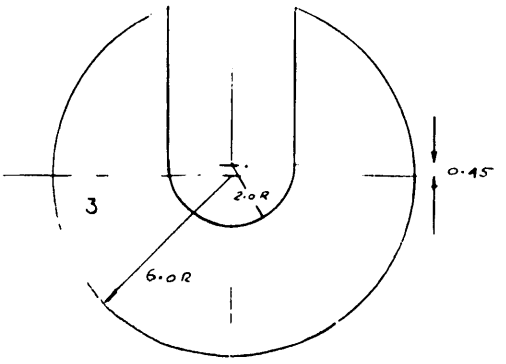

8
7
6
5
H
G
F
E
D
C
B
A
CROSS - SECTION A-A
4.0
O.D.
(0.048)
0.014
A
A
6
5
4
3
2
1
THIRD ANGLE PROJECTION

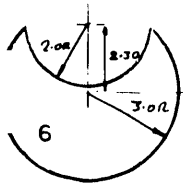
MTL., ITEMS 1-6 : SPRUCE

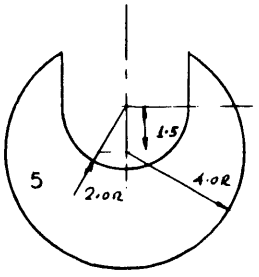


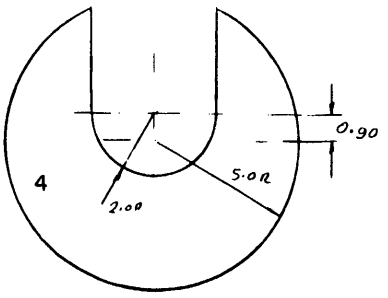




| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|

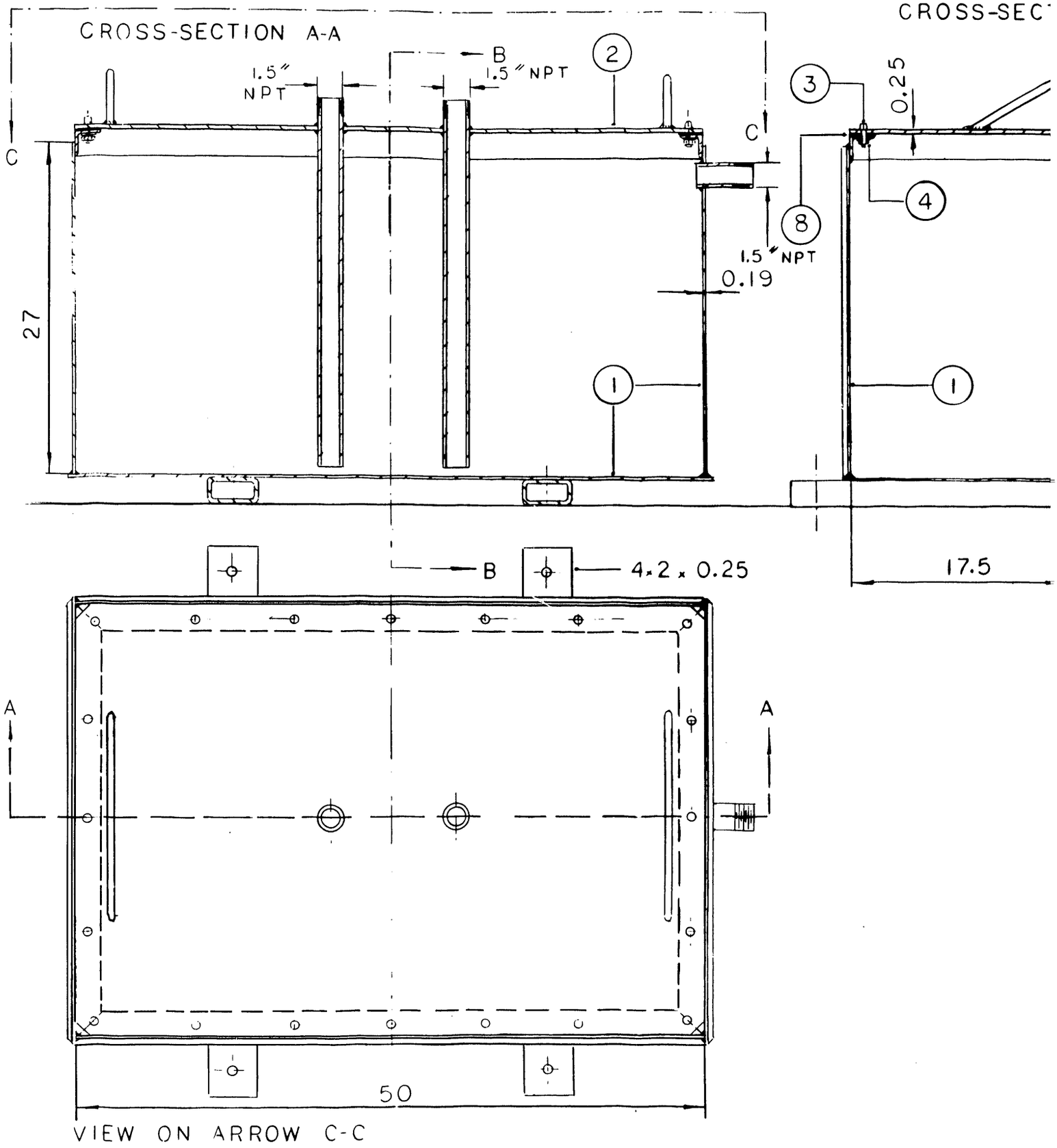
| UNLESS OTHERWISE SPECIFIED | SIGNATURES | DATE |
|---|---|---|
| DIMENSIONS ARE IN INCHES | DRAWN S.L.O. | 5,10.89 |
| TOLERANCES ON: | | |
| X IN. DECIMALS ± | | |
| XX IN. DECIMALS ± | | |
| ANGLES ± | | |
| FRACTIONS ± | | |

