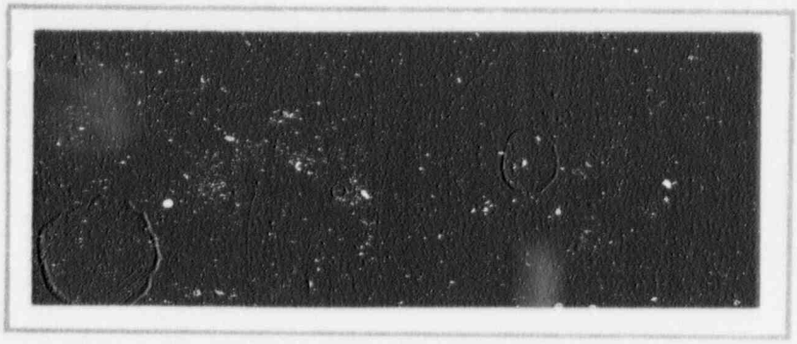

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TELEDYNE ENERGY SYSTEMS
110 W. TIMONIUM RD., TIMONIUM, MD. 21093

TOPICAL REPORT
U-FORM RADWASTE SOLIDIFICATION SYSTEM
REPORT NO. PPD-TR-7701

Revision 1

December 1979

FOREWORD

This first revision to the Radwaste Topical Report No. PPI-TR-7701 which was originally submitted to the Nuclear Regulatory Commission (NRC) on March 22, 1978 has been prepared to reflect (1) an improved process which yields no free standing water following solidification, (2) process chemicals which can be stored without degradations for a year or more instead of months, (3) mixing techniques which yield homogeneous, solid radwaste billets, and (4) a transfer of the product line from Nuclear Engineering Company, Inc., Jeffersontown, Kentucky to Teledyne Energy Systems, Timonium, Maryland.

The name Protective Packaging, Inc. (PPI) has been changed to the Protective Packaging Division (PPD) of Teledyne Energy Systems. The trade name of the original chemical process, Tiger Lock, has been dropped. The improved process is now called U-Form.

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I. INTRODUCTION

This report describes the Radwaste Solidification System manufactured by the Protective Packaging Division (PPD) of Teledyne Energy Systems (TES). The process equipment, chemistry, operational characteristics and data presented herein are based on systems already installed and systems in the process of delivery and installation in operating nuclear power generating plants in this country and overseas.

The main attributes of the U-Form Radwaste Solidification System (RSS) are:

1. The ability to form homogeneous solid radwaste billets of any desired size in a dry form, i.e. no free standing water following the solidification process.
2. The ability to store the process chemicals without degradation of their functions by premature polymerization for longer periods of time.
3. The low capital cost of a permanent installation and the low operating cost associated with (1) the use of the U-Form inexpensive process chemicals (2) minimum manhours required for the solidification process, and (3) minimal maintenance of the simplified pumping and handling system.
4. The ability to solidify boric acid, sulphate and resin effluents, and spent filters equally well without changing the process chemicals.
5. The low personnel radiation exposures which can be achieved by using this system.
6. The general safety realized by the use of the U-Form System. The process chemicals are non-flammable and in a liquid state which precludes the problems associated with airborne dust and the inhalation thereof. The resultant solidified billets are also non-flammable and dust free. (Bare, solid 50 ft^3 billets stored in the open have shown no deterioration due to temperature, rain storms or atmospheric pollution. Their surface is hard and smooth, typical of the thermosetting resins.)

I. INTRODUCTION (cont'd)

Teledyne Energy Systems developed the U-Form process mainly to eliminate the potential for free standing water which occasionally occurred with the earlier Tiger Lock process. TES also developed a new air sparging system to replace, if desired, the mechanical mixers associated with the original disposable liners. Attendant with the improved process chemicals came longer lifetimes for storage. Earlier materials would start polymerizing after a few months of storage, now no noticeable changes occur for the first year of storage and only additional test time will determine when the process chemicals will exhibit a change.

The U-Form process summarized in Figures I-1, I-2 and I-3 utilizes a two-component addition to the radwaste which is to be solidified. The first addition to the radwaste is an ammonium sulfate urea catalyst with proprietary additives. This mixture is blended by the air sparging system as the second component is added. The second component is non-reacted urea formaldehyde with proprietary additives which wen mixed with the radwaste and catalyst by the sparging unit results in an exothermic reaction and a homogeneous solid billet. Verification of the solidification process in real time can be determined by observing the temperature profile of the reaction as it takes place. As mixing and polymerization proceed the temperature increases uniformly, but at the onset of solidification, the temperature remains relatively constant for a period of minutes (air sparging is stopped at this point) and then increases again after the billet has solidified. This final temperature increase in the billet is due to the change in the heat transfer coefficient of the solid billet compared to the air sparged liquid mix. Finally, a topping cycle is used to solidify vapor condensations which have been generated during the warm solidification process. The topping cycle consists of injecting the two U-Form chemicals through a static mixer designed into the liner where they absorb and solidify the condensation liquids in a one to two inch layer which is simply an extension of the basic solid billet. At this point all lines are removed by means of quick disconnect connectors and the liner is ready for inspection and shipment. Visual proof of a dry billet can be accomplished, if desired, by removing a top cover plug or removing a plug at the base of the liner.
A detailed desription of this process is presented in Section VI,

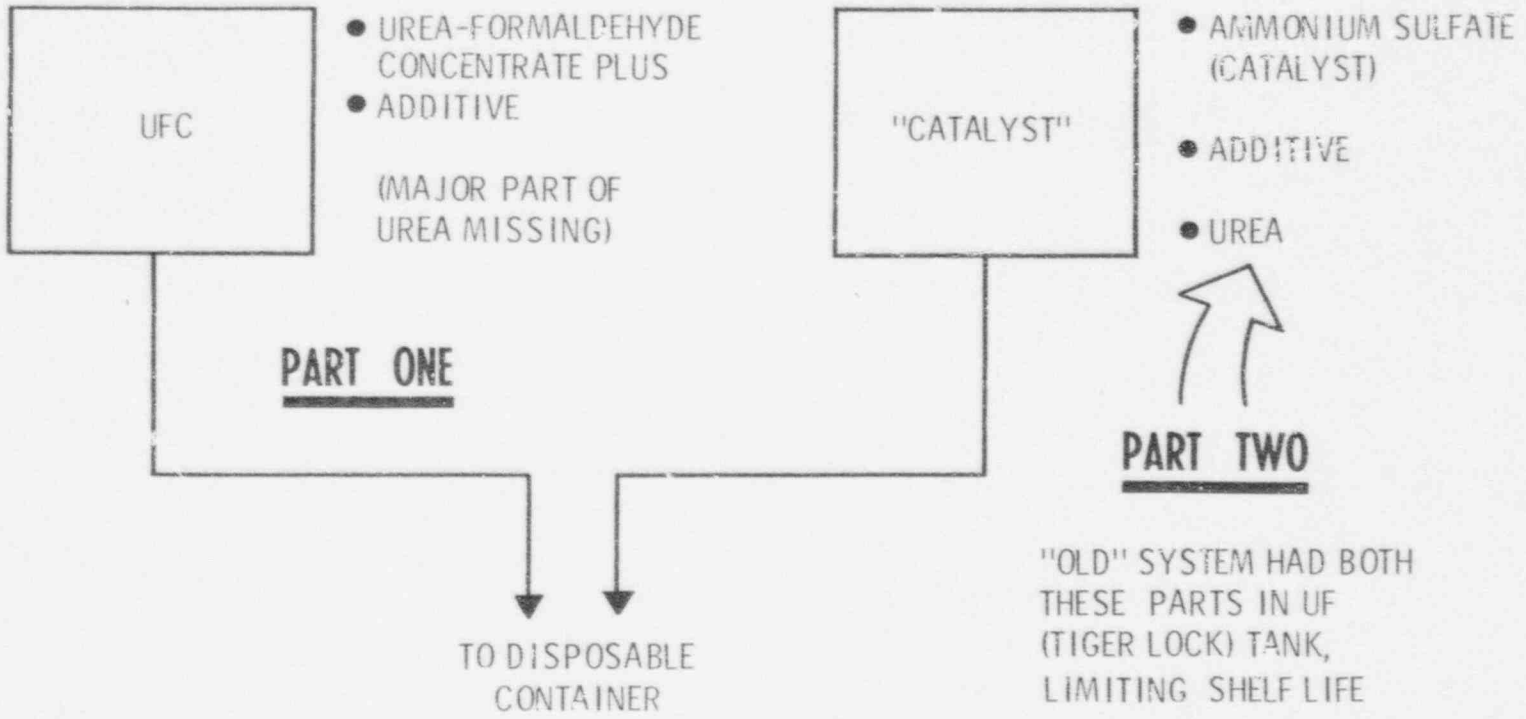

FIGURE I-1. U-FORM TWO - COMPONENT SYSTEM - DEFINITION OF TERM

	OLD (TIGER LOCK)	NEW (U-FORM)
CATALYST	SODIUM BISULFATE	AMMONIUM SULFATE PLUS ADDITIVES
CATALYST CORROSION	STRONG	MILD
SOLIDIFICATION AGENT	UREA FORMALDEHYDE (TIGER LOCK) PARTIALLY POLYMERIZED	UREA FORMALDEHYDE CONCENTRATE (UFC) WITH ADDITIVE
SOLIDIFICATION AGENT LIFE	90 DAYS	ONE YEAR MINIMUM
WASTE BLENDING TANK (WBT)	NONE	800-1500 GALLON ATMOSPHERIC WBT
pH ADJUSTMENT CAPABILITY	NONE	CAUSTIC OR ACID CAN BE ADDED TO WBT
SAMPLING METHOD	NONE	WBT RECIRCULATION AND SAMPLE LOOP

FIGURE I-2. U-FORM RADWASTE SOLIDIFICATION SYSTEM

	OLD	NEW
LINER MIXING	MECHANICAL AGITATOR, 5 HP MOTOR AND GEAR REDUCTION UNIT	DISPOSABLE AIR SPARGER MAINTENANCE-FREE
LINER TYPES REQUIRED	3 1-LIQUIDS ONLY 1-RESIN SLURRY 1-GENERAL (OPEN TOP, NO MIXER)	1 (OPEN TOP, AIR MIXER)
PROOF OF SOLIDIFICATION	VISUAL BY DRAINING	INSTRUMENTATION AND DIRECT SAMPLE -VISUAL AND BY DRAINING
FREE-STANDING WATER	1/2 GALLONS TO 20 GALLONS	NONE

FIGURE I-3. U-FORM RADWASTE SOLIDIFICATION SYSTEM (cont.)

I. INTRODUCTION (cont'd)

Process Chemistry and Testing.

The physical plant for processing the radwastes (Figure I-4) consists of (1) a waste blending tank and sampling system with provisions to adjust the pH of the radwaste for optimum solidification, (2) two process chemical storage tanks (3) a disposable liner complete with level and temperature probes, a dewatering line for resins, an air sparging unit, a static mixer, and (4) the modular pump units and controls for transferring the radwastes, the U-Form chemicals, and the dewater liquids. A detailed schematic of the system is shown in Figure I-5. This system represents one of Teledyne Energy Systems actual installations. It should be recognized that each application may require changes in functions, controls, auxiliary systems, etc. depending on the particular user's facility, specific requirements, and/or radwaste composition. A complete description of the system follows in Section II, System Description.

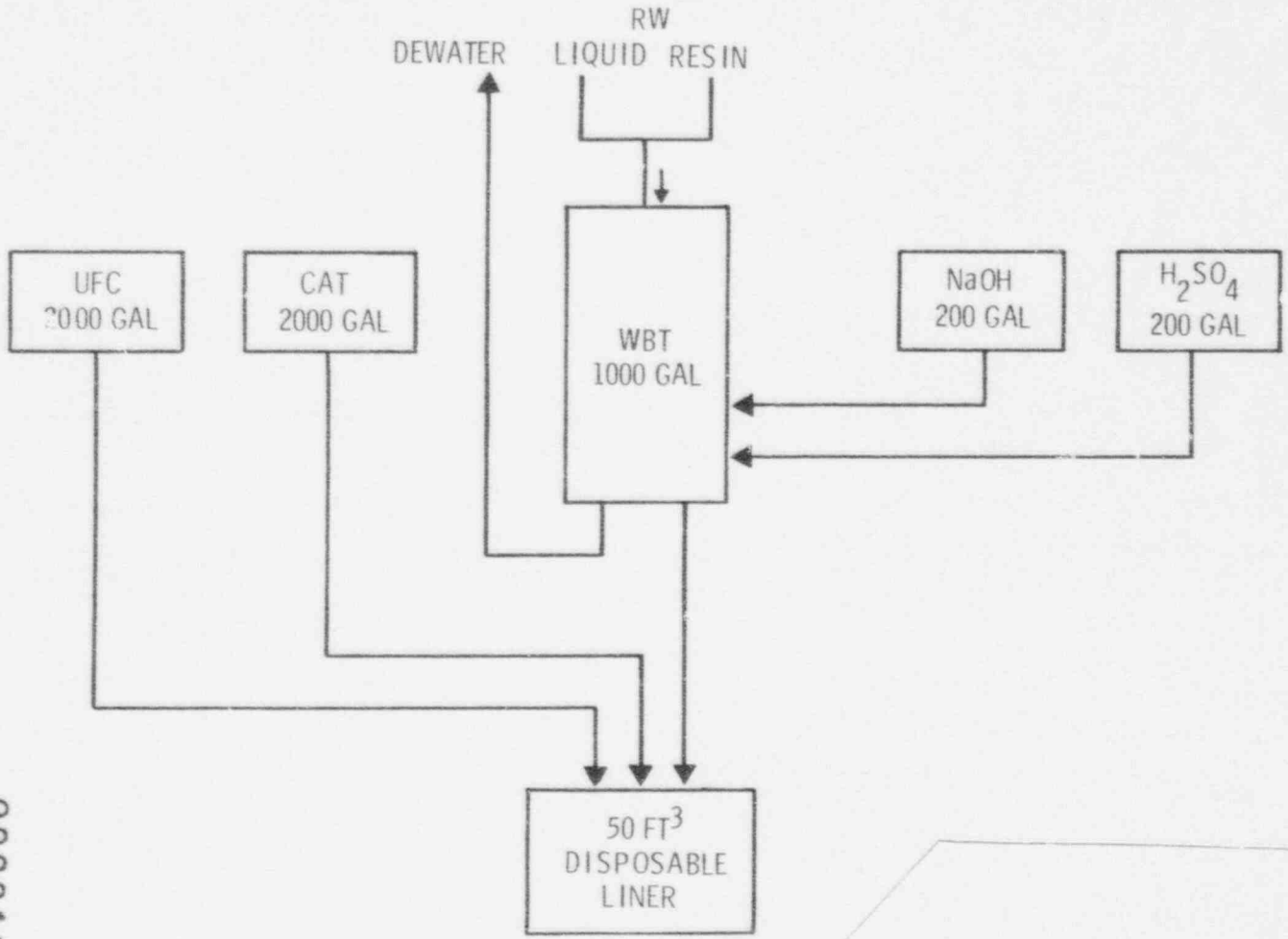

FIGURE I-4. U-FORM TWO COMPONENT SOLIDIFICATION SYSTEM

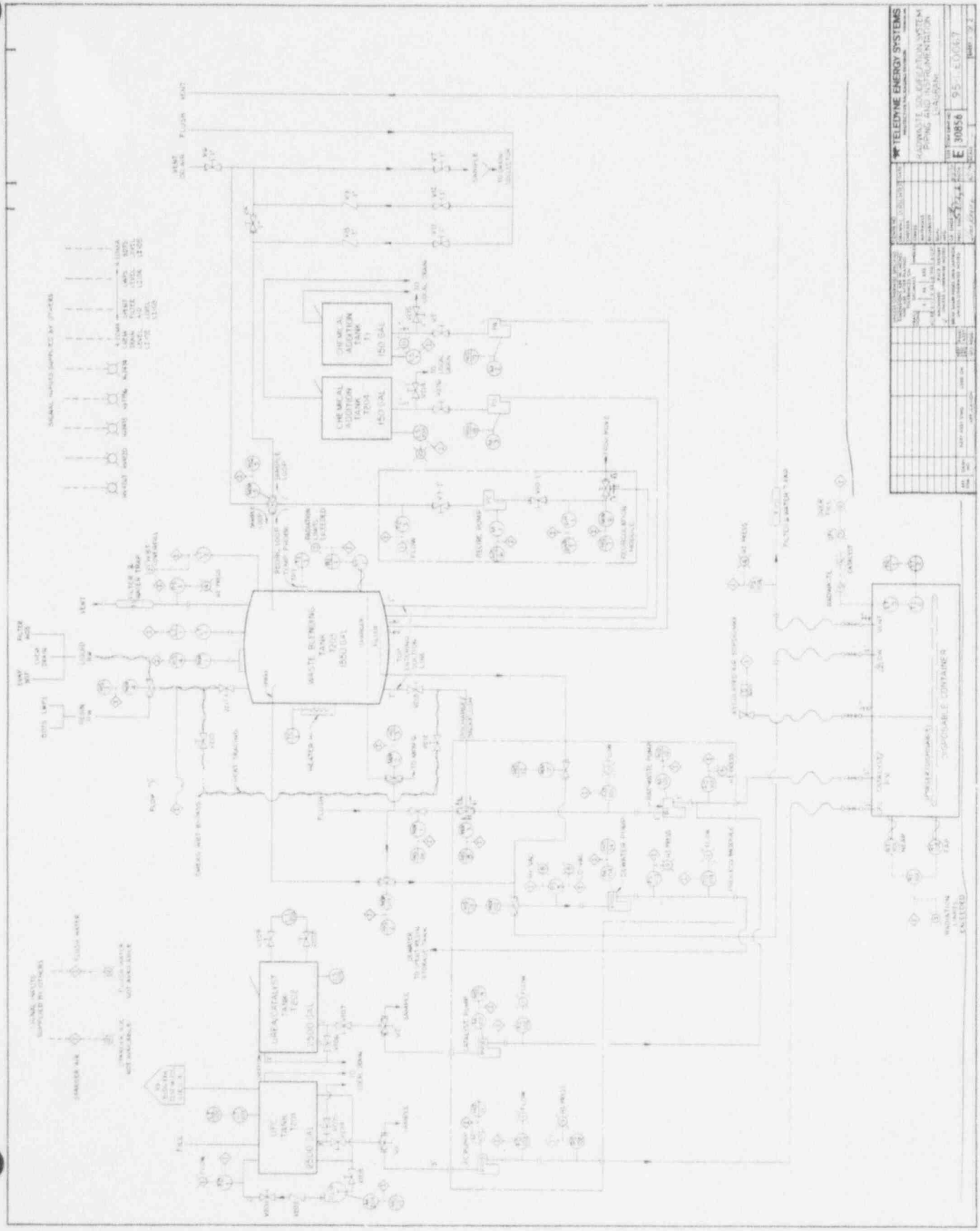

FIGURE I-5.

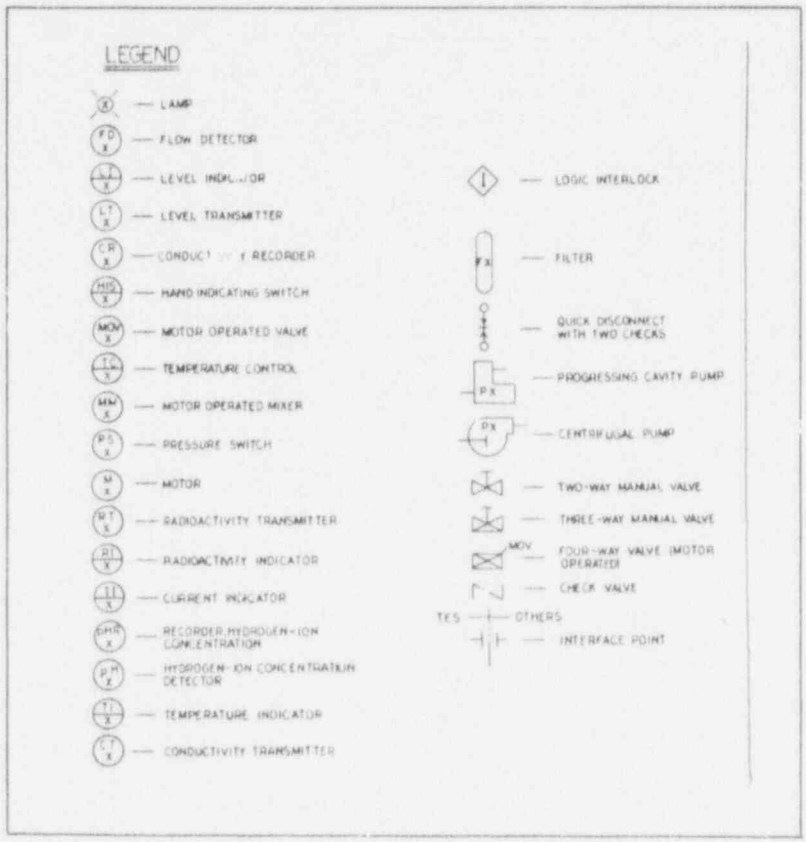

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FIGURE I-6 LEGEND FOR SCHEMATIC

II. PROCESS DESCRIPTION

The objective of the U-Form system is to collect, sample, treat and transport liquid and solid radioactive waste materials and ultimately to immobilize them in a form suitable for transport and permanent storage. The system consists of a Waste Blending Tank with accessories, two Chemical Addition Tanks, a Catalyst Solution Tank, a Urea Formaldehyde Concentrate (UFC) Tank, a Radwaste Pump, a Catalyst Pump, a Dewatering Pump, two Chemical Addition Pumps, a Recirculation Pump, a UFC Pump, Disposable Containers, and miscellaneous piping, valves and hoses. The basic flow diagram of the U-Form radwaste solidification system is shown in Figure I-5.

The Waste Blending Tank is a cylindrical vertical tank, with flanged and dished heads. Its internal equipment includes dewatering filters, a spray nozzle, a sparging ring, and a motor-driven agitator. Accessory equipment includes a recirculation pump, an ultrasonic level sensor, a radiation detector and an external heater. Since this tank receives and processes all radioactive liquid and slurry wastes, it requires installation inside heavy structural shielding. The tank's external heater is used to adjust tank temperature and if necessary, to preclude crystallization of boric acid concentrations, although the presence of additives will minimize that possibility. An ultrasonic level detector monitors tank liquid level and a radiation monitor records radiation level at a set distance from the tank. Piping is arranged so that resin beads cannot collect but flow through the system unobstructed.