GENERAL ELECTRIC

EXPERIMENTAL C.W.S. FUEL TANK – CONICAL FLOAT WITH DIAGONAL LINE AND FLEX-BRACE

SIZE E | 41E914206 | REV

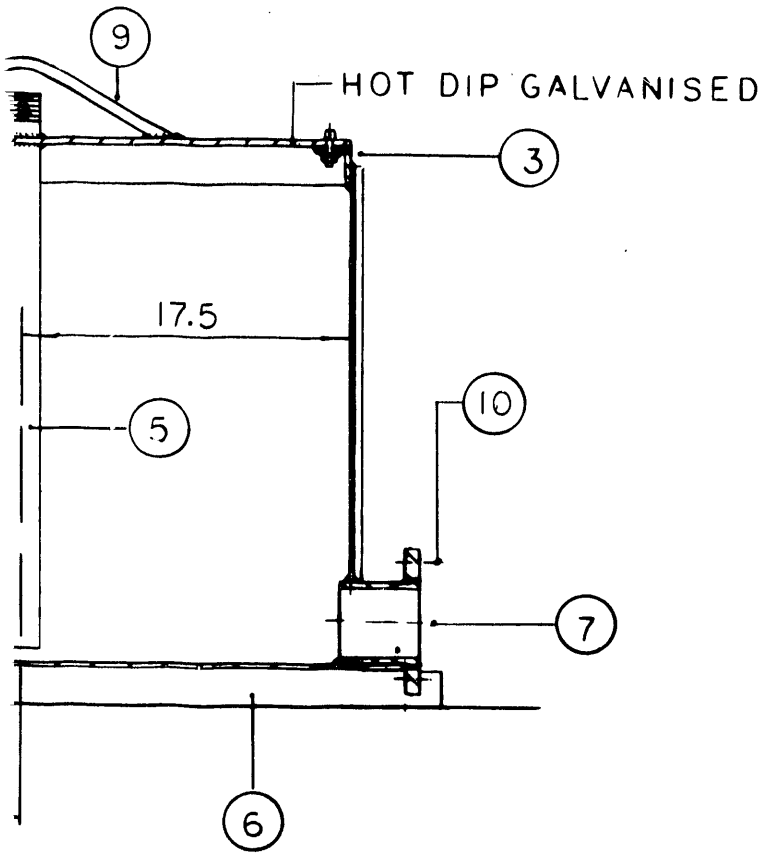
SCALE 1:2 | SHEET




THIRD ANGLE PROJECTION

FN-1147-F (B)
7-83

ION B-B




| | |
|---|---|
| 10 | 4″ THREADED FLANGE 150 LB |
| 9 | LUG |
| 8 | SEAL |