The composition of the radwaste to be solidified determines what functions are performed in the Waste Blending Tank. If resin radwaste is to be solidified it is singularly introduced to the Waste Blending Tank, dewatered, then reslurried with aqueous radwaste from evaporator bottoms. If liquid radwaste alone is to be solidified, it is similarly pumped into the Waste Blending Tank, but does not require dewatering.

After the Waste Blending Tank has been filled to the desired level, the contents are agitated to ensure a homogeneous mixture. This radwaste mixture is then pumped through the recirculation system for a sufficient period of time to assure that the contents of the

II. PROCESS DESCRIPTION (cont'd)

loop are representative of the Waste Blending Tank contents. While the radwaste is recirculating, the pH is constantly being monitored and recorded. The pH can be adjusted by incrementally adding either a 10% sulfuric acid solution or a 40% sodium hydroxide solution directly into the Waste Blending Tank through separate chemical addition lines by means of a metering pump.

Experience has shown that optimum solidification takes place at a moderately acid pH, betwen 5 and 7. A lower pH does not bar solidification, but it may shorten the reaction time and result in a more acidic end product. After the chemical treatment has concluded as specified in the Process Control Program, the four-way valve in the recirculation pump discharge line is activated to the sample position sending recirculating radwaste into the sampling system.

A sample is taken and analyzed by the plant chemistry lab to determine the specific ratio of solidification chemicals as outlined in the Process Control Program. The line is then flushed with air to clean out the sample line. After the sample has been evaluated and/or solidified, discharge of radwaste from the Waste Blending Tank can begin.

There are two general solidification situations which are to be faced.

The first, and most usual situation, involves solidification of liquid effluents discharged from the Waste Blending Tank, which may or may not contain suspended solids or particulates. In this instance, the liquid effluents are pumped into the disposable liner, chemicals are added, the liner contents are agitated to assure a homogeneous mixture, and solidification occurs.

The second situation provides for the encapsulation of solid objects, such as filter cartridges, within a block of solidified waste. The only differentiation between the two situations is that the disposable liner is first fitted with an internal basket, which is designed to catch and hold the filter, prior to receiving the liquid radwaste. Detailed procedures for conducting these operations are presented in Section IV.

A third situation, used only in emergency situations when the Waste Blending Tank must be by-passed, will permit dewatering of resin beads in the disposable liner, followed by a solidification

II. PROCESS DESCRIPTION (cont'd)

process conducted in the normal manner. This situation is not considered to be a regular operation.

A brief discussion of the types of radwaste forms treated by the U-Form system is described below. A detailed chemical description and test results is given in Section VI.

Aqueous Solutions

Within the limitations of solubility and acceptable solidification temperatures, concentrations of 8-12% by weight boric acid and 15-22% by weight sodium sulfate define the maximum levels of these salts that the U-Form system is designed to process. The incorporation of a Waste Blending Tank improves the handling of these streams by permitting adjusting of temperatures and pH, and diluting the materials with less concentrated floor drains and decontamination rinses. The introduction of other salts and laundry chemicals at their anticipated concentrations has not interfered with satisfactory solidification results.

Among the major aqueous radwaste constituents, there are distinctive chemical differences that influence solidification procecures. Boric acid in solution promotes a fast reaction rate of the U-Form concentrate and the catalyst mixture. At the higher end of the maximum concentration range, the boric acid reaction does not allow sufficient time for adding all the solidification components before the gelling stage begins, and results in some crystallization of boric acid. Injecting a small amount of 40% sodium hydroxide to the Waste Blending Tank increases the reaction time to allow full addition of solidification components before gelling has started, and sharply reduces the crystallization temperature of the solution. Only a small portion of the boric acid converted to sodium borate facilitates the improvement. Solutions of boric acid at 120°F and adjusted to pH = 6 with sodium hydroxide have been solidified successfully to dry solids in fifty cubic foot liners using a radwaste to U-Form chemicals volume ratio of about 1.25 (55% radwaste per billet).

Higher concentrations of sodium sulfate also require special treatment but of a different nature. Sodium sulfate promotes faster U-Form reaction but not by introducing new acidity. It is rather a concentration effect that is not significantly improved by adding a

II. PROCESS DESCRIPTION (cont'd)

reasonable amount of sodium hydroxide. Restricting solution temperature to 110°F and using a radwaste to U-Form chemicals volume ratio of about 0.85 provides good results. The volume ratio criteria is especially significant. Solutions diluted to 10-12% or less and/or containing boric acid and other salts will solidify at higher volume ratios approaching those required for boric acid solutions.

Slurries

Ion-exchange resin beads make up the principal insoluble components in slurries to be solidified. Dirt from floor drains, iron oxide rust, and filter aid particles are other components in slurries, but should not significantly complicate solidification at anticipated concentrations expected in practical operations.

Both cationic and anionic forms of resin beads either virgin or in various spent conditions can influence urea-formaldehyde solidification. Although blending with boric acid solution or other radwaste does minimize resin bead influence, optimum treatment should be based upon laboratory pre-test observation. The potential acid-neutralizing or exchange capability of resin beads is not indicated by pH readings. It has been found that bead reaction sites may inactivate the necessary catalytic sulfuric acid that normally forms during the early stages of solidification. Without the injection of 10% sulfuric acid to replace that amount that was removed, the solidification only proceeds to a wet, paste-like condition. Slurries of resin beads that may be dewatered leaving only a wet cake to be solidified may require a combination of steps for successful treatment. First, no more than 1.5 volumes of dewatered resin beads should be mixed with 1 volume of combined chemical components. If a successful laboratory solidification is not obtained under these conditions within 1 hour after mixing, acid adjustment with 10% sulfuric acid is indicated. A slurry of the dewatered resin beads and the catalyst mixture should be acidified until the pH is reduced one full unit. Then the urea-formaldehyde concentrate should be added and the solidification observed. Slow or incomplete hardening may indicate that a lower adjusted pH value is required. As mentioned earlier, resins can be re-slurried with liquid radwaste if desired.

II. PROCESS DESCRIPTION (cont'd)

Solids

One important consideration in the selection of agitation by air mixing was the disposal problem associated with radioactive filter cartridges in either fifty cubic foot liners or in some cases, fifty-five gallon drums. Since the air sparger system does not require a rigid agitator shaft, objects may be properly suspended in the geometric center of the container, and then surrounded by solidified material, preferably containing boric acid for improved shielding. In the absence of appropriate radwaste liquid, tap water must be used as a replacement. Approximately 1.0-1.2 volumes of tap water combined with 0.5 volume each of solidification components will form a firm, dry matrix. Immobilization of objects with undiluted solidification components should never be attempted as the resultant exotherm will be very active, and may result in boiling, which creates a porous, non-homogeneous billet.

Organics - Oils

The U-Form process has shown an ability to tolerate oils of varying weights when ratios have not exceeded 1.0 parts of oil to 1.0 parts of the combined chemicals. Therefore the contamination of waste effluents with trace amounts of oils is no problem. Where it is desired to solidify hydrocarbon oil as the sole waste, it will be necessary to mix 1.0 volume of oil with 0.5 volumes each of combined chemicals.

III. EQUIPMENT DESCRIPTION

Waste Blending Tank

The Waste Blending Tank subsystem provides the system the capability to hold, control the temperature, analyze, and chemically adjust quantities of radwaste before it is pumped into a disposable container for solidification. The Waste Blending Tank is a common preprocessing collection point for radwaste streams from plant storage tanks. At this collection point the tank's contents may be adjusted over a wide range. For example, resin beads may be dewatered in the tank and then reslurried with aqueous radwaste from evaporator bottoms prior to transfer to a disposable container. The Waste Blending Tank subsystem includes a method for adding chemicals to adjust the pH of the tank contents and for sampling the contents. This allows pH to be set within the range required for solidification when U-Form chemicals are injected into the disposable container with the radwaste. By providing a large margin of control over various parameters of the radwaste prior to pumping it into a disposable container, the Waste Blending Tank subsystem gives consistent results and a high level of predictability of the final product.

The Waste Blending Tank has a nominal 1550 gallon capacity and is a stainless steel type 316 cylindrical vertical tank, with flanged and dished heads. Its internal equipment includes a dewater filter assembly, a spray nozzle, a top entering motor-driven agitator, and a ring sparger. Accessory equipment includes a filter, water trap and pressure switch assembly, an ultrasonic level sensor, a radiation detector, a high liquid level sensor and an external heater with controls. The motor-driven agitator, in conjunction with the action of the recirculation pump, homogenizes and recirculates the tank contents to provide a uniform mixture for sampling, treatment and disposition. The tank's external heater is used to adjust temperature if necessary to prevent crystallization of high percentage boric acid concentrations, although the presence of adjusting chemical additives will minimize that possibility. The high liquid level sensor is used to detect a tank overfill condition. An ultrasonic level detector monitors tank liquid level, and a radiation detector records radiation level at a set distance from the tank. Piping is arranged

Waste Blending Tank (cont'd)

so that no opportunity is afforded for resin beads to collect. Pump suctions are taken through vertical internal standpipes (except for the filter suction); all other penetrations are made either through the top or the side of the tank.

Dewater Filter Assembly

One function of the WBT is to dewater ion exchange resins. The resins are first piped into the WBT in slurry form by plant pumps (not part of this system). Next, the water used to make up the slurry is returned to the plant for re-use. In the Emergency Bypass-Fill and Dewater Liner process, this dewatering may be done in a disposable liner. Aqueous radwaste, such as boric acid, may then be used to re-constitute, or re-slurry the resin beads. When done in a disposable liner, solidification chemicals are also added during the re-slurry operation. A disadvantage is that little control can be maintained on the pH of the combined resins, aqueous radwaste, solidification chemicals, and catalyst once all or part are in the end container. With the WBT, dewatering is done in the tank itself, and during addition of aqueous radwaste, the solids contents (percent of resin beads in aqueous radwaste) can be controlled and the pH adjusted if required. The dewater filter is an array of stainless steel wire coils. The outside surface of the wire is flat. The spacing between the narrowest openings in the coil is 25 microns. This configuration allows clogging that occurs when a particle becomes tightly wedged between the filtering gaps to be easily unclogged by backflushing. This type filter has been used in many applications and is well known in the power generation industry. The Dewater Filter Assembly consists of a manifold with an array of fourteen filters as shown in Figure III-1.

Ultrasonic Level Probe

The Ultrasonic Level Probe is a reliable non-contact method for measuring the level of the Waste Blending Tank contents. The Level Probe Assembly consists of a corrosion resistant sensor and solid state electronics. The electronics send a series of high powered pulses to the sensor which are transformed to acoustical pulses. The echos received from the target material are amplified and detected. The electronics produce a DC voltage and current output proportional to the distance to the material.

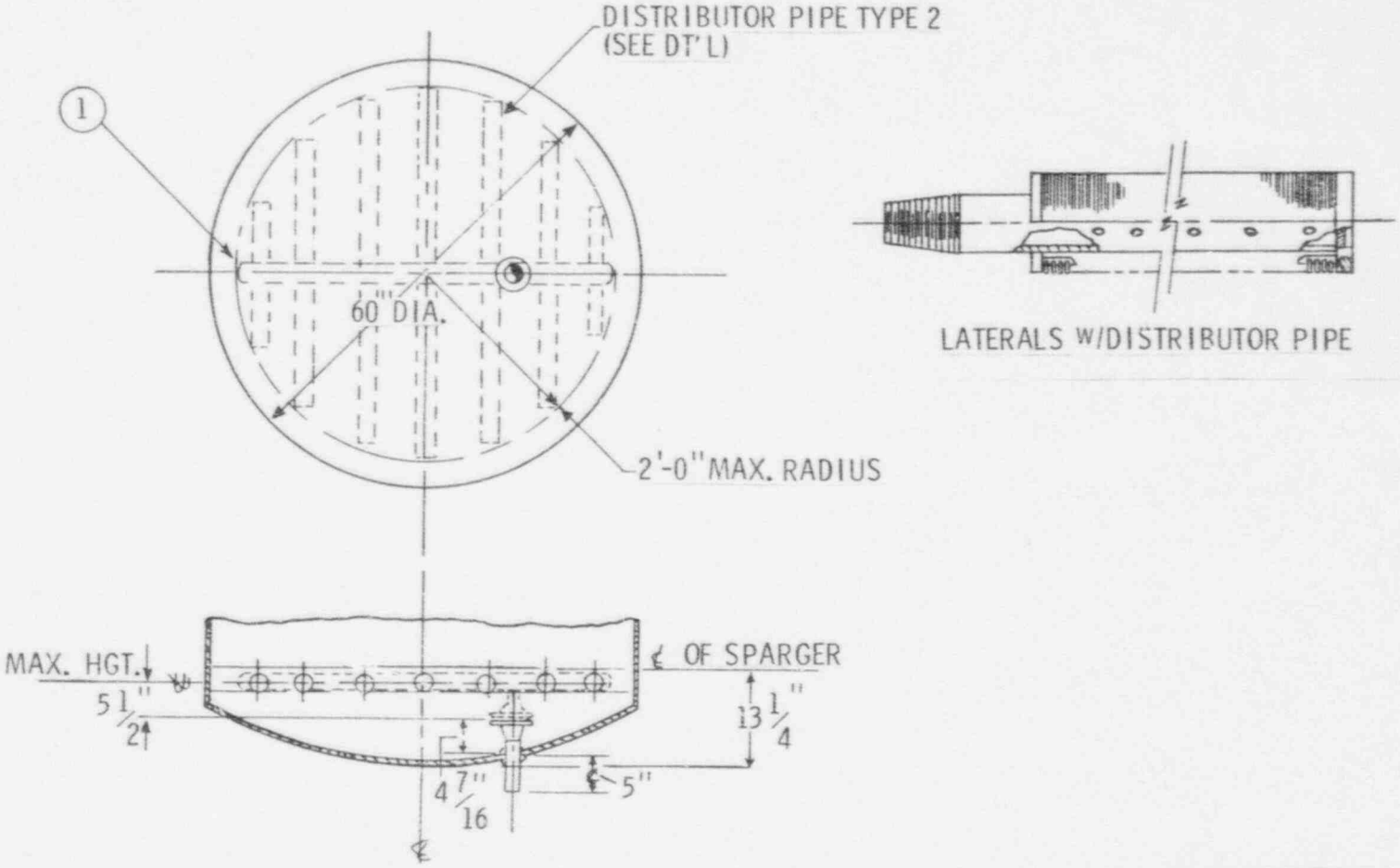

FIGURE III-1. DEWATER FILTER ASSEMBLY

High Level Probe

The High Level Probe is a Fluid Components Model 8-66 heat actuated liquid level controller which shuts the system off if the level of the Waste Blending Tank contents exceeds 100% set point. The probe will detect the presence or absence of any liquid regardless of type, viscosity, density, temperature, pressure or other characteristic. All parts of the probe which are exposed to the contents of the Waste Blending Tank are stainless steel. The electronic circuitry is completely solid state.

Radiation Monitor System

A General Atomic Radiation Monitoring System monitors the Waste Blending Tank room. This system consists of a Model RD-1 Monitor mounted in the WBT room and a Model RP-1A Readout Module on the Control Panel. The system has adjustable setpoints so that the system annunciators may be activated when the radiation level exceeds the setpoint value.

Spray Nozzle

This assembly is located near the top center of the WBT. The sprinkler is used to (a) wash down the internal surfaces of the WBT and (b) to add water to the WBT if required to dilute the tank contents. Washdown is part of a periodic routine to clean any residue from tank internals.

Heater and Controls

The Waste Blending Tank and associated piping that might carry boric acid must be heated. Boric acid crystallizes at approximately 97°F for an 8% solution and 160°F for a 16% solution. The heater is automatically activated by system logic during the WBT Fill operations (either Liquid or Resin) and whenever there is radwaste remaining in the WBT.

Filter and Vent Assembly

During the filling of a disposable container, the air displaced by the entering liquids and the air introduced into the container for mixing, are vented to the plant ventilation system via this assembly. The Filter and Vent Assembly is composed of a filter assembly and vapor trap, which are piped in series with the plant's vent line to remove any air-borne particulate matter or liquid which could be

Filter and Vent Assembly (cont'd)

exhausted into the vent system during radwaste processing. The filter assembly contains a filter element(s) capable of removing particles larger than 5 microns. The vapor trap contains a float which closes the vent line when a given quantity of liquid is accumulated in the trap. When the float closes off the vent line, a pressure sensing switch in the Filter and Vent Assembly is activated causing the system to perform an ABNORMAL STOP. The annunciator panel light marked DISPOSABLE CONTAINER OVERPRESSURE will be illuminated on the control panel and an alarm horn will be sounded. This type of vent line malfunction results in an immediate shutdown of the radwaste processing system. Periodic maintenance of the Filter and Vent Assembly should eliminate the frequent occurrence of this malfunction.

The exact same Filter and Vent Assembly is also provided for the plant vent line piped to the Waste Blending Tank (WBT). The assembly serves the same function in the WBT vent line and will also result in a system ABNORMAL STOP and control panel annunciation.

Flow Detector

The Waste Blending Tank inlet line is equipped with a Fluid Components Model 12-64 thermally activated flow switch. This is an interlock device to prevent the inlet pump from being operated if no flow is present due to clogging, air entry or any other abnormal condition.

Mixer Arrangement

The Waste Blending Tank Mixer Assembly is shown in Figure III-2. The heavy duty top entering mixer motor is rated 5 hp, 60 hertz, 3 phase electrical service. All mixer wetted parts are of type 316 stainless steel construction.

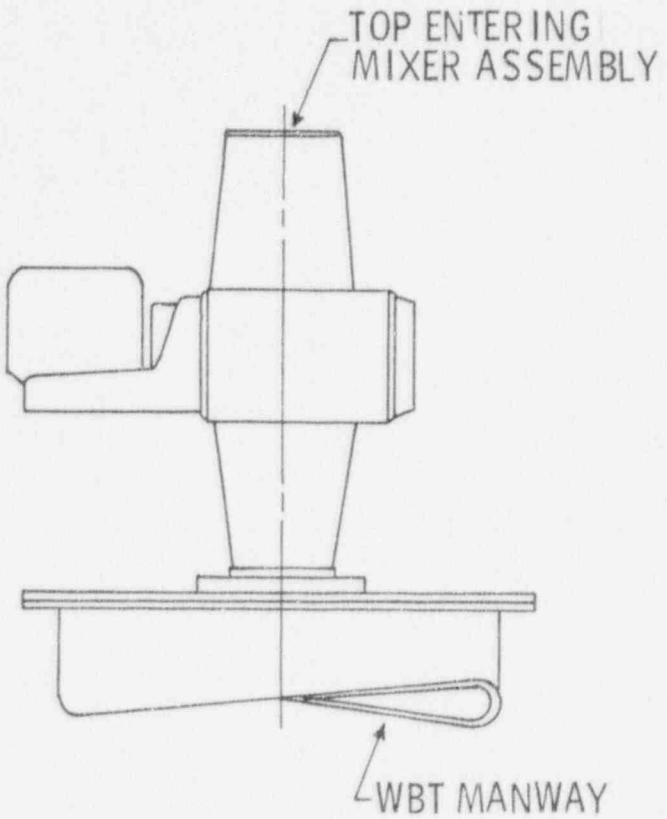

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FIGURE III-2. MIXER MOTOR

Chemical Addition System

The two component system requires the use of two pH adjustment chemicals; 10% H_2SO_4 to lower the pH and 40% NaOH to raise the pH of the Waste Blending Tank contents.

The tanks have a capacity of 150 gallons and are self-supporting. The tanks are constructed from 316 stainless steel to provide optimum corrosion resistance. Adding the chemicals to the tanks is done manually by pouring the chemical into an equal amount of water already in the tank. A sturdy platform should be permanently installed at the tanks so the chemicals can be added with maximum safety.

Each of the chemicals is pumped into the Waste Blending Tank via its own metering type pump and chemical addition line. The chemical addition pumps are Moyno progressing cavity type pumps with all wetted metal surfaces constructed of stainless steel type 316. The stator of the H_2SO_4 pump is manufactured from Hypolon and the stator of the NaOH pump from Epdm. Each pump is rated 1/2 hp, 1425 rpm for 190-380 volts, 60 hertz, 3 phase electrical service. The pumps add chemicals to the WBT at a rate of 3 gpm.

WBT Recirculation Module

The Waste Blending Tank Recirculation/Sample System serves three functions:

(a) To recirculate the contents of the Waste Blending Tank so that a representative sample of the contents may be obtained.

(b) To monitor the pH of the Waste Blending Tank contents as they recirculate to identify the chemicals required for pH adjustment.

(c) To provide a sample from the Waste Blending Tank contents so that it can be analyzed and solidified.

All metal wetted surfaces of the valves and piping are constructed of stainless steel type 316 and are capable of handling the Waste Blending Tank contents with minimum corrosion effects. All valves except maintenance valves are either automatically controllable or controllable through a shielding wall.

WBT Recirculation Module (cont'd)

Figure III-3 shows a diagram of the components of the loop. All valves are "Tufline" except the check valves which are "Powell" type. The valve actuator is a Raymond Control System type.

The next illustration, Figure III-4 shows the physical arrangement of the sampling loop; this arrangement is not obvious from the system schematic. Note that a loop exists that will hold, by gravity, the loop contents when the pump stops. As will be shown later, the lower valve on the loop (sample valve) and the upper (vent) valve in the loop, when opened, will allow the loop contents to be drained. This arrangement limits the sample quantity to a definite amount. When the volume of this part of the loop is known, a sample container can be designed to contain this amount without the possibility of an overflow occurring. Recommended piping bends in the loop are 5 diameter bends, minimum.

The next illustration, Figure III-5, shows the loop valves in a status that permits normal recirculation of the Waste Blending Tank contents. Dark-shaded valve ports indicate ports that are blocked.

Figure III-6 shows the valve conditions set for recirculation in the sample loop. This condition must be maintained for sufficient time to assure that the contents of the sample loop are representative of the tank contents.

Figure III-7 shows the loop in a condition to be drained. Note that the Waste Blending Tank recirculation path has also been re-established, although it is not necessary to maintain pump operation unless a recirculation phase is desired.

After sampling, a flush cycle is required to clear the sample loop. The conditions for performing this function are shown in Figure III-8. Resin beads have a tendency to adhere to piping walls even if piping is run in a vertical manner. In addition, resin plugging can occur if sufficient velocity is not maintained. Both phenomena may be observed in the sampling loop, so flushing is mandatory. The quantity of resin beads remaining in the loop after sampling may be insignificant when compared to the total quantity of resin beads in the sample. Nevertheless, flushing is still required to aid in clean-up of the sample loop and recirculation system prior to the next sample.

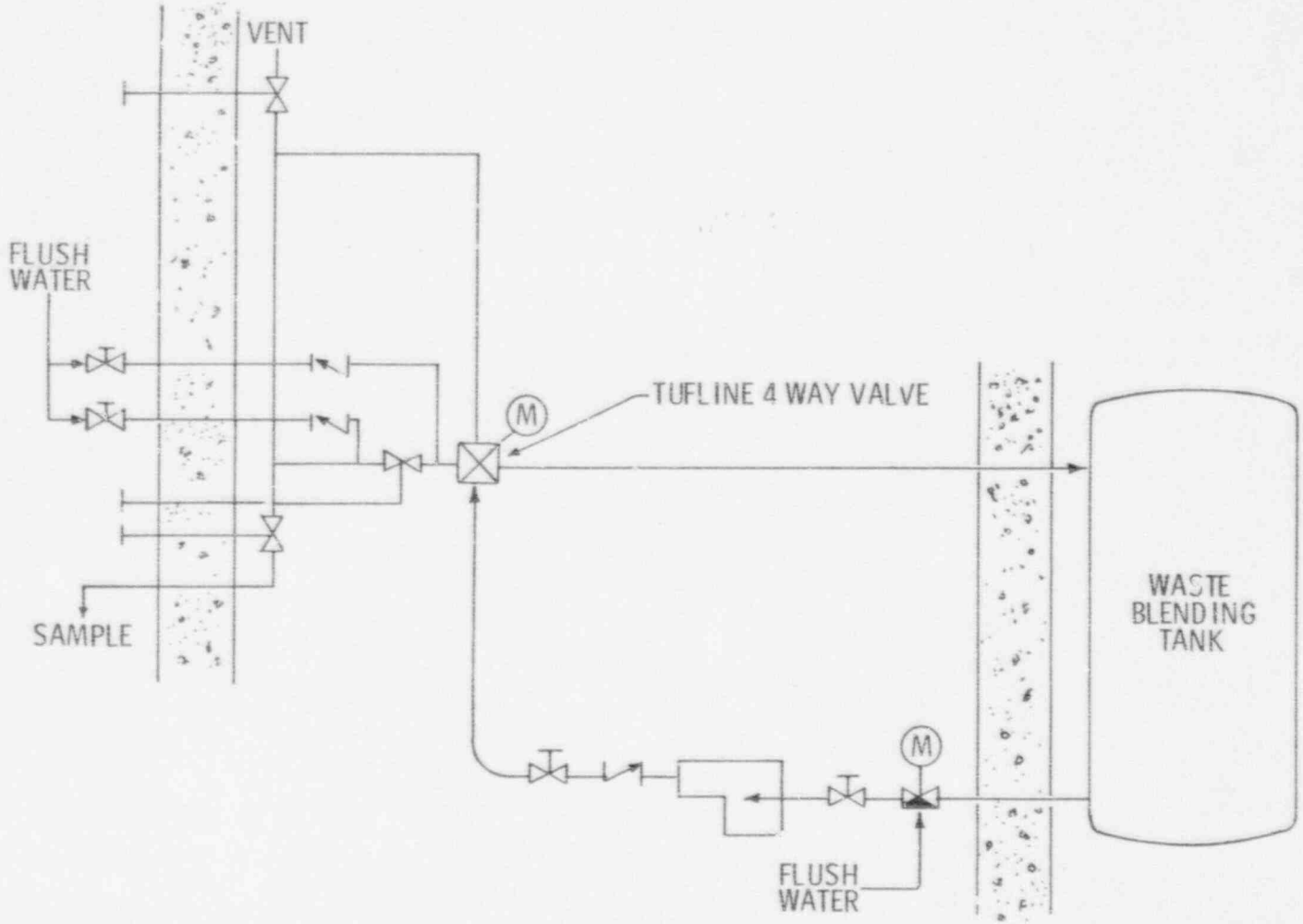


FIGURE III-3. WASTE BLENDING TANK RECIRCULATION/SAMPLE LOOP

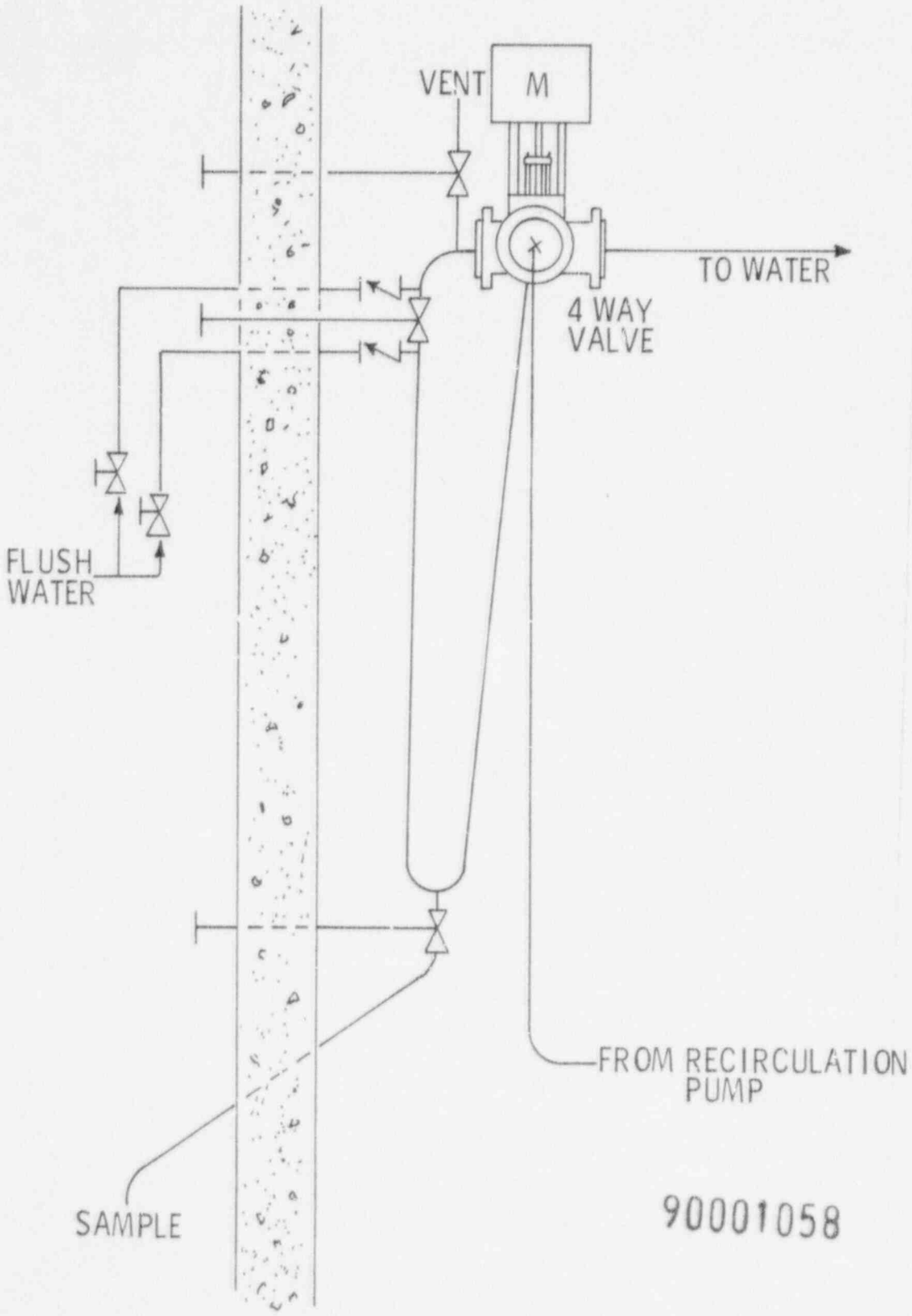


FIGURE III-4. RECIRICULATION/SAMPLE LOOP, PHYSICAL ARRANGEMENT

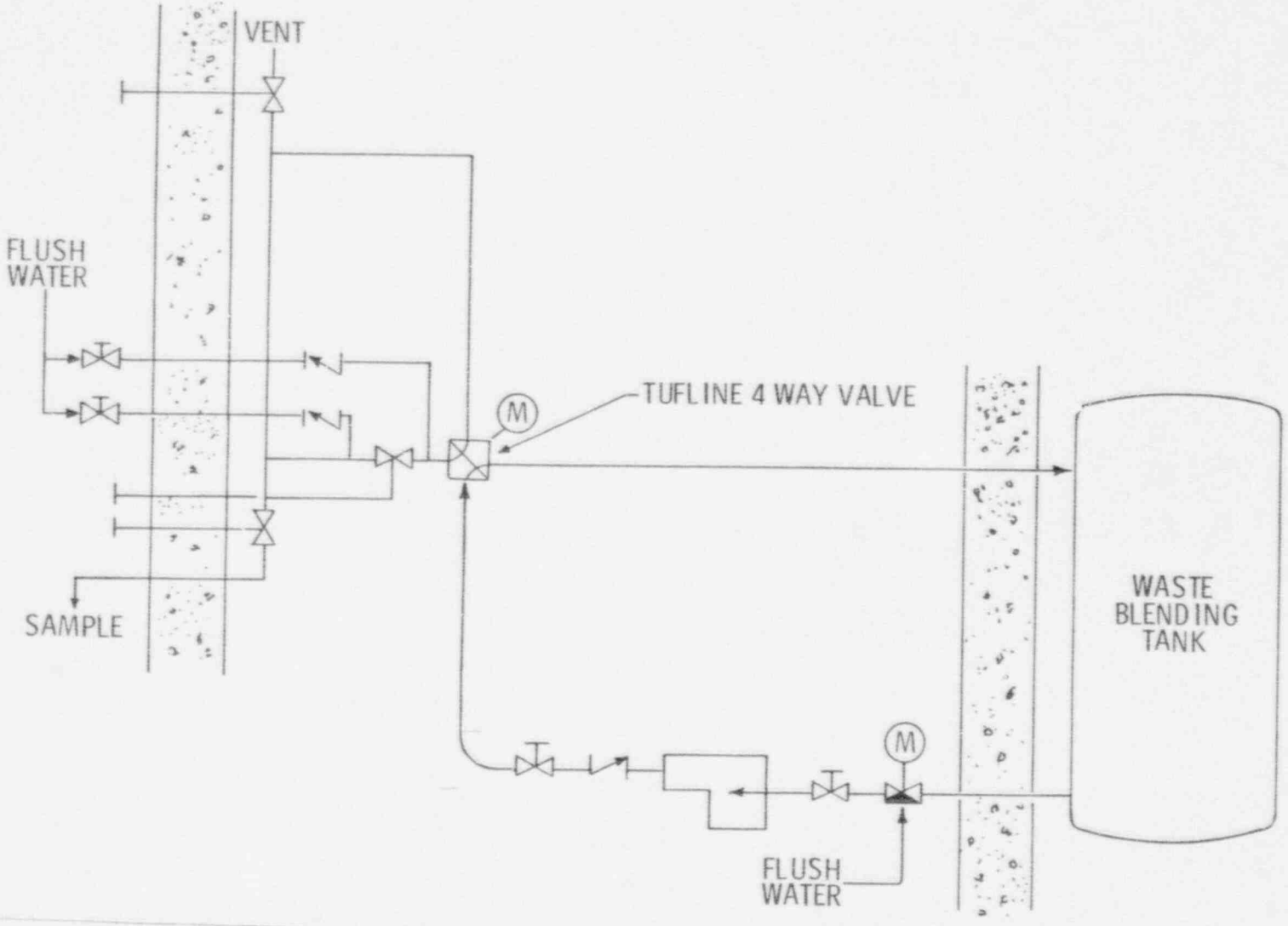


FIGURE III-5. RECIRCULATION/SAMPLE LOOP IN RECIRCULATION - ONLY MODE

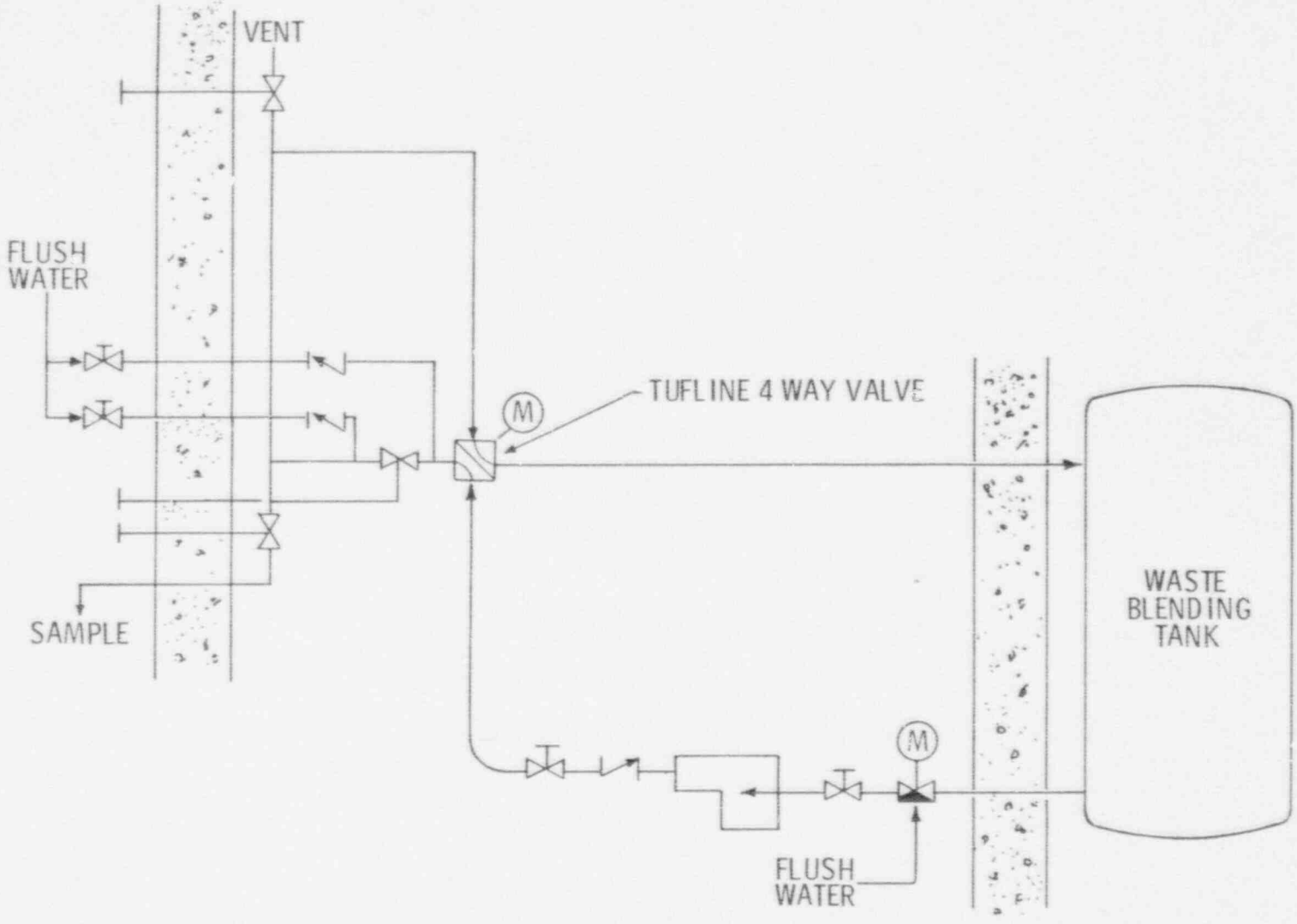


FIGURE III-6. RECIRCULATION/SAMPLE LOOP, CHARGING THE SAMPLE LOOP

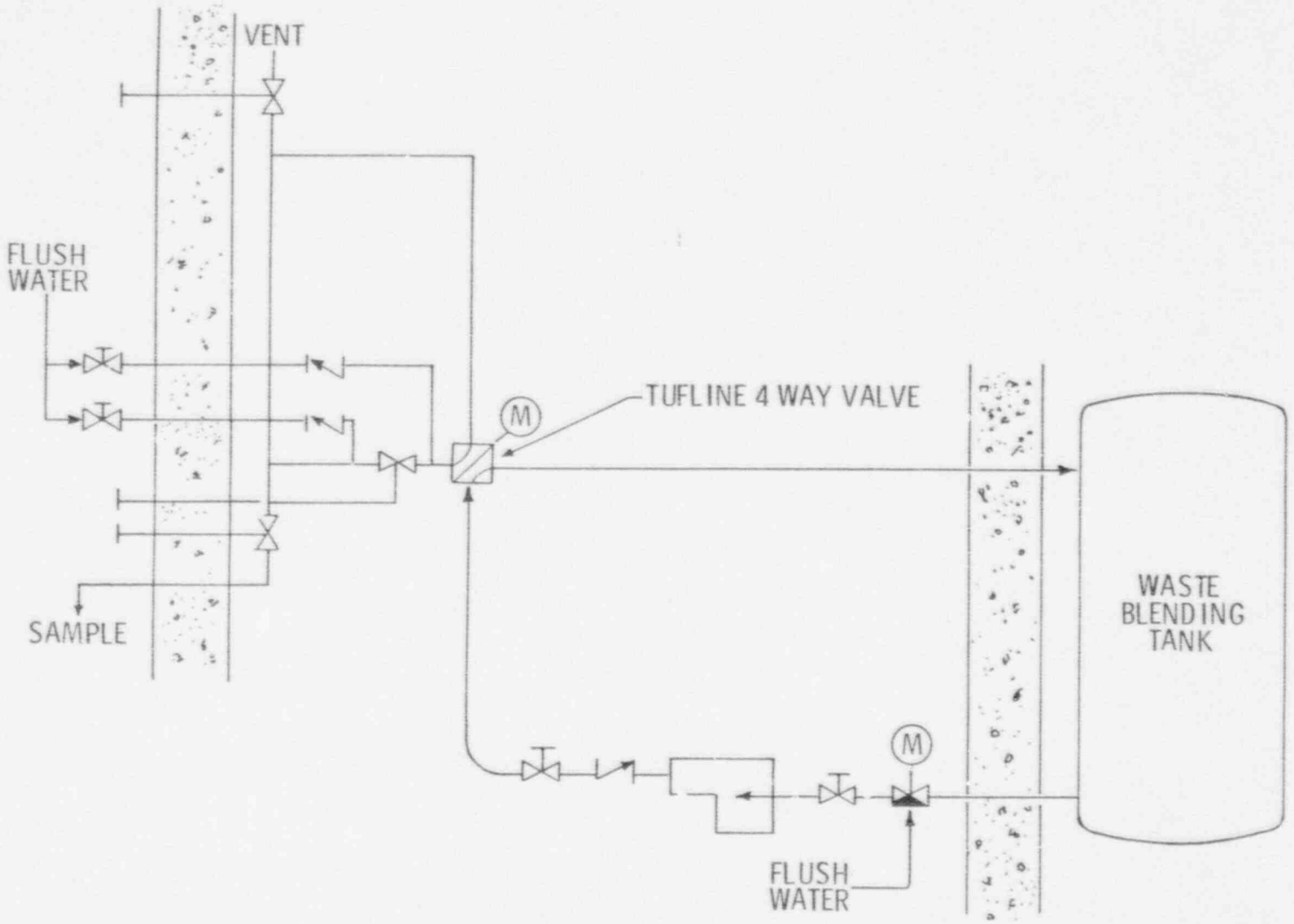


FIGURE III-7. RECIRCULATION/SAMPLE LOOP, CONDITION DURING SAMPLING

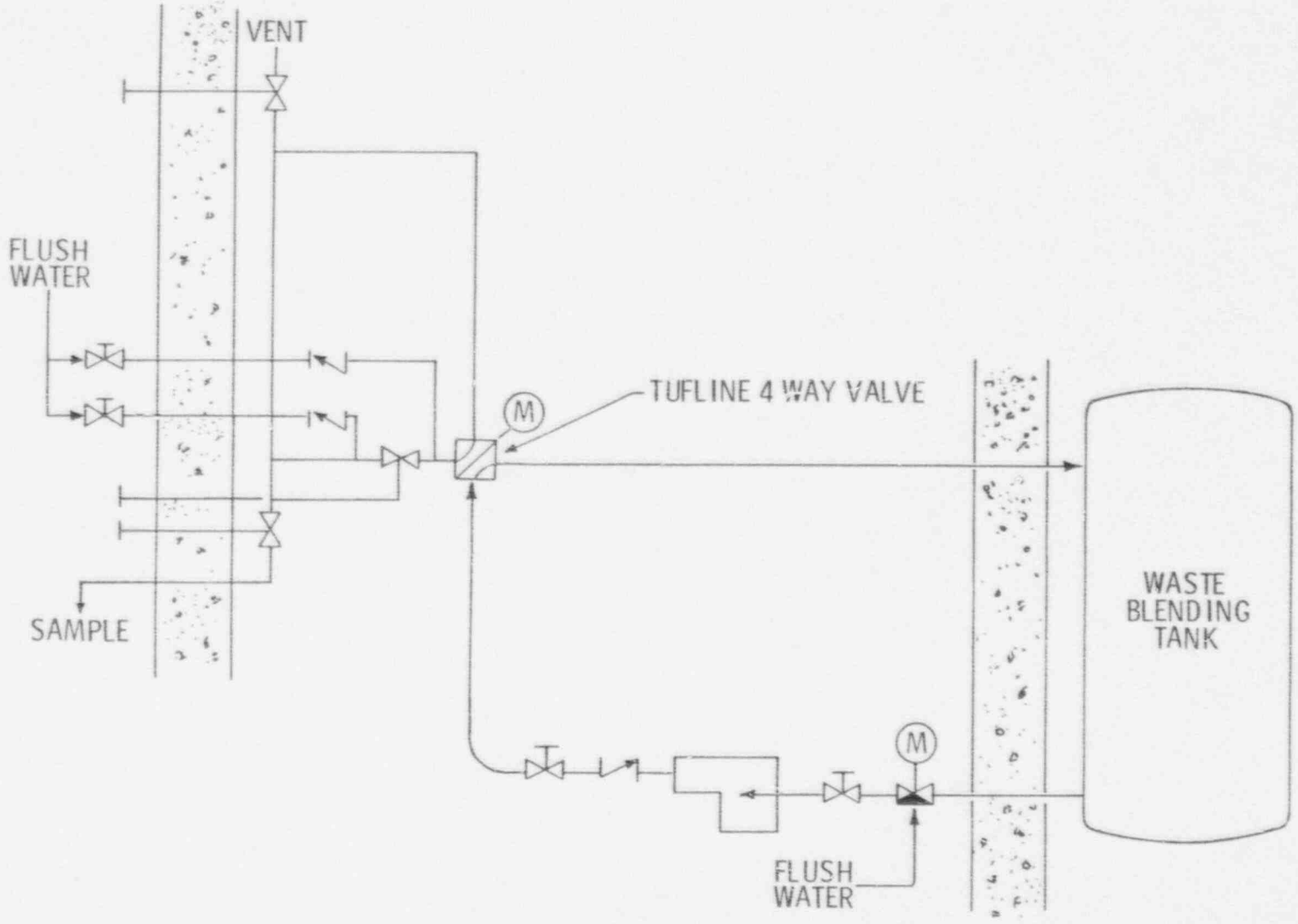


FIGURE III-8. RECIRCULATION/SAMPLE LOOP, FLUSHING THE SAMPLE LOOP

Recirculation Pump

The Recirculation Pump is a Moyno 1L6 progressive cavity type pump with all wetted metal surfaces constructed of 316 stainless steel. The pump is rated 2 hp, 60 hertz, 3 phase electrical service. The contents of the WBT are recirculated at a rate of ~15 gpm. The motor is coupled to the pump through a V-belt and pulley combination to achieve the pump output that is required for recirculation.

pH Monitor

The pH of the WBT contents is constantly monitored during the recirculation process by a Beckman Model 960-A pH Monitor. The monitor features a dual high/low relay contact closure for hook-up to annunciators. The pH monitor is interlocked so that the Fill Liner process will not proceed until the pH is adjusted to within acceptable limits of >5 and <7.