| 7 | 4″ BUTTERFLY VALVE 815W ATTACH. FLANGE |
| 6 | MOUNTING BEAMS |
| 5 | 1.5″ I.D. TUBE |
| 4 | WELD NUT N264 |
| 3 | BOLT 5/16-18 N22 |
| 2 | COVER PLATE |
| 1 | TANK WALLS-EPOXY COATED FPOM INSIDE |

REVISIONS

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|

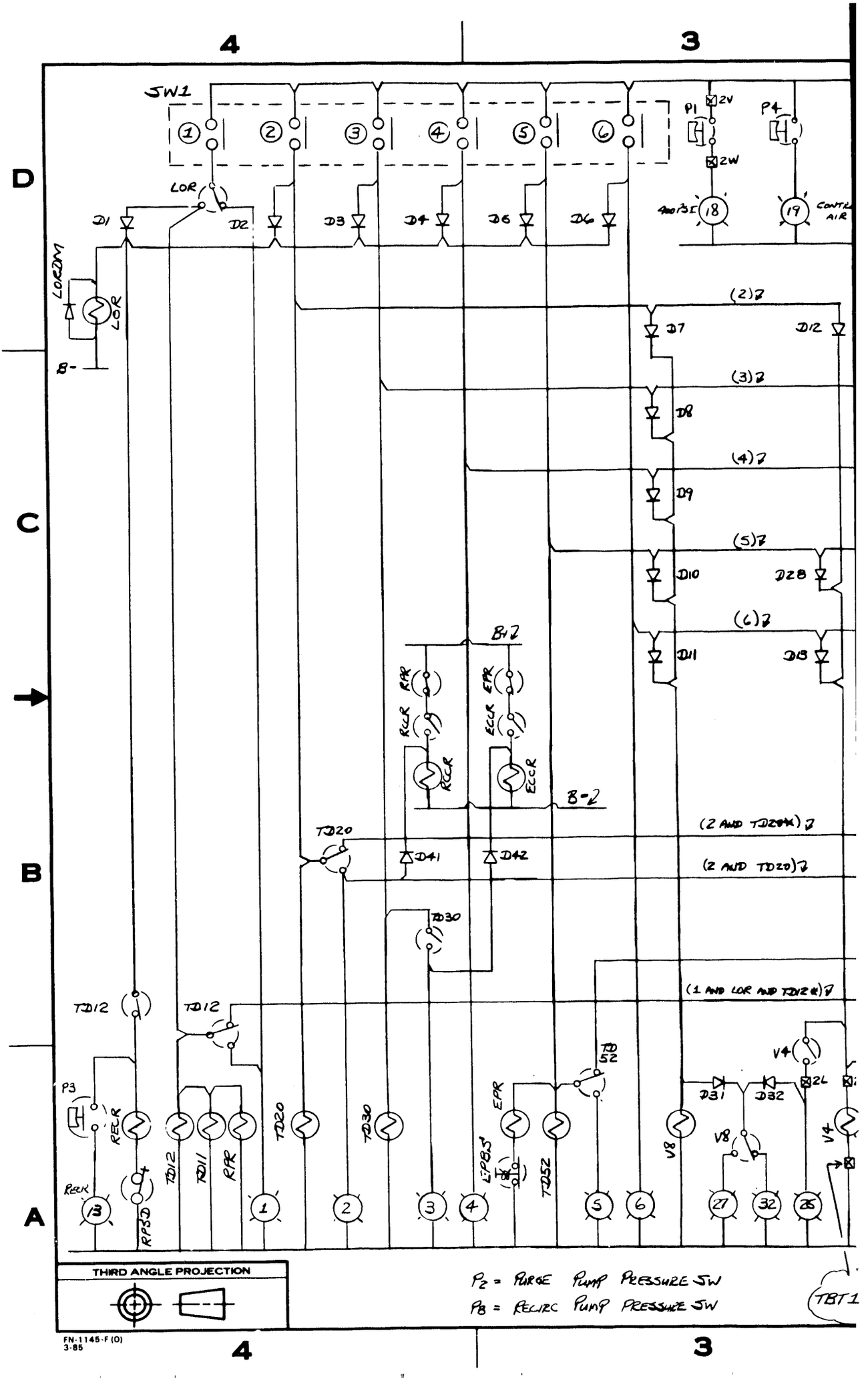
SIGNATURES — DRAWN S.L.O. — DATE 11/1/88