Process Module

The Process Module as shown in Figure III-9 consists of the required pumps, valves and instrumentation necessary for transporting, controlling and ultimate processing of liquid radwaste and solidification chemicals. The pumps, valves and instrumentation are mounted on a common base for convenience. All pumps (radwaste, dewatering, UFC and catalyst) are of the positive displacement type and are driven by electric motors. The catalyst, UFC and dewater pumps are Moyno types 2L3. These pumps are capable of pumping at a maximum rate of 10 gpm. The radwaste pump is a Moyno type 1L6 and pumps at a rate of 15 gpm. The type and model of each pump and motor is given in the Moyno pump data, Roper pump data, and GE motor data in the appendix. The UFC and catalyst pump are driven by variable speed direct current motors. The radwaste and dewater pumps are driven by constant speed AC motors. A three position electrically operated valve is mounted at the radwaste pump inlet to control the flow of radwaste and flush water through the system. Flow sensor and pressure switches are mountedin the piping. These units transmit electrical signals to the control module to regulate the pumps and valves for each of the processes; they also perform as safety devices to stop a process in the event of an abnormal condition.

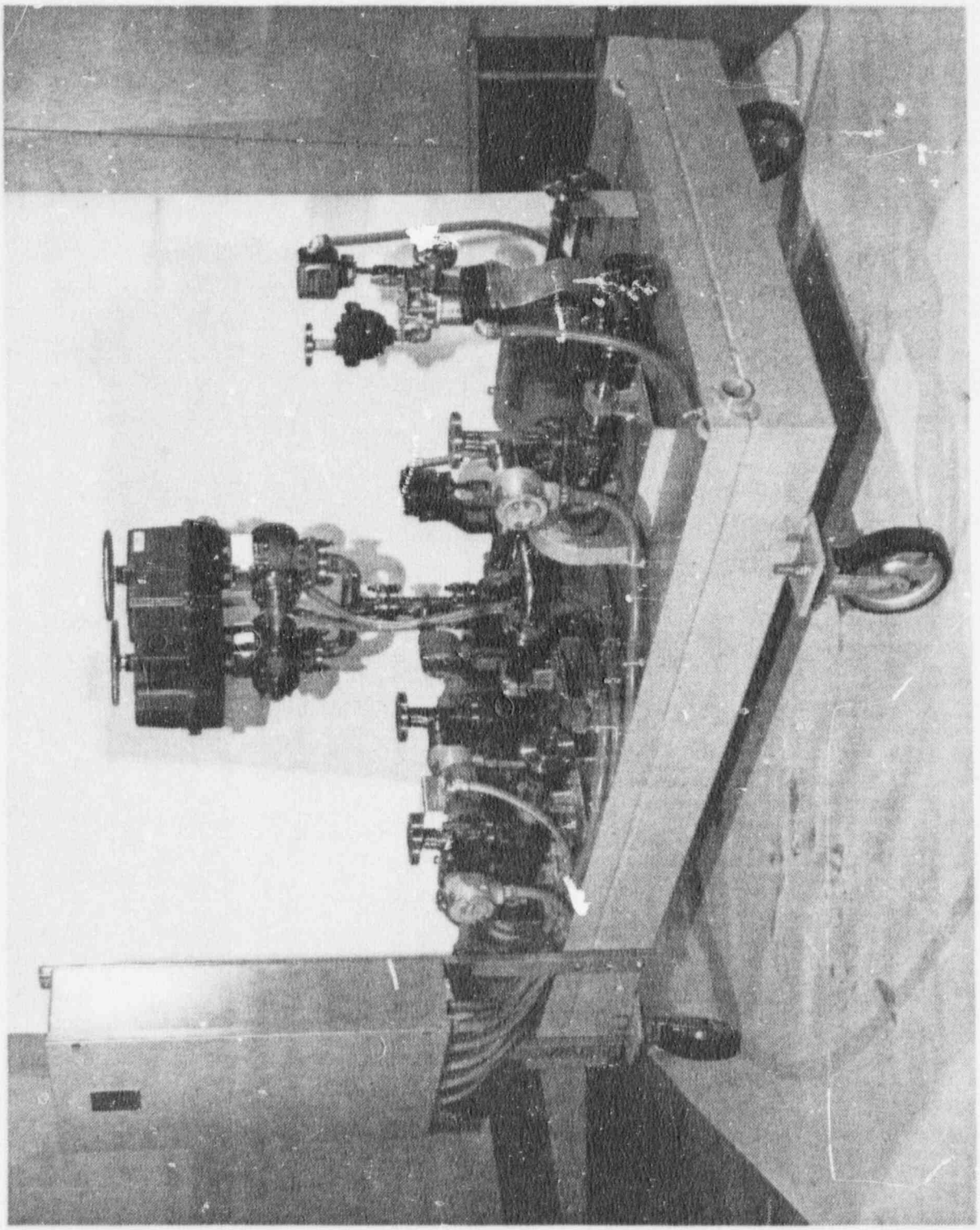


FIGURE III-9. PROCESS MODULE

Control Module

All of the automatic control logic is contained within the control module. Each solid-state module is easily inserted or removed for replacement. Figure III-10 is a photo of the control panel. The process selector and all other switches needed to select and control the processes, waste materials, etc. as well as all indicator lights required to monitor the automatic processes are located on this panel. The seven solidification and packaging processes are controlled by a selector button on the face of the panel. The seven automatic processes available to the operator are: WBT Fill-Liquid, WBT Fill & Dewater Resins, Fill & Solidify, Fill Only, Solidify Only, Emergency Bypass-Fill Liner, Emergency Bypass-Fill and Dewater Liner and Recirculation. For any of these processes, the selector button of the desired process must be depressed in conjunction with the start button. The indicator lights for each process indicate the process selected or in progress. Additional indicator lights are labeled and show the operation of the dewater pump, radwaste pump, UFC pump, catalyst pump and disposable container sparger. The lights labeled dewater flow, radwaste flow, etc. prove that there is flow through these respective systems; they "blink" when flow is expected, or pending, and glow steadily after flow is established. These flow indicators receive their signals from the flow switches on the dewater pump, radwaste pump, UFC pump, catalyst pump, WBT inlet line, and recirculation line. The operation of WBT inlet valve MOV 4 is indicated by the three-position lights "Resins Open", "Close" and "Liquid Open". These lights blink as the valves shift and remain on steady to indicate the final position. The 100% full and 90% full indicators show the level of material in the liner. The "over pressure", "overfill" and "radiation limits exceeded", "valve inoperative", "flush water or sparger air unavailable" and "no flow" lights indicate abnormal or emergency conditions. The solid state logic system consists of an array of electronic modules and their inter-connecting wiring. These modules receive information in the form of electrical signals from the process module, liner level probe, etc., assimilate and correlate this information, and produce an output in the form of another electrical signal. The various output signals are amplified and relayed to the pump and valves to control the processes and also light the indicator lights in the panel.

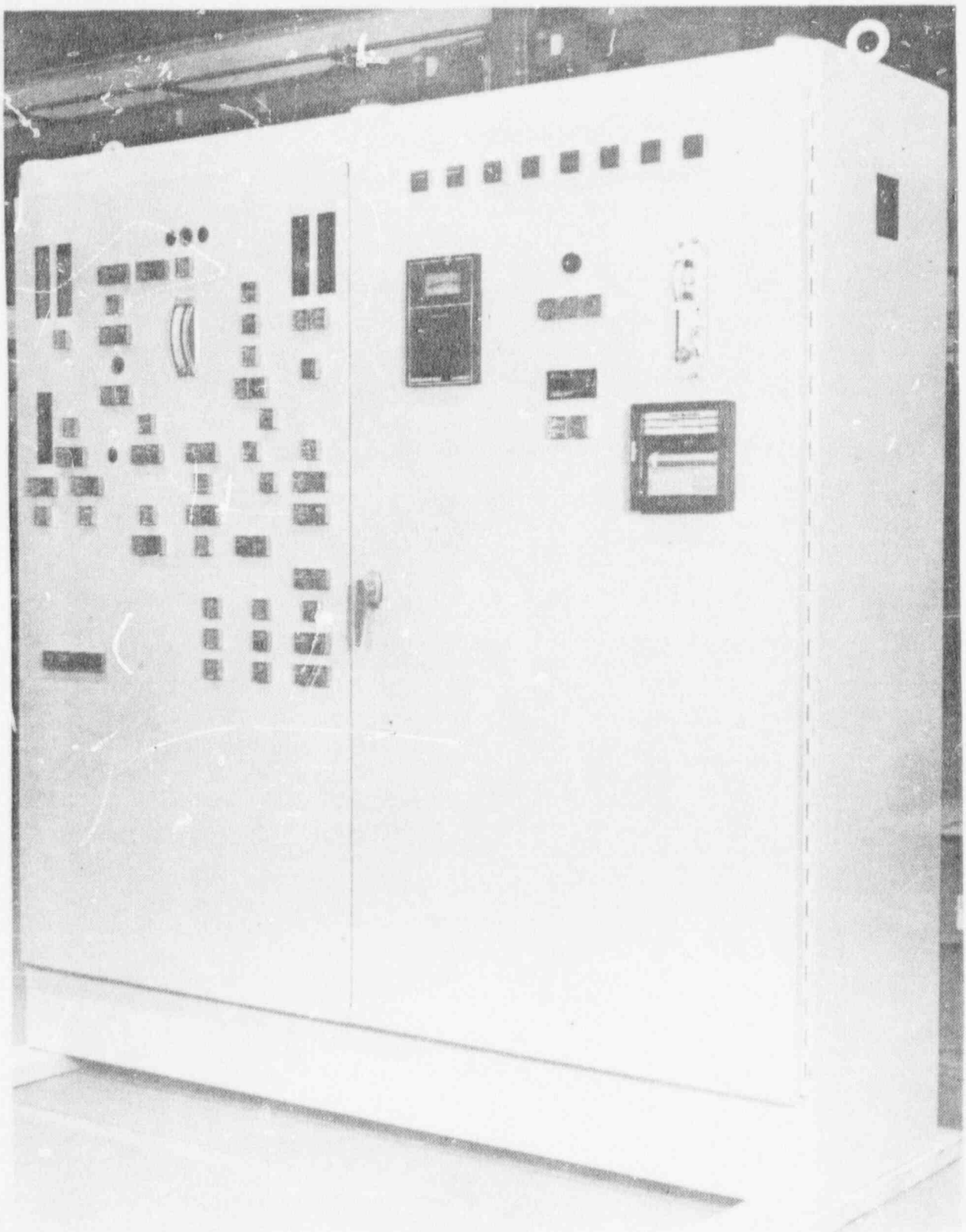


FIGURE III-10. CONTROL PANEL

Control Module (cont'd)

Thus, the actions taken by the process module are the result of the schedule of the particular process selected and the level of material in the liner.

The control logic features the following interlocks.

Process Interlock

Process selection is interlocked such that once the start button is depressed for a particular process, that process will continue until completion even if the selector switch position is changed and the start button depressed again. This precludes the possibility of mixed processes, evaporator concentrates being dewatered, etc.

Process Stop

Any process may be stopped at any time by depressing the stop button. Restart the system by depressing the reset button. If the process is stopped while the radwaste pump is operating, automatic flush will take place.

Power Failure

In the event of a power failure, the memory units will cause the system to resume the original process when power is restored (reset button and start buttons must be depressed).

Valve/System Interlocks

Both the three-way radwaste valves are interlocked so that the radwaste pump motor cannot start until either valve is fully opened.

Proof of Flow Circuit

If flow does not commence within a predetermined time after pumps start up, the system will stop and the Abnormal Stop light will come on. This will occur if flow stops during any process. (Radwaste, UFC, Catalyst or Dewater Process).

Indicator Lights

A blinking indicator light shows that the electronic control system is demanding a certain action and that action is not completed; a steady indicator light verifies complete action or a stable condition.

Indicator Lights (cont'd)

Single unit (blinking) indicator lights are provided for each of the four flow indicator switches. Blinking indicator lights are also used to prove the action of the three-way valves. Single unit indicator lights go on with each of the pump motors. Additional single unit lights are used to label the six processes. A light indicates waste liner 70% full, waste liner 100% full, or liner mixer in operations. Other lights indicate emergency conditions: "over-fill", "over-pressure", or "rad-exceed".

Radiation Level Exceed Interlock

If either "high" (cask surface) or "low" (10 ft. from source) radiation level is exceeded, the rad-exceed and abnormal stop lights BOTH come on, and the system stops. if the radwaste pump is operating when rad-exceeds, automatic flush will take place.

Overfill Interlock

If the liner is filled above the normal (100%) level, the system will stop and the overfill and abnormal stop lights will come on. No automatic flush will occur.

Over-Pressure Interlock

If an over-pressure condition occurs in the process module lines or disposable liner, the over-pressure and abnormal stop lights will BOTH come on and the system will stop; without automatic flush.

Failed Electrical Connection Lock-Out

If the electrical circuitry from the control panel to the waste liner becomes "open" (due to a poor connection at the liner level probe receptacle) or for any other reason, the system will "Abnormal Stop". An unconnected or improperly connected liner level probe plug will prevent the system from starting initially.

Dewater Low-Vacuum Cut-Off

If the vacuum at the suction side of the dewater pump drops to a pre-determined low value, the pump will shut off. This normally signifies completion of a dewatering cycle, as air is drawn through essentially dry material, but it may also be the result of a failed suction hose, leaking connections, etc.

Dewater High-Vacuum Cut-Off

If the vacuum at the dewater pump suction should become abnormally high, the pump will shut off. This condition is almost always due to a clogged dewater filter (in the disposable liner) and may result if dewatering of material containing very fine particles is attempted.

Catalyst Low Level Interlock

If catalyst level drops below the minimum level during a process, catalyst low light will come on; the process will continue to a normal completion. The system will refuse to start again until the supply tank has been replenished. The recommended minimum quantity of catalyst is approximately 50 gallons.

Audible Alarm Silence Interlock

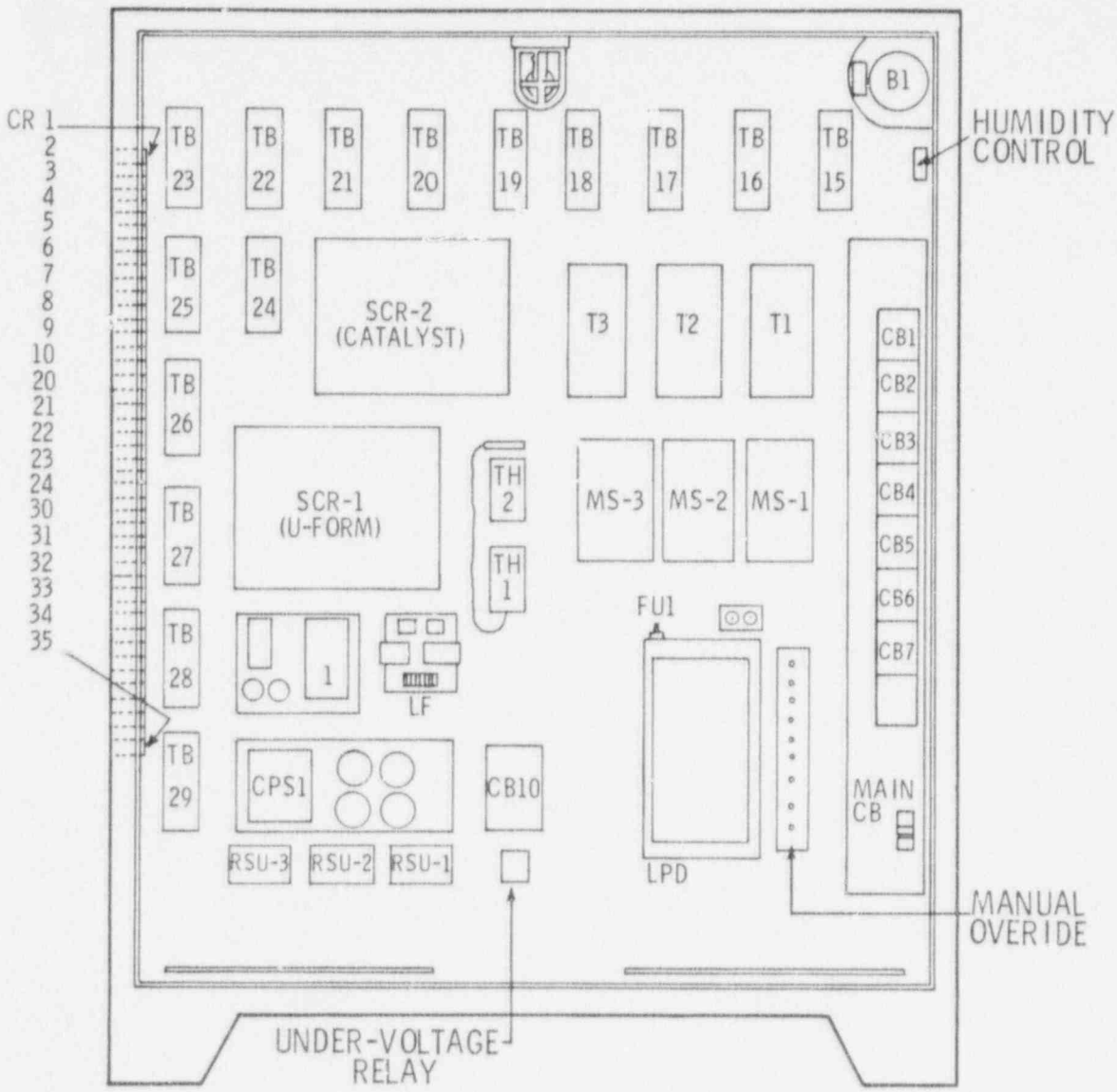
If the audible alarm has been silenced, the system cannot be restarted until the alarm silence selector switch is placed in the alarm connected position to ensure that an audible alarm will be received if an abnormal condition should occur.

Power Module

The power module contains the 3-phase power distribution panels, transformers, motor starters, SCR (variable speed direct current motor) drives, power supplies for the logic and control systems, single phase distribution panel, and relays. The arrangement and location of these devices is shown on Figure III-11. The rpm of the U-Form and catalyst pumps are adjusted by rotating the speed adjusters on the respective SCR drive unit. All pumps and both 3-way valves may be controlled manually by the hand control switches on the SCR's, motor starters, or valve control relay buttons.

Filter Transfer Cask

The Filter Transfer Cask (Figure III-12) is a lead lined container with a removable bottom for receiving and discharging spent filter elements. The interior of the transfer cask is fabricated from stainless steel to minimize contamination problems and the exterior is fabricated from carbon steel to provide durability and structural integrity. Sandwiched between the two steel shells is



(DOORS NOT SHOWN)

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FIGURE III-11. POWER MODULE COMPONENTS LOCATION

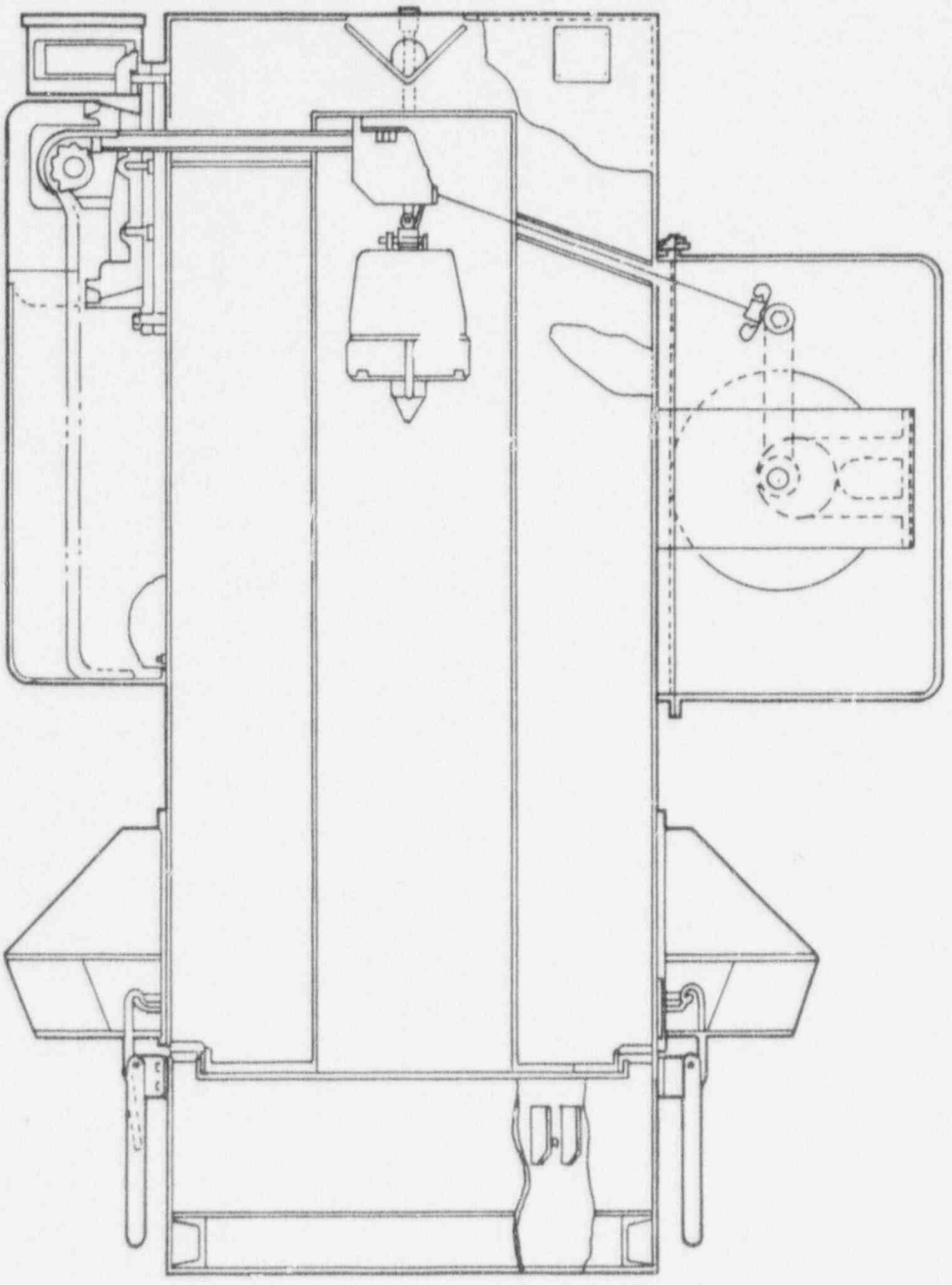

FIGURE III-12. FILTER TRANSFER CASK

Filter Transfer Cask (cont'd)

approximately 6 inches of lead to attenuate the radiation from the highest activity filter to less than .01 rem/hr. at the outer surface of the cask. The cask is designed for remote handling and operation to reduce the exposure time of an operator in the radiation field. The grapple assembly (Figure III-14) is designed to engage the filter elements and is operated by a separate pendant switch incorporated in the cask/hoist controls. The grapple is fail-safe in design to prevent a filter element from being released during a power failure or similar problem.

Disposable Liners

Most disposable liners are 50 ft^3 sheet steel tanks in which solidification takes place. An air sparger is mounted internally for reliable, efficient mixing of the radwaste and chemicals. All liners are protected on the exterior surface with a coat of industrial primer. The interior surfaces are protected from corrosion with a coal tar epoxy coating. The level of material in each liner is detected electrically using 6 electrodes secured to the vertical instrumentation probe. The liners are shown in Figure III-14 and described below.

Type I Liner

This liner is a closed tank supplied with male quick disconnect fittings for radwaste, catalyst, UFC, compressed air, and vent line attachment. This liner should be used only in conjunction with the Fill & Solidify, Fill Only, Solidify Only and Emergency Bypass-Fill Liner automatic processes.

Type II Liner

This liner is the same as the Type I liner with the additional capability to dewater resin beads. This liner may only be used in conjunction with the Emergency Bypass-Fill and Dewater Liner automatic process.

Type III Liner

This liner is provided with a removable top and a centrally suspended basket. With the top removed, this liner will receive a spent filter cartridge. The top is installed and secured in place, then the liner is filled with radwaste and solidified, entrapping the filter cartridge. This liner may only be used in conjunction

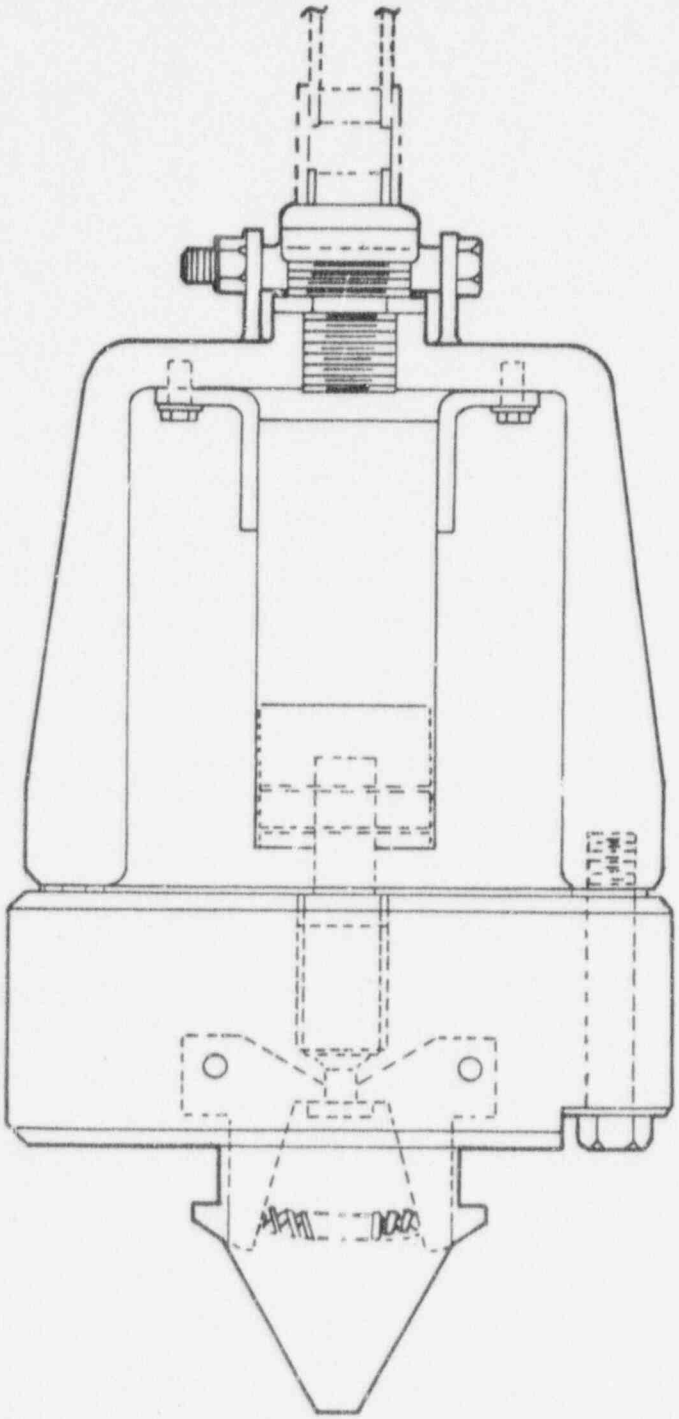

FIGURE III-13. FILTER TRANSFER CASK GRAPPLE ASSEMBLY

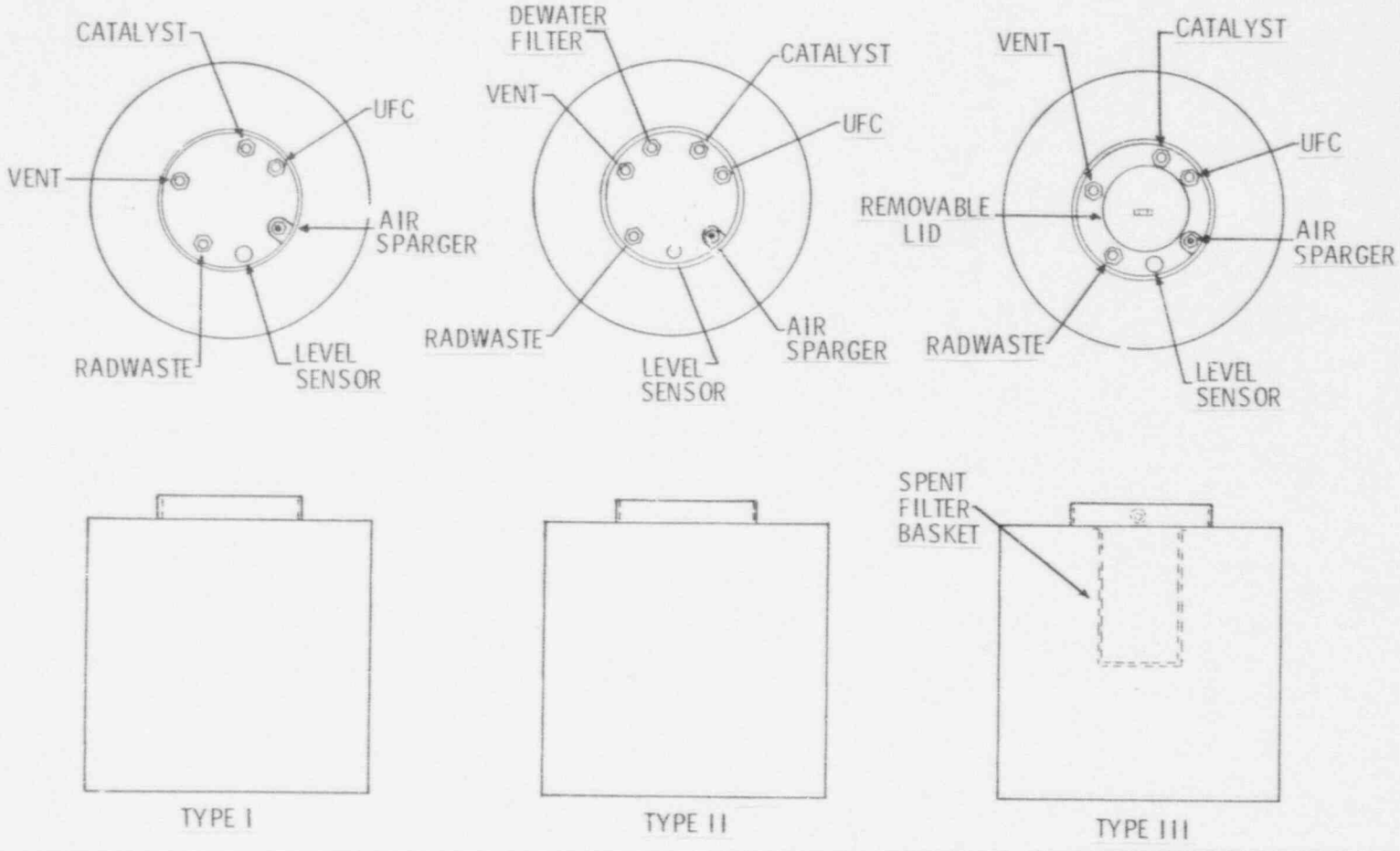

FIGURE III-14.

Type III (cont'd)

with the Fill & Solidify, Fill Only, Solidify Only and Emergency Bypass-Fill Liner automatic processes.

55 Gallon Drum

The drums are DOT 17H type 55-gallon steel drums with removable heads as shown in Figure III-15. In the appendix is a standard specification (ANSI for DOT 17H, universal drums. Each drum is provided with a lid modified to meet the requirements of the drum capper and a rigid polyethylene liner and lid for internal corrosion protection. The stacking capacity of the DOT 17H drums was tested by Monsanto Research Corporation's Mound Facility (Miamisburg, Ohio). An empty DOT 17H drum was subjected to a dead load of 4,500 pounds for 24 hours without damaging the drum. This test suggests that seven of these drums, filled with solidified radwaste, could easily be stacked in a vertical configuration without jeopardizing the integrity of the drums.

Fill and Washdown Station

The Fill and Washdown Station contains the necessary equipment and facilities for filling, securing and decontaminating a disposable container (either 55-gallon drum or 50 ft^3 liner) in preparation for shipment. The processing area requires a floor space of approximately 12' by 24' exclusive of walls. A straight, 20' set of guide rails set flush in the floor and paralleling a shielding wall moves a motor-operated rail cart through the processing area. There are four stations located along this rail. The first station is a Loading Position. The plant overhead crane is used to position an open, empty 55-gallon drum on the rail cart initially located in this area. With remote controls, located on the other side of the shielding wall, the cart containing the drum is moved to the second station, the Fill Station. At this position, a jib crane lowers the Fill Shield and Mixer Assembly to contact the top edge of the open drum. The operator then initiates the fill and solidify process or other process selected on the system control panel. When this is complete, the cart containing

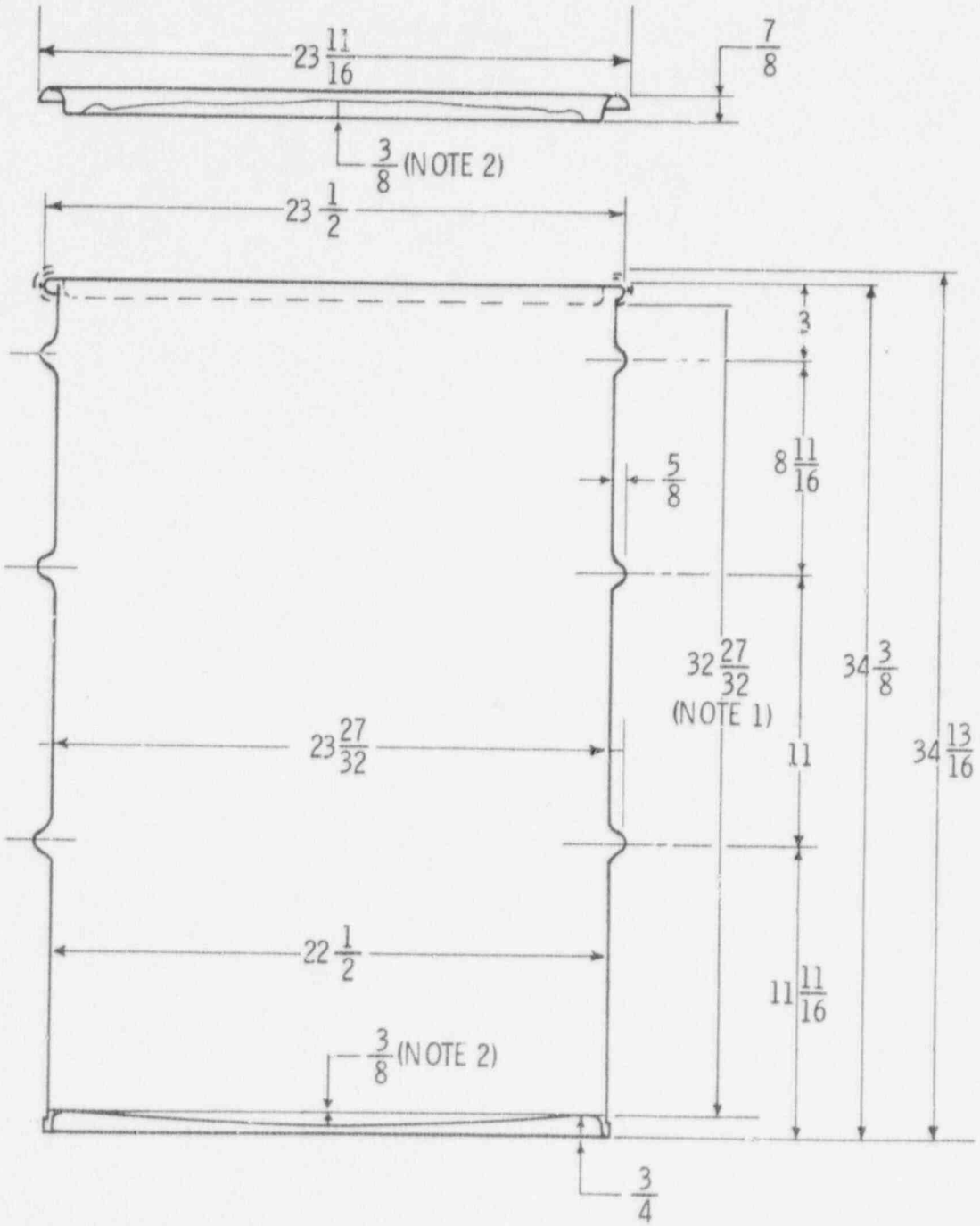

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FIGURE III-15. FIFTY-FIVE GALLON U.S. FULL REMOVABLE HEAD UNIVERSAL DRUM, DOT - 17H

Fill and Washdown Station (cont'd)

the filled, open, 55-gallon drum is moved to the Capping Station. The operator loads the drum lid on the overhead lid positioning device on the control station side of the shielding wall, and actuates a control that moves the lid to the "hot" side of the wall and positions it on the drum, tightening the circular band that secures the lid to the drum. (The standard 3 1/2" ring bolt on the band is replaced by a 7" bolt).

Transportation Shields

The 50 ft^3 liner lead shield thickness is 4 inches. The unit weighs approximately 26,400 pounds, is approximately 60 inches in diameter by 60 inches in height. Two lids are bolted onto the unit after a liner is inserted; a primary lid and a secondary lid. The former weighs approximately 1,100 pounds, the latter approximately 2,000 pounds.

A drum transportation shield is recommended for handling 55-gallon drums in the radwaste fill area and for transporting the filled drums to the drum storage area. It is recommended that the 55-gallon drum be inside a transportation shield prior to disposal and solidification of a spent filter cartridge as well as normal radwaste solidification. The transportation shield is designed to mate with the spent filter transfer cask body to enable a spent filter to be discharged into the drum while the drum is completely shielded.

The shield is maneuvered by a facility bridge crane using a sling which remains attached to the transportation shield lid. This sling can be removed from the lid and attached to the shield body for purposes of moving only the shield body. With the shield lid removed, enough area of the drum is exposed to enable conventional 55-gallon drum handling tools to be used to remove the filled drum from the shield. The inside bottom surface of the shield is sloped to enable decontamination water to be drained from the shield through a built-in drain.

IV. SYSTEM OPERATIONS

A. WASTE BLENDING TANK

1. Dewatering and Reslurrying

The dewater process provides the capability for removing transport water from a resin bead slurry and returning it to the power plant for reuse. Dewatered resin beads can then be reslurried with a controlled amount of aqueous evaporator bottoms. This concentrated radwaste mixture of resin beads and evaporator bottoms allows the plant to solidify much more efficiently and economically. The dewatering/re-slurrying sequence is an integral part of two fully automatic processes; Fill WBT-Resins, and Emergency Bypass Fill and Dewater. Logic sequences for each of these processes are appended to this section. In the former process, which is used most often, resins are dewatered in the Waste Blending Tank. In the latter case, which is seldom used, resins are dewatered in a disposable container which has been adapted with a dewater filter assembly. The dewater filter assembly is an array of stainless steel wire coils with narrow slots 25 microns in width. The design allows the filter to be easily unclogged by backflushing should particles become wedged between the filter gaps. The dewater sequence for the Waste Blending Tank consists of filling the tank to a preset level (level C in Figure IV-1) with a slurry of water and resin beads. Once the level sensor detects that level C has been reached, the dewater pump, P101, starts and continues until all of the transport water has been drawn off, leaving a layer of dewatered resin beads. The control principle is a low vacuum signal from the dewater pump pressure switch, PS103 and an appropriate level signal from the level sensor, LI1. With both signals present, the tank must have material to a certain height (C) and that material must be dewatered.

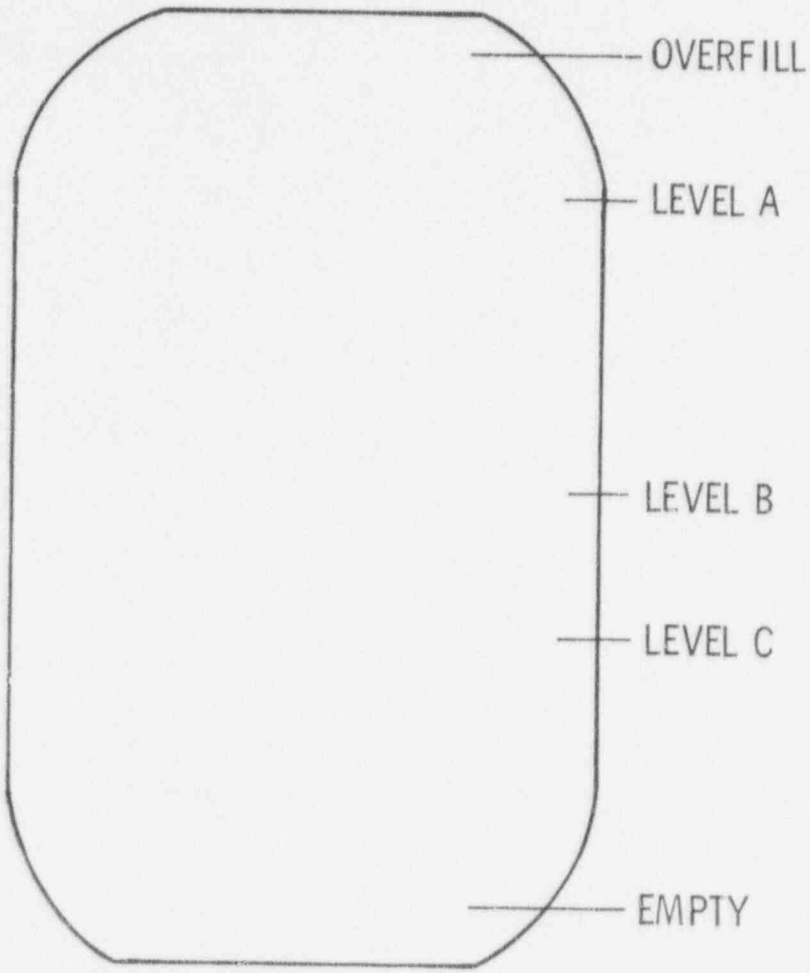


FIGURE IV-1. WASTE BLENDING TANK

1. Dewatering and Reslurrying (cont'd)

When this occurs valve MOV 4 rotates to the liquids position and the WBT is filled to level B with evaporator bottoms. Level B is calculated to replace only enough liquid to produce a pumpable slurry. The WBT sparger and mixer start and continue to mix until the tank is empty.

B. WBT FILL - RESINS

1. Operator closes manual valves V6, V7, V11, V12, V205, V206, V214, V215, V210, V212 if open and opens manual valves V3, V4, V5, V10, V201, V203, V204, V207, V208, V209, V211, V213, V216 if closed. Operator manually rotates V1 to the UFC tank/UFC pump position and V2 to the urea catalyst/urea catalyst pump position.
2. Operator selects either BDTS or LWPS resin waste for processing by pressing the corresponding button on the control panel.
3. Operator depresses the WBT Fill - Resin process "on" button.
4. WBT heater is automatically activated if the temperature of the WBT is below 120°F as detected by the temperature probe. The high level detector, level sensor and radiation monitor are on continuously.
5. Motor operated valves rotate to their normal start positions as defined below.