GENERAL ELECTRIC

CLEAN WATER AND COAL SLURRY TANK

SIZE D — DWG NO. 41 D 715 481 — REV

SCALE 1:5 — SHEET


4
3
SW1
P1
2V
2W
P4
LOR
D1
D2
D3
D4
D5
D6
LOR2M7
LOR
B-
(2)Z
D7
D12
(3)Z
D8
(4)Z
D9
(5)Z
D10
D28
(6)Z
D11
D13
B-1Z
RCLR RPR
RCLR
ECLR EPR
ECCR
B-2
TD20
D41
D42
(2 AND TD20X)Z
(2 AND TD20)Z
TD30
(1 AND LOR AND TD12X)Z
TD12
TD12
P3
RCLR
RCLR
RPSD
TD12
TD11
RPR
TD20
TD30
EPR
LPBS
TD52
TD52
V4
D31
D32
V8
V8
V4
13
1
2
3
4
5
6
27
32
28
THIRD ANGLE PROJECTION
P2 = PURGE PUMP PRESSURE SW
P8 = RECIRC PUMP PRESSURE SW
TBT-1
FN-1145-F (O)
3-85

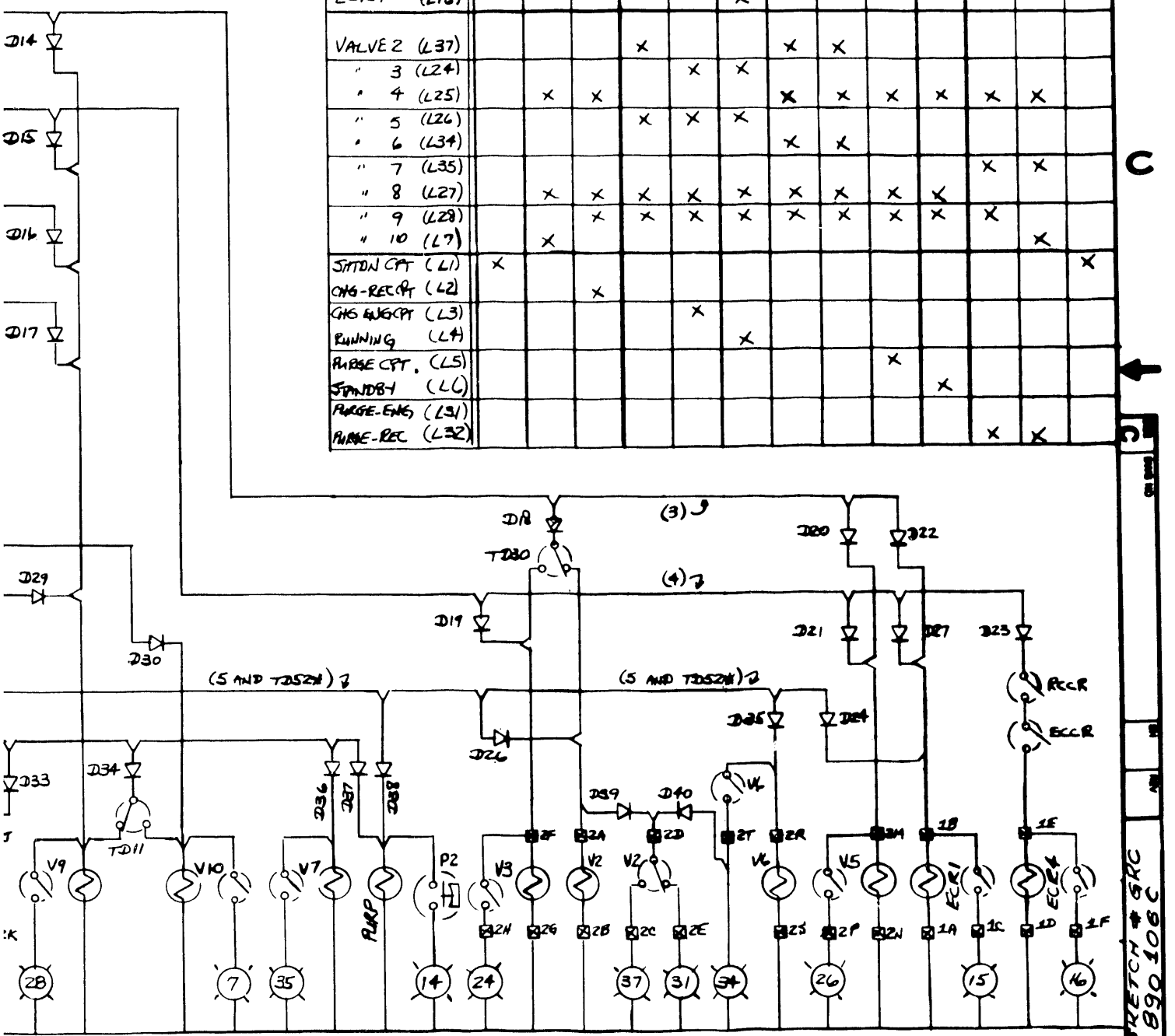
| SIZE | DWG NO | SH | REV |
|---|---|---|---|
| C | | | |