MOV 1 closed
MOV 2 closed
MOV 3 WBT/radwaste discharge position
MOV 4 closed
MOV 5 recirculation pump/WBT position
MOV 6 WBT/recirculation pump position
MOV 7 closed
MOV 101 closed
MOV 102 WBT/dewater pump position
HV 2473 closed
HV 2474 closed
HV 4220 closed
HV 7756 closed

6. If the operator pressed the LWPS resin waste button the process proceeds as follows:
   (a) Valve HV 4220 rotates open
   (b) Valve HV 2473 rotates open, then after an interval for backflushing, closes

   The sequence proceeds with Step 8.

7. If the operator pressed the BDTS resin waste button the process proceeds as follows:
   (a) Valve HV 7756 rotates open
   (b) Valve HV 2474 rotates open, then after an interval for backflushing, closes.

   The sequence proceeds with Step 8.

8. Operator depresses the system "start" button. Valve MOV 4 rotates to the resins position.

9. The plant resin waste discharge pump starts and continues to pump until the contents of the WBT reach a 50% level. For this to occur the following operating conditions must exist:
   (a) Flow detector FD2 senses flow
   (b) Pressure switch PS1 high pressure limit has not been reached
   (c) High level detector LT2 overfill condition has not been reached
   (d) Radiation monitor high radiation limit has not been reached
   (e) Flush water is available

   The sequence proceeds with Step 11.

10. The plant waste discharge pump does not start or starts and shuts off due to one of the abnormal conditions listed below. System alarm will sound identifying the abnormality; operator must depress "silence" button to stop alarm.
   (a) Flow detector FD2 does not sense flow
   (b) Pressure switch PS1 high pressure limit has been reached
   (c) High level detector LT2 overfill condition has been reached

10. (cont'd)

(d) Radiation monitor high radiation limit has been reached

(e) Flush water is not available

Operator must manually resolve abnormality prior to proceeding. Once the abnormality has been resolved the operator presses the RESET and CONTINUE buttons which restarts the system at the point at which it was halted.

11. If the operator initially pressed the LWPS resin waste button the process proceeds as follows:

(a) Valve HV 4220 closes

(b) Valve HV 2473 opens while the waste discharge pump continues to run

(c) After an interval pump M5 shuts off and valve HV 4220 opens

(d) After an interval HV 4220 and HV 2473 close

The sequence proceeds with Step 13.

12. If the operator initially pressed the BDTS resin waste button the process proceeds as follows:

(a) Valve HV 7756 closes

(b) Valve HV 2474 opens while the waste discharge pump is still running

(c) After an interval pump M5 shuts off and valve HV 7756 opens

(d) After an interval HV 2474 and HV 7756 close

The sequence proceeds with Step 13.

13. WBT inlet valve MOV 4 closes.

14. Valve MOV 7 opens.

15. Dewater pump P 101 starts and continues until the resin beads are dewatered as detected by the pump suction pressure switch PS5 (low vacuum). The following normal operating conditions must exist for this to occur:

(a) Flow detector FD104 senses flow

(b) Pump discharge pressure switch PS103 high pressure limit has not been reached

(c) Pump suction pressure switch PS5 high vacuum limit has not been reached

(d) Flush water is available.

15. (cont'd)

Sequence proceeds with Step 18.

16. Dewater pump P101 does not start or starts and shuts off due to one of the abnormal conditions listed below. A system alarm will sound; operator must depress the "silence" button to stop the alarm.

(a) Flow detector FD104 does not sense flow

(b) Pump discharge pressure switch PS103 high pressure limit has been reached

(c) Flush water is not available

Operator must manually resolve abnormality prior to proceeding. Once the abnormality has been resolved, the operator presses the RESET and CONTINUE buttons which restarts the system at the point at which it was halted.

17. Dewater pump P101 starts and shuts off as a result of the dewater filter clogging (pressure switch PS5 high vacuum limit reached). The following sequence is initiated:

(a) MOV 101 rotates to the dewater line flush position

(b) After a time interval, valve MOV 101 closes

(c) Dewater pump P101 starts

(d) If the dewater filter clogs again (high vaccum), steps (a) through (d) repeat once more

(e) If filter clogs again (high vacuum), dewater pump shuts off

(f) If the filter clears, the dewater pump starts and continues until pressure switch PS5 (low vacuum) indicates the dewater process is complete.

18. Valve MOV 101 rotates to the dewater line flush position, then after an interval for backflushing MOV 7 closes. The dewater pump starts, then after an interval for forward flushing, shuts off.

19. MOV 101 closes.

20. WBT inlet valve MOV 4 rotates to the liquid position and remains in that position until the WBT is "full" and the forward flush cycle is completed. For this to occur the following normal operating conditions must exist:
    (a) Flow detector FD 2 senses flow
    (b) Pressure PS1 high pressure limit has not been reached
    (c) High level detector LT2 overfill condition has not been reached
    (d) Radiation monitor high radiation limit has not been reached
    (e) Flush water is available

    The sequence proceeds with Step 22.

21. The WBT inlet valve MOV 4 remains closed or opens and closes due to any one of the abnormal conditions listed below. A system alarm identifying the abnormality will sound; operator must depress the "silence" button to stop the alarm.
    (a) Flow detector FD2 does not sense flow
    (b) Pressure switch PS1 high pressure limit has been reached
    (c) High level detector LT2 overfill condition has been reached
    (d) Radiation monitor high radiation limit has been reached
    (e) Flush water is not available

    Operator must manually resolve the abnormality prior to proceeding. Once the abnormality has been resolved the operator presses the RESET and CONTINUE buttons which restarts the system at the point at which it was halted.

22. The liquid waste discharge line is backflushed to the liquid storage tank and forward flushed to the WBT.

23. WBT inlet valve MOV 4 closes.

24. Process complete.

C. EMERGENCY BYPASS - FILL AND DEWATER LINER

1. Emergency bypass valves V 210 and V 212 are manually opened by the operator.
2. WBT valves V 211 and V 213 are manually closed by the operator.
3. The operator presses the Emergency Bypass - Fill and Dewater Liner button and the system "start" button.
4. Valve MOV 4 rotates to the resins position.
5. Disposable container instrumentation comes on.
6. The radwaste pump starts and runs until the radwaste level in the disposable liner reaches a determined level. For this to occur the following normal operating conditions must exist:
   (a) Disposable container Filter and Water Trap pressure switch PS 104 high pressure limit has not been reached
   (b) Disposable container instrumentation is on
   (c) The radiation monitor high radiation limit has not been reached
   (d) Flow detector FD 101 senses flow
   (e) Pressure switch PS 101 high pressure limit has not been reached
   (f) Flush water is available

   Sequence proceeds with Step 8.
7. The radwaste pump does not start or starts and shuts off due to one of the abnormal conditions listed below. A system alarm identifying the abnormality will sound; operator must depress the "silence" button to stop the alarm.
   (a) Disposable container Filter and Water Trap pressure switch PS 104 high pressure limit has been reached
   (b) Disposable container instrumentation is off
   (c) The radiation monitor high radiation limit has been reached
   (d) Flow detector FD 101 does not sense flow

7. (cont'd)

(e) Pressure switch PS 101 high pressure limit has been reached

(f) Flush water is not available

Operator must manually resolve abnormality prior to proceeding. Once the abnormality has been resolved the operator presses the RESET and CONTINUE buttons which restarts the system at the point at which it was halted.

8. Valve MOV 3 rotates to the backflush position.

9. Valve MOV 1 opens, then after an interval, MOV 3 rotates to the forward flush position.

10. Radwaste pump P1 starts and runs for an interval. The following normal operating conditions must exist:

(a) Flow detector FD 101 senses flow

(b) Pressure switch PS 101 high pressure limit has not been reached

Sequence proceeds with Step 12.

11. The radwaste pump starts and shuts off due to one of the abnormal conditions listed below. A system alarm identifying the abnormality will sound; operator must depress the "silence" button to stop the alarm.

(a) Flow detector FD 101 does not sense flow

(b) Pressure switch PS 101 high pressure limit has been reached

Operator must manually resolve abnormality prior to proceeding. Once the abnormality has been resolved the operator presses the RESET and CONTINUE buttons which restarts the system at the point at which it was halted.

12. Valve MOV 1 closes and MOV 3 rotates to the discharge line/radwaste pump position.

13. Valve MOV 102 rotates to the disposable container/ dewater pump position.

14. Dewater pump P 101 starts and continues until the resin beads are dewatered as detected by the pump suction pressure switch PS5 (low vacuum). The following normal operating conditions must exist for this to occur:

(a) Flow detector FD 104 senses flow

14. (cont'd)

(b) Pump discharge pressure switch PS 103 high pressure limit has not been reached

(c) Pump suction pressure switch PS5 high vacuum limit has not been reached

Sequence proceeds with Step 17.

15. Dewater pump P 101 does not start or starts and shuts off due to one of the abnormal conditions listed below. A system alarm identifying the abnormality will sound; operator must depress the "silence" button to stop the alarm.

(a) Flow detector FD 104 does not sense flow

(b) Pump discharge pressure switch PS 103 high pressure limit has been reached

(c) Pump suction pressure switch PS5 high vacuum limit has been reached

Operator must manually resolve abnormality prior to proceeding. Once the abnormality has been resolved the operator presses the RESET and CONTINUE buttons which restarts the system at the point at which it was halted.

16. Dewater pump P 101 starts and shuts off as a result of the dewater filter clogging (pressure switch PS5 high vacuum limit exceeded). The following sequence is initiated:

(a) MOV 101 rotates to the dewater line flush position and MOV 102 rotates to the dewater/disposable container position

(b) After a time interval, valve MOV 101 closes and MOV 102 rotates to the disposable container/ dewater pump position

(c) Dewater pump P5 starts

(d) If the dewater filter clogs again (high vacuum), steps (a) through (d) repeat once more

(e) If filter clogs again (high vacuum), dewater pump shuts off

16. (cont'd)

(f) If the filter clears, the dewater pump starts and continues until pressure switch PS5 low vacuum indicates the dewater process is complete

17. Valve MOV 101 rotates to the dewater line flush position.

18. Valve MOV 102 rotates to the disposable container/WBT position.

19. After an interval to allow for backflushing, MOV 102 rotates to the dewater pump/flush position.

20. The dewater pump starts and after an interval for forward flushing, shuts off.

21. MOV 101 closes

22. WBT inlet valve MOV 4 rotates to the liquid position.

23. The plant waste discharge pump starts and continues to pump until the level in the disposable container reaches a determined level. For this to occur, the following operating conditions must exist:

(a) Flow detector FD2 senses flow

(b) Pressure switch PS1 high pressure limit has not been reached

(c) High level detector LT2 overfill condition has not been reached

(d) Radiation monitor high radiation limit has not been reached

24. The plant waste discharge pump does not start or starts and shuts off due to one of the abnormal conditions listed below. A system alarm identifying the abnormality will sound; operator must depress the "silence" button to stop the alarm.

(a) Flow detector FD2 does not sense flow

(b) Pressure switch PS1 high pressure limit has been reached

(c) High level detector LT2 overfill condition has been reached

(d) Radiation monitor high radiation limit has been reached

Operator must manually resolve abnormality prior to proceeding. Once the abnormality has been resolved the

24. (cont'd)
operator presses the RESET and CONTINUE buttons which restarts the system at the point at which it was halted.

25. The liquid waste discharge line is backflushed to the liquid storage tank and forward flushed to the liner.

26. WBT inlet valve MOV 4 closes.

27. Process complete.

D. RECIRCULATION

1. Operator depresses the recirculation process "on" button.
2. WBT mixer motor MM1 starts.
3. pH detector turns on.
4. Recirculation pump P2 starts and continues to run. If flow detector FD3 does not sense flow or flush water is unavailable or mixer motor MM1 does not start, the recirculation pump will shut off and a system alarm identifying the abnormality will sound. Opertor must depress the "silence" button to stop the alarm. To continue, the operator must manually resolve the abnormality and then press the RESET and CONTINUE buttons.
5. After the recirculation pump has been running for at least 10 minutes the operator may take a sample by depressing the SAMPLE button which initiates the following sequence:
   (a) Recirculation pump P4 shuts off
   (b) Valve MOV 5 rotates to the sample position
   (c) Recirculation pump P4 starts
   (d) After an interval recirculation pump P4 stops
   (e) Valve MOV 5 rotates to the recirculation position
   (f) Recirculation pump P4 starts again and continues to run
6. The recirculation pump P4 continues to run indefinitely until the operator presses the recirculation process "STOP" button. When the operator does press the recirculation process STOP button the following sequence is initiated:
   (a) After a period of time, valve MOV 2 rotates to the flush/recirculation line position
   (b) Valve MOV 6 rotates to the recirculation forward flush position then after an interval, recirculation pump P2 shuts off
   (c) Valve MOV 6 rotates to the backflush position, then after an interval, valve MOV 2 closes

7. pH monitor and mixer motor MM1 shut off.
8. Valve MOV 6 rotates to the recirculation position.
9. Operator manually flushes the sample line if required.

E. SOLIDIFICATION COMPONENTS AND PROCESS CHEMICALS

1. Urea-formaldehyde Concentrate

Urea-formaldehyde concentrate is primarly an aqueous syrup marketed by Georgia-Pacific as "GP-5326" or by Borden Chemical Co. as "CR-4". The nominal analysis by weight is 60% formaldehyde (as CH_2O) and 25% urea. This purchased product as supplied is stable indefinitely and contains no catalytic agents to promote polymer reactions. Physically, the substance is a colorless, transparent liquid have a viscosity of about 400 $\pm$ 100 cps (ρ=1.325). Miscibility in water is infinite, and the reported closed cup flash point (Pensky-Martens) is above 150°F. Chemically, the syrup is mostly dimethylol urea and excess formaldehyde hydrates. Such compositions were found to be stable at a pH of 7 to 9, and are described in U.S. Patent 2,652,377 assigned to Allied Chemical Co. (1953).

Storage of the urea-formaldehyde syrup at room temperature is acceptable, but the substance contains a significant amount of free formaldehyde which in the vapor form is a respiratory irritant. Containment, therefore, should be below 100°F, and venting provided to a fume removal system.

In order to obtain satisfactory solidification results the urea-formaldehyde concentrate component must contain an additive substance. Normally about 3 parts are dispersed in 100 parts by weight of urea-formaldehyde syrup (GP-5326). The powder is essentially insoluble in the syrup and must be dispersed or redispersed several hours before a planned solidification operation.

A convenient means of verifying satisfactory additive content is to mix 100 ml. of urea-formaldehyde concentrate with 300 ml. of tap water at 25°C in a wide-mouth pint jar. After standing for 1 hour with intermittent

1. Urea-formaldehyde Concentrate (cont'd)

mixing, a Brookfield (Model RVT) viscosity test at 20 rpm will indicate approximately 3800-4000 cps, if the 3 parts are present. If a low viscosity is still obtained after remixing and retesting, additional additive is required for correction. It should be noted that each part of additive increases viscosity of test mix about tenfold.

2. Catalyst Mixture

The urea-formaldehyde concentrate requires both additional urea and a specific catalytic agent to undergo the solidification process that properly immobilizes radwaste materials. The catalyst mixture contains the necessary urea and ammonium sulfate catalyst to accomplish this preferred reaction. The composition is by weight: 50 parts urea, 15 parts ammonium sulfate, and 50 parts tap water. In addition, 1 part of another additive is required as a polymer modifier and leach control agent. All of the above chemicals must be of "technical grade" purity or better as supplied by manufacturers guaranteeing product analysis.

When properly prepared, the catalyst mixture is a clear solution at room temperature (60-100°F) without more than a trace of sedimentation. The specific gravity is about 1.20 or about 10 pounds per gallon. The pH is buffered by the presence of urea and should be in the range of 6.0-6.8. During reaction with the urea-formaldehyde concentrate, ammonium sulfate and formaldehyde combine to form sulfuric acid. The programmed release of this secondary catalyst is necessary for the formation of a firm solid matrix.

Preparation of practical quantities of catalyst mixture requires agitation of the components and a means of heating the system. Urea has a negative heat of solution (cooling effect) and will not dissolve completely until the mixture is reheated to room temperature. Use of hot water @165-175°F overcomes the chilling effect of the dissolving urea, so that post-heating is

2. Catalyst Mixture (cont'd)

unnecessary to accomplish rapid solution.

Contract purchase of prepared catalyst mixture in bulk avoids the problems of solids handling and batch operations. It is recommended, however, that a vendor's certificate of analysis accompany each shipment, and that a pH test and hydrometer specific gravity be performed before unloading. Mutually agreeable test methods and specifications should be pre-arranged between purchaser and vendor.

3. 10% Aqueous Sulfuric Acid

For control of excess alkalinity, either actual or latent, 10% sulfuric acid is added to the Waste Blending Tank as required. Latent alkalinity may be encountered with higher concentrations of certain ion-exchange resin beads. Such activity will not necessarily be evident by pH, but the beads will neutralize or exchange with the necessary catalytic quantities of sulfuric acid liberated normally by the interaction of catalyst mixture and urea-formaldehyde concentrate.

Sulfuric acid with "technical grade" purity is acceptable, either purchased as a concentrate or already diluted to 10 $\pm$ 0.2% sulfuric acid by weight. Use of diluted acid is based upon the following considerations:

(a) It is not anticipated that common radwaste streams will require significant acid adjustment.

(b) Higher concentrations, such as 50%, would necessitate more resistant and costly piping, valves, pumps, etc.

(c) Lower acid concentration is less hazardous for operating personnel, and affords more precise control of acid corrections under the same pumping conditions.

4. 40% Aqueous Sodium Hydroxide

Control of acidity in the Waste Blending Tank is accomplished by the addition of 40% sodium hydroxide. Overly acidic conditions may accelerate undesirably the rate of urea-formaldehyde condensation, and also result in a matrix more subject to shrinkage and less able to retain solidified liquids. Boric acid evaporator concentrates normally require adjustment with about 2% by weight of sodium hydroxide solution for satisfactory solidification. The amount of sodium hydroxide necessary for reaction control should be determined by laboratory solidification tests.

The strength of the sodium hydroxide solution should be controlled to 40 $\pm$ 0.5% with minimal carbonate and iron content. Strong solutions of sodium hydroxide readily absorb carbon dioxide from the air to form carbonates, so that unused reagent exposed for extended periods should be analyzed and then re-approved accordingly for operational use.

F. SOLIDIFICATION PRE-TEST

1. Sampling Prerequisites

It is essential that the sample taken for solidification pretest represent the contents of the Waste Blending Tank. To assure dispersion of insoluble particulates, the blending tank mixer motor must be operated. Then the material must be transferred through the recirculation sample loop by operating the appropriate valves and pump motor. Time of mixing and recirculating will have to be established based on obtaining uniform samples from "worst case" mixtures.

2. Sampling Method

The shielded sampling device is designed to remove a constant 250 ml. of volume while the Waste Blending Tank is recirculating. The sample valve in the recirculation loop is opened and the sample container filled. The sample valve is then turned off, and the sample container capped for transfer to the laboratory. The sample is to be used in its entirety during solidification testing to avoid any non-uniformity arising from segregation in the material after sampling. An initial sample would be usually mixed with 100 ml. each of catalyst mixture and urea-formaldehyde concentrate, thereby providing an approximate one-pound mass of material to evaluate solidification effects.

3. Test Procedure, Observations and Measurements

(By Remote or Shielded Operation)

(a) Drain the entire contents (250 ml.) of the sample container (Fisher No. 2-540-11 & 12, pg. 645) into the 800 ml. disposable solidification container (Fisher No. 2-593-50E, pg. 86) resting on an adjustable platform.

(b) Raise sample platform so that thermocouple, air agitator manifold, and heating probe (Fischer No. 11-463-15, pg. 480) are sufficiently immersed. Initiate air mixing, and then check operation of temperature readout and/or recorder. If foam persists, add specified anti-foam from

(b) (cont'd)
a pre-calibrated automatic pipet (Fischer No. 13-686, pg. 962).

(c) If temperature is below that anticipated for full-scale solidification, activate heating probe and control temperature using regulator (Fischer No. 11-463-45, pg. 481). If temperature is high, allow sample to cool while continuing air mixing. Turn off heater before proceeding to Step (d).

(d) Drain in the required volume* of standard catalyst mixture (100 ml. for the initial test) from a calibrated 250 ml. separatory funnel (Fischer No. 10-437-5C, pg. 372). Allow delivery to be rapid, and note temperature (on chart) at completion. Note: There should be no temperature rise or other sign of a reaction at this point.

*With experience solidifying various radwaste mixtures, the initial test volume may be more or less than 100 ml.

(e) Slowly drain in an equal volume (same as delivered in Step (d) of freshly mixed urea-formaldehyde concentrate from another calibrated separatory funnel (Fischer No. 10-437-5C). Control addition time to about 5 minutes by adjusting stopcock. Note: Slow delivery simulates the conditions for full scale solidification, and allow for nearly complete drainage from the separatory funnel.

(f) Continue air mixing until temperature exotherm is decelerating, but is at least 30°F higher than at the start of urea-formaldehyde concentrate addition. For acceptable solidification, the 30°F temperature rise should take place between 10 and 25 minutes after start of this addition.

(g) When the reactivity rate of the test sample is in the required range, lower sample platform before solidification prevents easy removal of the agitator manifold andother probes. Then allow sample to complete solidification for 1 hour after start of urea-formaldehyde concentrate addition. At this point inversion of the sample and container should result in no flow or deformation of the solid, and no significant (more than a few drops of condensate) loss of liquid material.

4. Corrective Options

(a) Sodium Hydroxide (Temperature Rise Too Fast)

(1) Reduce radwaste temperature 10°F and repeat test.

(2) Adjust pH in the Waste Blending Tank by adding 40% sodium hydroxide until pH is increased by one unit (i.e., from 4.5 to 5.5) but is not above 7.

(b) Sulfuric Acid (Temperature Rise Too Slow)

(1) Increase radwaste temperature 10°F and repeat test.

(2) Adjust pH in the Waste Blending Tank by adding 10% sulfuric acid until pH is decreased by one unit (i.e., from 6.0 to 5.0) but is not less than 3.

Note: The same corrective option may be repeated; that is, the temperature may be adjusted another 10°F in the same direction or the pH likewise changed by another unit.

(c) Change in Volume Ratio

If the solidified sample is unacceptable by the criteria in Step (g) (above), a retest is in order using increased amount of solidification chemicals. First try an increase to 125 ml. of each component added to the same 250 ml.

(c) (cont'd)
of test sample (1:1 volume ratio). If test billet is still wet or soft, retest using 155 ml. of each component to provide a volume ratio of 0.8:1.0.

G. CHEMICAL ADJUSTMENT TO WASTE BLENDING TANK

1. Reagent Addition

The system requires the use of two pH adjustment chemicals, H_2SO_4 to lower the pH and NaOH to raise the pH of the Waste Blending Tank contents. The tanks for containing these chemicals have a 150 gallon capacity, a level indicator, and are self-supporting. The tanks are constructed from stainless steel type 316. Adding the chemical to the tank is done manually by pouring the chemical full strength into an equal amount of water already in the tank. A sturdy platform should be permanently installed at the tanks so the chemicals can be added with maximum safety.

Each of the chemicals is pumped into the Waste Blending Tank via its own metering type pump and chemical addition line. The chemical addition pumps are "Moyno" progressing cavity type pumps with all wetted metal surfaces constructed of stainless steel type 316. According to the type of radwaste to be treated the operator can control the amount of reagent added to the WBT by the length of time he allows the pump to run. By adding small quantities of chemicals to the tank and monitoring the response of the pH meter the operator can bring the pH of the WBT contents into an acceptable range.

2. Sampling and Testing

A typical Waste Blending Tank sample collection sequence might be as follows:

(a) Fill Sequence

(1) Insert disposable sample liner into container cavity and replace removable cover.

(2) Elevate shielded sample container into position to engage fixed head using the lift table.

(3) Obtain Waste Blending Tank sample; flush sample line with air to dislodge remaining

(3) (cont'd)
resin beads. Close sample line.

(4) Lower shielded sample container assembly using lift table. Using the two holes in the removable cover as access points, perform desired analytical operations which may include a solidification of the contents. Solidification verification may include probing with a rod or removal of cover to view disposable sample container.

(b) Solidification Verification

(1) Control waste sample temperature.

(2) Check pH and adjust as necessary with standard reagents.

(3) Transfer required volume to insulated disposable solidification container.

(4) Insert temperature measuring and agitation device.

(5) Begin agitation and drain in pre-measured volumes of solidification components.

(6) Start timer and note mix temperature after addition is complete.

(7) Observe sample and adjust agitation as necessary to obtain good mixing.

(8) When heavy thickening is noted just prior to gelation, record the elapsed time and peak temperature, and remove agitation and temperature measuring devices.

(9) If gel time and temperature profile are acceptable, allow billet to continue hardening for at least 2 hours in the insulated container before evaluating hardness, dryness, and uniformity.

(c) Disposal

(Applicable only with use of PPD Sample Transfer Cask)

(1) Assure shielded cover is in place, then wheel table/shielded container assembly to disposal area.

(2) Remove cover, position table near sample transfer cask which is suspended from an overhead hoist.

(3) Engage transfer cask grapple assembly with center hole in disposable sample liner and lift liner, from its shielded container cavity, up inside the shielded transfer cask.

(4) Using sample transfer cask and overhead hoist for positioning, lower disposable sample liner into a 55-gallon drum for future/immediate solidification.

For each Waste Blending Tank sample, a disposable sample container is used. However, the sample collector itself is reuseable.

H. SOLIDIFICATION PROCEDURE

1. Checkout of Chemical Components

Ensure that the UFC and catalyst tanks have sufficient volume for operation. The UFC component is 100.0 parts by weight of commercially available UF concentrate to which has been added 3.0 parts powdered proprietary additive. This additive is essentially insoluble in the UFC and must be re-dispersed by agitation periodically. Mixing is required for at least one-half hour before and continuously during processing. Prior to initiating any automatic process for solidification the viscosity of the mixed UFC must be checked to verify that the additive is properly dispersed, using the viscosity test described in section E-1. The catalyst ingredients remain in solution indefinitely and do not require mixing.

2. Utilities Checkout

(a) Electrical

The Power Module is energized by switching on the main circuit breaker. Once the Power Module has been energized, any of the pumps, mixers or 3-way valves may be operated manually by their respective hand control switches; or the system may be run in the automatic mode. Verify that each valve is operated by the manual override switches in the Power Module enclosure. Switch manual override switch to OPEN and back to AUTO. Verify that the actuator coupling rotates to open and closed positions. Repeat the operation for all valves. Check the operation of the pumps by rotating the manual switch on the motor starter to the hand position only for an instant. Do not allow the pumps to run dry for more than ten seconds. To do so may damage or destroy the synthetic rubber stator.

(b) Water

With the radwaste hcse discharging into a waste container, rotate the flush and waste discharge valves to the positions specified below.

Valve	Position
MOV 3	Flush/Radwaste Pump
MOV 1	Open
MOV 101	Spray/Dewater Line
MOV 2	Sparger MOV 6

Flush water should be discharged from the system into the waste container. Similarly repeat this operation for the catalyst, UFC and dewater pumps. Solidification of radioactive materials must not be accomplished until the above procedure has been completed.

(c) Air

Verify that a constant supply of compressed air is available for the WBT and disposable container spargers. A minimum of 20 cfm at 3 psi is required for optimum mixing of solidification chemicals and radwaste in the disposable container. A minimum supply of air at a determined cfm and a determined psi is required for re-suspending dewatered resin beads in the WBT.

3. Fillhead Connection

50 ft^3 Liners

When processing radwaste in 50 ft^3 liners the procedure for connecting the fillhead assembly to the liner proceeds as follows:

(a) Remove a 50 ft^3 liner from storage and place it inside a transportation shield.

(b) Using an overhead crane, position the liner/shield assembly in the fill area.

(c) Remove the transportation shield lid and place beside the cask.

(d) Using the jib crane, position the Fill Shield Assembly over the liner.

(e) Connect the four hoses and instrumentation wiring to their corresponding connections on the liner.

(f) The liner is now prepared for filling and solidifying radwaste.

4. Radwaste Transfer

The transfer of chemically adjusted radwaste from the Waste Blending Tank to the disposable container for solidification is controlled automatically by system logic. This automatic process (Fill and Solidify) proceeds after the operator has pressed the "Fill and Solidify", "Recirculation" and "Start" buttons. The process will then only proceed if the radwaste in the Waste Blending Tank has been chemically adjusted. The solidification reaction depends upon controlling the pH of the radwaste. In order to guarantee consistent results, the sequence will stop to prevent the possibility of pumping radwaste which has not been chemically treated into a disposable container. Under normal circumstances, the operator should not attempt to bypass the automatic process by manually controlling the pumps and valves. The Fill and Solidify automatic process consists of the following steps:

(a) Fill and Solidify

(1) A disposable container, either a 55 gallon drum or a 50 cubic foot liner is moved to the fill area where the appropriate connections are made for discharging the radwaste and chemicals.

(2) The operator presses the Recirculation, and Fill and Solidify buttons. Both buttons must be pressed for the process to begin. The Fill and Solidify process proceeds with step (3) in conjunction with the Recirculation process. Operator depresses the system "start" button.

(3) If the pH is within acceptable limits the process continues with step (4). If the pH exceeds the set limits, the sequence will not proceed to the next step, although the recirculation pump will continue to run. Once the operator has properly adjusted the pH the process can be reinitiated by pressing the RESET and START buttons.

(4) UFC recirculation pump P201 starts and runs for 30 minutes only if it has not been on for 30 minutes within the last 8 hours.

(5) Disposable container instrumentation is activated.

(6) MOV 3 rotates to the flush/WBT discharge line position.

(7) Valve MOV 1 opens for an interval to clear the WBT discharge line, then closes.

(8) MOV 3 rotates to the WBT/radwaste pump position.

(9) The radwaste pump P1 starts and runs until the preset radwaste level in the disposable container is reached. For this to occur the following normal operating conditions must exist.

a. Disposable container Filter and Water Trap pressure switch PS 104 high pressure limit has not been reached

b. Disposable container instrumentation is on

c. The radiation monitors' high radiation limit have not been reached

d. Flow detector FD 101 senses flow

e. Pressure switch PS 101 high pressure limit has not been reached
f. Flush water is available
g. Sparger air is available

Sequence proceeds with Step (11)

(10) The radwaste pump does not start or starts and shuts off due to one of the abnormal conditions listed below. A system alarm identifying the abnormality will sound; operator must depress the "silence" button to stop the alarm.

a. Disposable container Filter and Water Trap pressure switch PS 104 high pressure limit has been reached.
b. Disposable container instrumentation is off
c. The radiation monitors' high radiation limits have been reached
d. Flow detector FD 101 does not sense flow
e. Pressure switch PS 101 high pressure limit has been reached
f. Flush water is unavailable
g. Sparger air is unavailable

(11) Valve MOV 3 rotates to the backflush position.

(12) Valve MOV 1 opens, then after an interval MOV 3 rotates to the forward flush position.

(13) Radwaste pump P1 starts and runs for an interval.

The following normal operating conditions must exist.

a. Flow detector FD 101 senses flow
b. Pressure switch PS 101 high pressure limit has not been reached

Sequence proceeds with Step (15).

(14) The radwaste pump starts and shuts off due to one of the abnormal conditions listed below. A system alarm identifying the abnormality will sound; operator must depress the "silence" button to stop the alarm.

a. Flow detector FD 101 does not sense flow

b. Pressure switch PS 101 high pressure limit has been reached

Operator must manually resolve abnormality prior to proceeding. Once the abnormality has been resolved, the operator presses the RESET and CONTINUE buttons which restarts the system at the point at which it was halted.

(15) Valve MOV 1 closes and MOV 3 rotates to the WBT/radwaste pump position. Disposable container sparger starts.

(b) Catalyst Mixture Addition

The addition of the catalyst to the disposable container is controlled automatically by the Fill and Solidify process. The sequence for adding the catalyst is detailed as follows:

(1) The urea/catalyst pump P 102 starts and runs until the level in the disposable container reached a determined level. The following normal operation conditions must exist:

a. Flow detector FD 102 senses flow.

b. Pressure switch PS 101 high pressure limit has not been reached

c. Disposable container sparger is on

Sequence proceeds with the addition of UFC to the disposable container.

(2) The urea/catalyst pump P 102 does not start or starts and shuts off due to one of the abnormal conditions listed below. A system alarm identifying the abnormality will sound; operator must depress the "silence" button to stop the alarm.

a. Flow detector FD 102 does not sense flow

b. Pressure switch PS 101 high pressure limit has been reached

c. Disposable container sparger is off

Operator must manually resolve the abnormality prior to proceeding. Once the abnormality has been resolved, the operator presses the RESET and CONTINUE buttons which restarts the system at the point at which it was halted.

(c) Urea Formaldehyde Concentrate Addition

The addition of the UFC to the catalyst/radwaste mixture in the disposable container is controlled automatically by the Fill and Solidify process as follows:

(1) The UFC pump P 103 starts and runs until the level in the disposable container reaches a pre-determined level. The following normal operating conditions must exist:

a. Flow detector FD 103 senses flow

b. Pressure switch PS 2 high pressure limit has not been reached

(2) The UFC pump P 103 starts and shuts off due to one of the abnormal conditions listed below. A system alarm identifying the abnormality will sound; operator must depress the "silence" button to stop the alarm.

a. Flow detector FD 103 does not sense flow

b. Pressure switch PS 2 high pressure limit has been reached

Operator must manually resolve the abnormality prior to proceeding. Once the abnormality has been resolved, the operator presses the RESET and CONTINUE buttons which restarts the system at the point at which it was halted.

(d) Disconnection of Fillhead 50 ft^3 Liners

The hoses are disconnected from the disposable liner by operating the crane which lifts and "snaps" the quick disconnects free (Fig. IV-2). Next the fill shield is removed via the crane. Lower this assembly to the floor. The four hoses can be swung out of the radiation stream from a remote position. Lift and install the lid on the shield cask and bolt in place. The entire assembly may then be lifted and transported to the shipping area via the overhead crane.

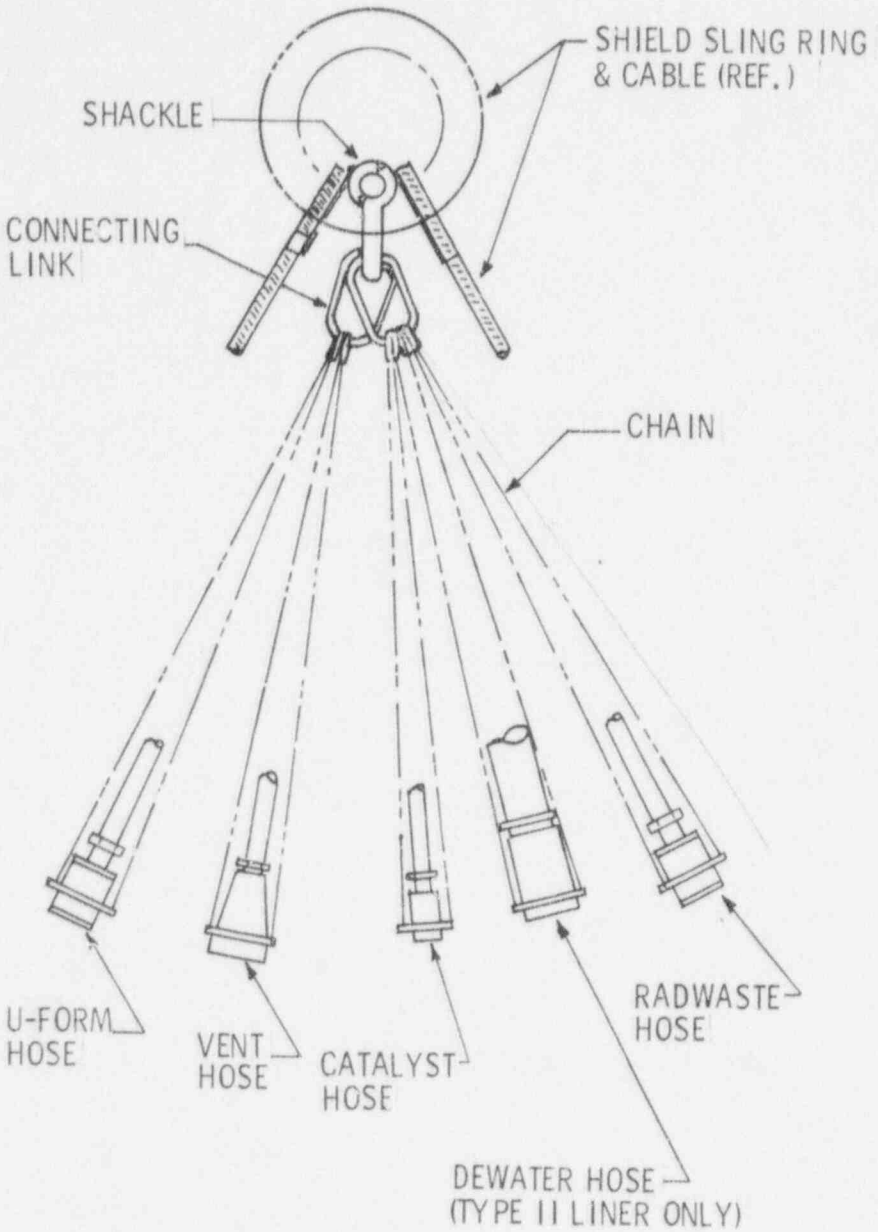


FIGURE IV-2. SUGGESTED QUICK DISCONNECT CHAIN RIGGING

I. EMERGENCY PROCEDURES

A number of safety features have been incorporated into the automatic control system so that abnormal or unsafe conditions will result in the automatic shut-down of the particular process in operation. These features have been incorporated as safegaurds that are intended to operate very infrequently and only when absolutely necessary. They are not provided for the purpose of relieving the operator of the responsibility of alert surveillance and judgment that is always mandatory when handling radioactive waste materials.

All the abnormal stop safety features will terminate the operation with an auto flush cycle except the overfill and overpressure condition, in which case the addition of flushing water could aggravate the problem. In these cases, or in the case of power failure, operation ceases abruptly; if the radwaste pump stops while pumping slurry, it may "slump" and be reluctant to start again. The pump may have to be forcibly rotated with a strap wrench or in extreme cases, disassembled or replaced. If an overpressure condition is a result of the vent filter trap or hoses clogging, these components may be cleaned or replaced and the process resumed. If the liner is overfilled, it must be removed, the cause of the failure determined and a new liner installed before the process may be re-initiated.

CAUTION: WHENEVER THE SYSTEM HAS STOPPED UNDER CONDITIONS WHICH DO NOT PERMIT AN AUTO FLUSH TO BE DONE, THE SYSTEM WILL CONTAIN RADIOACTIVE MATERIAL. THIS IS PARTICULARLY TRUE WHEN THE RADWASTE PUMP STOPS WHILE PUMPING RESIN SLURRY, AS DISCUSSED ABOVE. EXERCISE PROPER RADIOLOGICAL CONTROL PROCEDURES, IN ACCORDANCE WITH LOCAL DIRECTIVES, TO AVOID EXCESSIVE PERSONNEL EXPOSURE WHENEVER APPROACHING THE SYSTEM UNDER THESE CONDITIONS.

V. INSTALLATION INSTRUCTIONS

The U-Form Solidification System is designed as a modular package to facilitate field installation. The modules may be arranged in a variety of ways, dependent upon the space available in the power plant.

A. Physical Arrangement

1. Packaging Area

The packaging area, where the one-ton hoist, fill shield, etc. will be located, should be carefully selected to be an isolated area, yet still accessible for moving disposable containers into and out of the packaging area. Access to and from this area for both primary and alternate material handling equipment is important for smooth operation. The one-ton hoist should be securely mounted to a wall or column as specified on the drawings provided.

2. Process Module Location

The Process Module should be located as close as possible to the packaging area and preferably, slightly above the container such as a balcony. When this is not possible, the disposable container vent assembly should be removed from the Process Module and re-mounted on the wall above the one-ton hoist so that the vent hose rises continuously from the container to the vent assembly avoiding the formation of a "loop seal" which would interfere with the proper venting of the disposable container.

3. Process Module Mounting

The Process Module should be securely mounted to the floor or mounting pad, using the feet provided. Vertical mounting, such as on a wall, is possible, but will require re-orientation of several gravity sensitive components. A drain connection is provided at one corner of the module, and the feet should be shimmed to pitch the entire skid toward this corner to facilitate

3. Process Module Mounting (cont'd)

draining. The drain connection may be plugged or piped to a catch basin as desired. Due to the possibility of solidification chemicals reaching the drain, direct piping to a sewer or waste water system is not recommended.

4. Control Module Location and Mounting

The Control Module should be located in a position convenient to the operator. A clear view of the packaging area, within limits allowed by radiological control measures, is desirable, but not mandatory. The Control Module enclosure should be securely mounted to the floor, using the feet provided. The Radiation Monitor System enclosure may be mounted atop the Control Module, or placed elsewhere, convenient to the operator.

5. Power Module Location and Mounting

The Power Module may be placed adjacent to the Control Module, or in the vicinity of the Process Module, if desired. While the Power Module need not be accessible for normal operation of the system, access for maintenance or manual operation must be considered. A shielded location, similar to that provided for the control panel operator, should be provided to limit exposure to maintenance personnel. The Power Module should be securely mounted to the floor, using the feet provided.

B. Electrical Interconnection

The Power Module receives and distributes electrical power throughout the system. Standard field wiring and techniques are suitable for this system, and no special considerations are required. The electrical enclosures provided are suitable for top, bottom or side cable entry, as desired.

C. Mechanical Interconnection

When the Process Module is located in close proximity to the packaging area, the flexible hoses provided with the system may be directly connected to their respective flanges on the Process Module. When the packaging area is further from the Process Module than the length of the hoses allow, field piping should be used to reach the packaging area. All piping should be 316 stainless steel, capable of withstanding 150 psi, and of the same sizes as the lines on the Process Module from which they extend. When the distance to be piped is excessive, or when significant vertical separation is involved, then the dewatering pump pressure (vacuum) switch should be relocated from the pump suction manifold on the Process Module to the piping at the packaging area, where the dewater hose will be connected, to ensure proper operation.

VI. CHEMISTRY AND TEST PROGRAM

A. Chemical Components and Reactions

The modified "U-Form" polymerization and solidification process is substantially different from the "standard" urea-formaldehyde system which has been used for some time. These differences extend from the starting formulations, through the chemical reaction route followed, to the final dry solid formed.

The U-Form system uses two chemical mixtures added to each other in equal volumes. The UF concentrate (GP-5325) consists mainly of monomethylol urea, dimethylol urea, methylene glycol, and some polyoxymethylene glycols, with very little urea-formaldehyde polymer product. A hydrophyllic additive is also present as a suspension. This system is stable for more than a year when stored at temperatures under 90°F. Formaldehyde is present in a high ratio to urea.

In the previous UF system, all of the urea and formaldehyde were contained in one solution of urea-formaldehyde pre-polymer. This included some of the chemicals contained in the UFC plus substantial amounts of short chain urea-formaldehyde polymers. A slow continuing chain growth proceeded in this mixture even at ambient temperature, limiting the effective storage life to about three months.

The catalyst solution of the U-Form system consists mainly of an aqueous ammonium sulfate solution plus nearly half of the urea required in the polymerization. A proprietary additive which helps immobilize some metal ions is also present in a small amount. This solution is only mildly acidic (pH~6) and can be stored and handled without recourse to expensive corrosion resistant tanks, lines, and pumps. It has an indefinite storage life. The old urea-formaldehyde process used an aqueous sodium bisulfate catalyst which was mixed with the pre-polymer in approximately a 1:16 ratio. This material was strongly acidic (pH~2-3) and required expensive corrosion resistant tanks, pumps, and lines. Since it was added in such small quantities, it was also subject to error in the proper quantity being added.

The solidification reaction in the U-Form process proceeds through a self-programmed release of acid catalyst concurrent with the formation of large quantities of low molecular weight cyclic products before extensive cross-linking occurs. The hydrophylic

VI. CHEMISTRY AND TEST PROGRAM (cont'd)

additive helps to retain the water in the pores and capillary channels formed throughout the billet, especially after long storage times. The combined presence of the cyclic compounds and the extremely viscous water help minimize the continuance of cross-linking which caused the shrinkage observed in the "standard" U-F systems. This reduces any tendency to squeeze weep water out of the billet in storage. In the standard urea-formaldehyde systems, the large amounts of acid and urea-formaldehyde chains present at the start of the reaction lead directly to the formation of long chains and extensive cross-linking. These conditions also favor the destruction of any cyclic pre-polymer products which were present. Noticeable shrinkage was observed after solidification.