REVISIONS A

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| A | REV A 03/08/89 ARC DEL TDS1, ADD EPBS, RPBD | | |

X = ACTIVE

| DEVICE | ① START | ② CHARGE RECIRC T0 | ② CHARGE RECIRC T30 | ③ CHARGE ENGINE T0 | ③ CHARGE ENGINE T30 | ④ RUN | ⑤ PURGE ENGINE T0 | ⑤ PURGE ENGINE T10 | ⑤ PURGE ENGINE T20 | ⑥ STAND BY | ① SHUT DOWN T0 | ① SHUT DOWN T15 | ① SHUT DOWN T65 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TD11 | | | | | | | | | | | | X | X |
| TD12 | | | | | | | | | | | | | X |
| TD20 | | | X | | | | | | | | | | |
| TD30 | | | | | X | | | | | | | | |
| TDS2 | | | | | | | | | X | | | | |
| RECR (L13) | | X | X | X | X | X | X | X | X | X | X | X | |
| PURP (L14) | | | | | | | X | X | | | X | X | |
| ECR1 (L15) | | | | X | X | X | X | X | | | | | |
| ECR4 (L16) | | | | | | X | | | | | | | |
| VALVE 2 (L37) | | | | X | | | X | X | | | | | |
| " 3 (L24) | | | | | X | X | | | | | | | |
| " 4 (L25) | | X | X | | | | X | X | X | X | X | X | |
| " 5 (L26) | | | | X | X | X | | | | | | | |
| " 6 (L34) | | | | | | | X | X | | | | | |
| " 7 (L35) | | | | | | | | | | | X | X | |
| " 8 (L27) | | X | X | X | X | X | X | X | X | X | | | |
| " 9 (L28) | | | X | X | X | X | X | X | X | X | X | | |
| " 10 (L7) | | X | | | | | | | | | | X | |
| SHTDN CPT (L1) | X | | | | | | | | | | | | X |
| CHG-REC CPT (L2) | | | X | | | | | | | | | | |
| CHG ENG CPT (L3) | | | | | X | | | | | | | | |
| RUNNING (L4) | | | | | | X | | | | | | | |
| PURGE CPT. (L5) | | | | | | | | | X | | | | |
| STANDBY (L6) | | | | | | | | | | X | | | |
| PURGE-ENG (L31) | | | | | | | | | | | X | X | |
| PURGE-REC (L32) | | | | | | | | | | | | | |



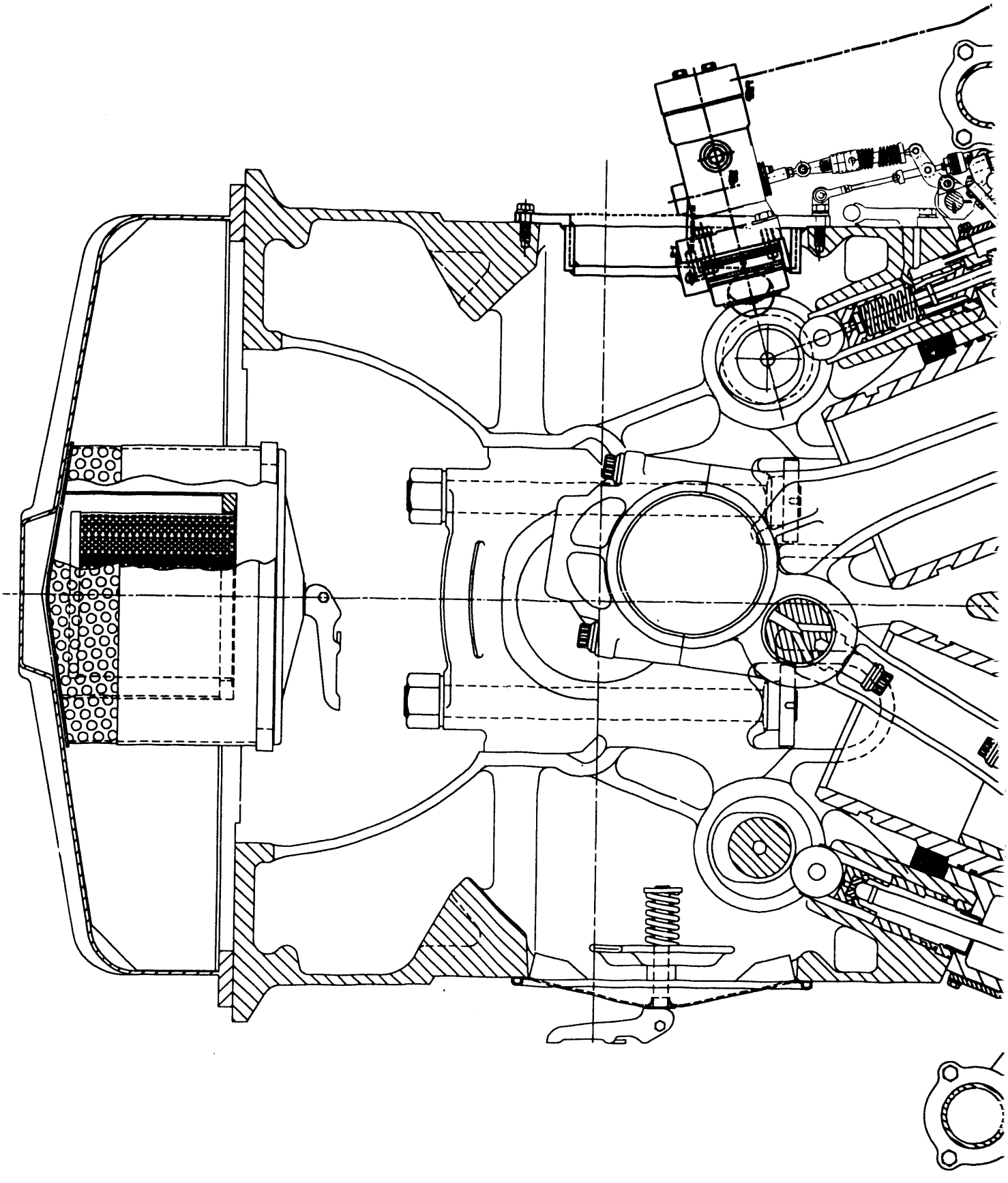

SKETCH # SRC 890105 C

-37-

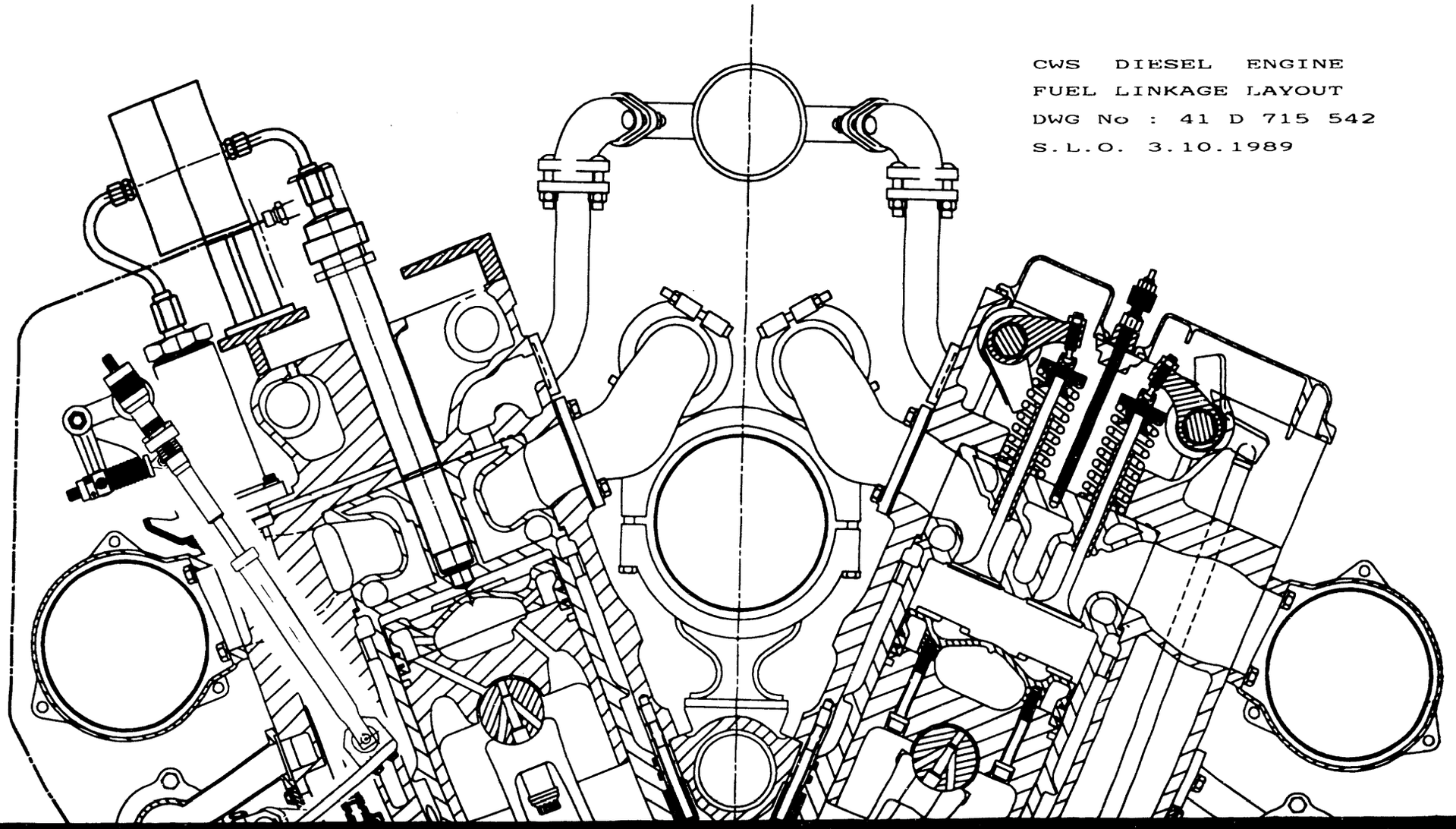
REFERENCE: RMS SKETCH # 1026

| SIZE | FSCM NO | DWG NO |
|---|---|---|
| C | ARC 1-6-89 | 41C640527 |
| SCALE | | SHEET 1 OF 3 |

DISTR TO



CWS DIESEL ENGINE
FUEL LINKAGE LAYOUT
DWG No : 41 D 715 542
S.L.O. 3.10.1989



# END

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