All of the materials used in this system are used in agricultural and food applications, which gives a good indication of their environmental safety. They are all readily available in commercial quantities at low bulk prices as an added attractive feature.

B. Test Program

Hundreds of laboratory solidifications have been successfully performed using the "U-Form" process on various simulated radwaste materials. These have included boric acid solutions up to 12 weight per cent, sodium sulfate solutions up to 22.9%, dewatered resin beads, mixtures of boric acid and dewatered resin beads, and a modified sample containing Radiacwash, boric acid and dirt. Other tests successfully solidified used motor oil, vacuum pump oil, and toluene.

In our pilot plant program these processes have been successfully scaled up to 50 cubic foot liners of 12% boric acid, and 55 gallon drums of 22.9% sodium sulfate, dewatered resin beads, and 12% boric acid plus resin beads, as well as the Radiacwash system mentioned above.

All of these systems except the last have been successfully formed into dry, free-standing billets using the new "U-Form" process. The Radiacwash system formed a very good dry billet except

VI. CHEMISTRY AND TEST PROGRAM (cont'd)

for a small portion of mud which was not able to be adequately stirred by the mixing system. However, the extremely high concentration of dirt used in this test far exceeds any practical situation that would normally be encountered in an operating plant.

The compositions of the various types of simulated waste streams solidified with no free water using the "U-Form" process are listed in Table VI-1.

C. Solidification Formulae

As was discussed in the Process Description section, the operating parameters must be adjusted for various radwaste streams. Fortunately, in the cases studied thus far (which include all the normal plant streams), the adjustment are rather simple and straightforward. These are described below.

1. Boric Acid Wastes (12% max.)
   pH adjusted to 6 $\pm$ 1/2 unit (with 40% NaOH solution) temperature preferably 110-120°F (max.) after catalyst addition. Chemical component ratios = 1.25-1.5 parts RW:0.5 part Catalyst solution:0.5 UFC mixture.
2. Sodium Sulfate wastes (22.9% max.)
   pH adjusted to 6 $\pm$ 1/2 unit (with 10% H_2SO_4, if necessary) temperature preferable 110-120°F (max.) after catalyst addition. Chemical component ratios = 0.8-0.9 parts RW:0.5 part Catalyst solution:0.5 part UFC mixture.
3. Resin Beads (mixed, spent, dewatered)
   pH adjusted with 10% H_2SO_4 until change of 1 unit observed. Temperature - 70°-120°F (max) after Catalyst addition. Chemical component ratios = 1.5 parts beads:0.5 parts Catalyst solution:0.5 parts UFC mixture.

These formulae will hold for all normally encountered plant situations. Abnormal situations are easily ascertained in the preliminary lab sample solidification required in the process control. Normal gel time for 300-800 cc lab samples is 8-12 minutes. Too

TABLE VI-1 SUMMARY OF RECENT TESTS USING "U-FORM" PROCESS

Simulated Radwaste	RW/Chemical Ratio	Billet Size	Amt. of Liquid After Solidification	Comments
12% Boric Acid	1.25:1	55 gal.	0	
	1.25:1	50 cu. ft.	0	
	1.35:1	50 cu. ft.	0-300 cc	*Water only found on sample w/low additive
	1.25:1-1.5:1	400 cc	0	
22.9% Sodium Sulfate	0.8:1	55 gal.	0	
	1:1	55 gal.	Mushy	
10%-11% Sodium Sulfate	0.8:1-1.25:1	400 cc	0	
20%-22.9% Sodium Sulfate	0.8:1-1.75:1	400 cc	Trace	Absorbed after 4 days
Dewatered Resin Beads 50-50 IR400-IR120	1.5:1	55 gal.	0	
	1.35:1+12% Boric Acid	55 gal.	Trace	
	1.5:1	400 cc	0	

*50 cu. ft. liner stored outdoors for 2 months after solidification. Bottom drain opened and top inspection port opened every two weeks. No free water observed at bottom drain. Small amount of condensate water found on top of cap (drops only).

VI. CHEMISTRY AND TEST PROGRAM (cont'd)

fast a gel time indicates the generation or presence of excess acid in the system. Caustic (40% NaOH) should be added to the waste blending tank to bring the mixture within specs and a new grab sample solidified.

Too slow a gel time, on the other hand, indicates insufficient acid to properly catalyze the reaction. The pH of the material in the waste blending tank should be adjusted with 10% H_2SO_4 and a new grab sample solidified in the laboratory.

Should the sample gel in the normal time range, but the resulting billet remain soft, then the chemical ratio must be adjusted toward less radwaste in the sample. The Catalyst and UFC mixtures will always be added in equal quantities regardless of other corrections.

VII. SAFETY AND RELIABILITY

A. Solidification Process

The U-Form process has been developed to yield a solidified billet of radwaste completely free of residual water, including that which is attributable to condensation effects. The process parameters have been tested with variations in solution pH, temperature, and chemical ratios to assure that the solidification will take place under expected reactor operating conditions and effluents typical of those operations. To assure the reliability and safety associated with the process, the following steps are identified:

1. All radwaste batches are adjusted to the proper pH value for successful solidification by a sampling and chemical addition process.

2. All radwaste batches are pre-tested by solidification of a nominal one pound sample taken from the radwaste blending tank or equivalent. All chemicals used in this test are drawn from the facility tanks to assure exact chemical representation in the test sample.

3. No radwaste can be processed until the test sample has been successfully solidified.

4. A topping cycle is performed after the basic radwaste billet has been formed to eliminate any condensation water. The topping cycle together with continuous venting of the liner to the plant air filtering system results in a dry billet.

5. Finally, the solidified billet can be inspected visually by opening the top inspection port and/or by removing the drain plug at the base of the liner.

The U-Form process and the procedures to be used for solidification were developed specifically to meet the requirements of technical position paper of the Effluent Treatment Systems Branch ETSB 11 - 1,3: Design Guidance for Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants.

To date, all test solidifications from 1 pound samples to 50 ft^3 liners have been successful when the proper procedures as outlined above have been followed. The Quality Assurance Program which

VII. SAFETY AND RELIABILITY

applies to the design and manufacture of PPD U-Form solidification systems, presented in Appendix A under separate cover. However, since there are variations in the operating environs and radwaste materials from plant to plant, a specific process control and operating procedure report is supplied for each specific installation.

B. Failure Mode and Effects

The types of equipment failures discussed in this section are presented in an effort to realistically evaluate their effect on the system and operating personnel and to anticipate preventive or corrective measures where possible.

1. Power Failure During Processing

Because no catalyst is mixed with UFC outside a disposable liner, no irreversible solidification in the lines can occur. However, in processing radwaste materials, power failure consequences must be considered. Boric acid radwaste is processed at an elevated temperature in order to preclude crystallization. If a sustained power failure is experienced and crystallization occurs, corrective action might be required after power is available, before processing can continue. Crystallization begins at the edges of the solution and "grows" inward toward the center as the solution cools. At room temperatures (approximately 68°F to 90°F) crystallization of the entire cross section of material in system piping would take several hours; power would likely be restored before this occurred. Additional boric acid or boric acid-containing radwaste moving through the system from the heated waste blending tank would break down the crystals. At reduced temperatures during an extended power outage, complete crystallization might occur. In that event, portable electric heaters can be used for heating the pump and valve components until a free flow is obtained.

Resins caught in the system piping, valves and pumps during a power outage will tend to gravitate out of the suspended state and settle. This condition is easily cured after restoration of power by flushing the system.

2. Pump Failure During Processing

In considering pump failure, the radwaste pump or radwaste motor pump presents the most serious consequence. With "hot"

VII. SAFETY AND RELIABILITY

radwaste in the system, approved radiological safety procedures developed by plant personnel, must be used to repair a failed pump. If the electric motor is defective, it may be repaired in place or removed and replaced. If the pump itself fails (e.g. broken shaft, ruptured seal, broken casing, etc.), more elaborate precautions and maintenance are required. If a pump is leaking but operable, it is best to manually flush the system, decontaminate the entire module, and then replace the pump. If the pump is inoperable, but can be turned by hand, the pipe plug(s) must be removed to drain the pump and flush water passed through the pump and out the drain. Module decontamination is then required followed by pump repair/placement.

3. Logic System Failure

If a failure of the logic system occurs, the system may be placed in the MANUAL mode and motors and valves operated to flush the system and shut it down. The MANUAL mode in the system is an operating mode, and does not mean that operating personnel must manually turn valves or rotate pumps.

4. Hose Connector Failure

A failure of the radwaste hose, such as a rupture, or failure of the quick-disconnect fittings on the Liner end of this hose must be considered a catastrophic failure. The manufacture of these hoses is rigidly controlled. They are of the same type fittings used for refueling ships and aircraft, i.e. of very reliable design. Nevertheless, some installations specify a closed-circuit television monitoring system although this is not a part of the standard system described in this report. The effect of a radwaste hose/fitting failure, at its worst, would be to pump radwaste in the vicinity of the Liner. Radiation sensors would alert the operator to shut down the system. Extensive decontamination effort would probably be required. For this reason, initial plant design should locate the fill area within an area that minimizes the effects of this type failure.

5. Failure to Solidify

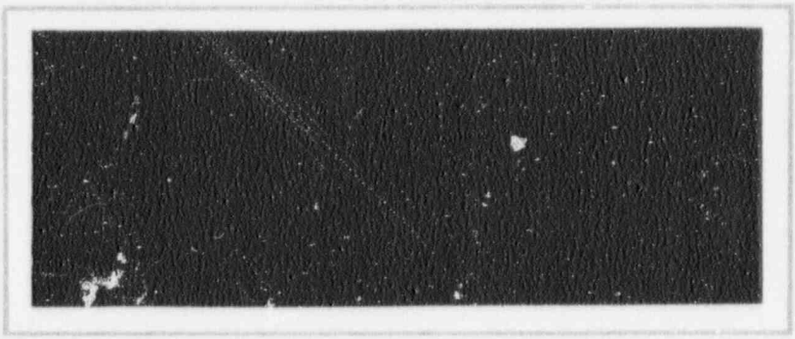
If the radwaste contents of a Disposable Liner fail to solidify due to operator using improper pH, wrong mixing ratios, etc., radiological safety control measures established by the Process Control Program (PCP) for this event must be put into effect. If the Liner

VII. SAFETY AND RELIABILITY (cont'd)

is full, it should be disconnected from the system and moved into a storage area so that radioactive decay (if practical) will lessen handling problems. After this, a catch basin can be used to drain the liner liquid contents as the pipe plug is removed from the lower edge of the liner. This liquid can then be reprocessed for subsequent solidification. If partial solidification has occurred, or if the radwaste contains solids which clog the drain hole, a suitable sump pump and hoses must be rigged through the top cover to remove the liner contents for eventual reprocessing.

6. General Reliability

To date, PPD systems have not had to operate on a continuous basis. Some of our units are installed as backup or emergency use. As a result, long term system operational reliability data is not available, except as attributed to individual pumps, valves, and components as described in the manufacturer's data found in Appendix B.



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TELEDYNE ENERGY SYSTEMS
110 W. TIMONIUM RD., TIMONIUM, MD. 21093

APPENDICES A & B FOR TOPICAL REPORT U-FORM RADWASTE SOLIDIFICATION SYSTEM, REPORT No. PPD-TR-7701

December 1979

A Product of
Protective Packaging Division of
TELEDYNE ENERGY SYSTEMS
110 West Timonium Road
Timonium, Maryland 21093

FOREWORD

These appendices supplement the Topical Report entitled U-Form Radwaste Solidification Syste, Report No. PPD-TR-7701, Revision 1, dated December, 1979.

CONTENTS

APPENDIX A

TELEDYNE ENERGY SYSTEMS
Protective Packaging Division

QUALITY ASSURANCE PLAN

Quality Policy and Doctrine

The Management of Teledyne Energy Systems subscribes to and supports a Quality Program that assures product conformance to specifications.

Meaningful Product Conformance to Specifications must be designed, scheduled and built into the product.

Meaningful Product Conformance to Specifications can only be attained when supported by all management and functional segments of the company.

Meaningful Product Conformance to Specifications creates satisfied customers and encourages new and carry-on contracts for Teledyne Energy Systems products.

Contents

1.0 INTRODUCTION

The Quality Assurance Plan delineated within this document has been prepared to meet the intent of Appendix B, 10 CFR 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants." This plan will be executed by Teledyne Energy Systems in conjunction with radioactive waste processing and handling systems fabricated and supplied by Teledyne Energy Systems, Protective Packaging Division.

Teledyne Energy Systems' functional organization arrangement is incorporated within this document as well as a discussion of the Quality Assurance responsibility areas of each department (refer to Fig. 1). The Quality Assurance program is described and the pertinent criteria of Appendix B, 10 CFR Part 50 are addressed as individual items.

The objective of this Quality Assurance Plan is to establish and maintain an effective and economical quality system to provide reasonable confidence that the systems and components fabricated and supplied will perform satisfactorily in service. The Quality Plan design has been based upon consideration of the quality history of past programs, design review and verification, and the necessity to impose controls and surveillance over critical manufacturing and safety related activities.

Quality Assurance measures contained within this plan and utilized by Teledyne Energy Systems have been executed and documented as a matter of course within our normal mode of operation on other programs. The Quality Assurance Plan contained herein will become effective on April 1, 1979 and will not be made retroactive.

2.0 ORGANIZATION

The Teledyne Energy Systems organization is shown in Figure 1. The inter-relationship of Quality Operations to other management functions is clearly shown. This organizational structure permits a close relationship of Quality personnel with program activities to achieve high program efficiency while retaining unimpeded access to higher management. The Quality Operations Department has the required authority and organizational freedom to provide its inspection and control functions with independence from undue influence of costs and schedules.

Functionally, the Division Manager has the overall responsibility to coordinate all of the activities affecting the final package such that delivery can be made within schedule and cost goals. These activities include design, analysis, fabrication, assembly, test, quality control, handling and shipping. These activities are accomplished through assigned representatives from the applicable operating departments who form the division "team." As indicated, each representative is responsible to a department manager to maintain unimpeded communication with high level management.

In brief, the Quality Assurance functions of each department or section are as follows:

a. Central Engineering Section - Responsible for the functions related to design, design reviews, analysis safety and reliability, and engineering documentation control.

b. Manufacturing Department - Responsible for those functions affecting material and production control.

c. Materials Engineering and Test Department - Responsible for activities related to material selection and

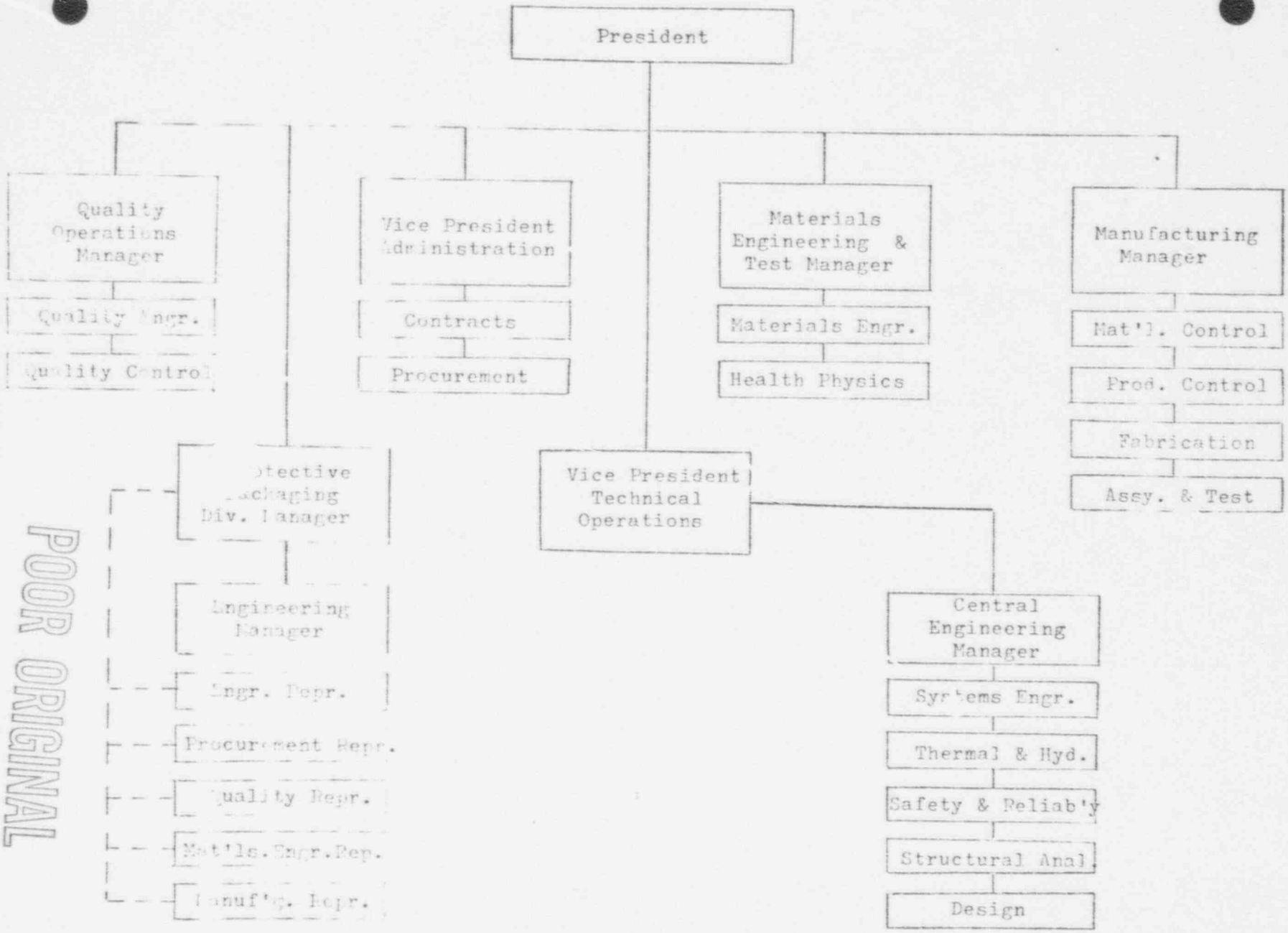

FIGURE 1. TELEDYNE ENERGY SYSTEMS ORGANIZATION

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specification, process specifications and health physics aspects of the subject deliverable hardware.

d. Quality Operations Department - The Quality Control function is responsible for conducting inspection and control activities to assure that out-of-spec hardware is identified and withheld from use unless written and approved authority is received. Quality Engineering is charged with the planning and auditing aspects of Quality. This activity also includes the review of TES documentation to assure that proper inspection and control measures are incorporated.

In certain instances the execution of portions of this Quality Assurance Plan may be delegated to an outside organization but TES retains the responsibility for the subject program and the reliability of its products.

All persons performing quality assurance functions are given the authority and freedom to identify quality assurance deficiencies; to initiate, recommend or provide corrective actions; and to verify that directions are implemented properly.

3.0 QUALITY ASSURANCE PROGRAM

The Quality Assurance Program described within this document has been established and will be implemented for the design, fabrication, assembly, and testing of deliverable products. The purpose of the Quality Assurance Program is to plan, document and carry out all of the activities required to provide adequate confidence that the products will perform safely in service.

Teledyne Energy Systems has operated within the scope of numerous Quality Program Plans under contract to various Government agencies and has evolved, over the course of many years, a group of standards and policies contained in manuals which address most Quality Assurance Criteria. This document maximizes the use of these existing manuals, by reference, where applicable. The manuals which delineate procedure and policies regarding many Quality Assurance activities are as follows:

a. Quality Manual (ES-265) - This manual, maintained by the Quality Operations Department, details the activities of Quality personnel through individual Quality Directives. Those directives applicable to this plan are contained herein as Appendix I.

b. Engineering Documentation Standards - This document, maintained by the Central Engineering section describes drawing and process preparation, release and revision controls.

c. Manufacturing Department Procedures Manual - This manual, maintained by the Manufacturing Department covers receipt, identification, storage control and shipment of materials as well as tool control and equipment maintenance.

d. Procurement Policies and Procedures Manual - This manual maintained by the Administration Department, details activities pertaining to the procurement of materials, equipment and services.

The text of this plan however, shall supersede and take precedence over all other documents and specific Quality Directives contained in Appendix I. A brief discussion of the applicable Quality Assurance Criteria requirements follow.

3.1 Design Control

The design control function is to assure that the applicable regulatory requirements, the product design configuration, and materials of construction, as described in the applicable specifications, are properly translated into drawings, specifications, procedures and special instructions.

The product assembly, subassembly and component detail drawings will be accomplished in the Design and Test Group of the Central Engineering Section. Drawings are reviewed and approved by a checking group within the same group to assure compliance with the applicable drafting practices. The drawings will also be reviewed for verification of design adquacy by the structural analysis, safety and reliability, and thermal and hydraulic sections, as applicable. The design verification will be achieved by calculative methods. Additional review will be performed by the Materials Section of the Materials Engineering and Test Department, if applicable, to assure the suitability of materials, components, equipment and processes for their intended application. The Materials Engineering and Test Department also will generate material and process specifications, as required, to achieve performance parameters.

Quality Operations will record and document drawing and specification changes to assure that each delivered end item (package) is traceable back to the proper change level of the drawings and specifications defining it.

Final Engineering document review and approval will be performed by the Division or Engineering Manager to assure that the proper acceptance criteria for inspections and test are delineated and that all of the appropriate approvals have been obtained.

The procedures defining the activities of drawing, specification and process preparation, release, and revisions are set forth in the "Engineering Documentation Systems" manual. The drafting practices specified in the manual basically conform to MIL-D-1000, Form 2 and to MIL-STD-100.

3.2 Procurement Document Control

Procurement documents will be reviewed by Quality Engineering to ensure that listed materials, equipment or services are clearly specified, to assure that adequate Quality controls are suitably included or referenced in the procurement documents, and to add the appropriate directions for certifications and source and/or recieving inspection in accordance with the requirements of Quality Directive 8.1 (Procurement Documents - Quality Requirements). This directive in conjunction with the "Procurement Policies and Procedures Manual" constitute the control for processing of procurement documents or changes thereto.

3.3 Instructions, Procedures and Drawings

Teledyne Energy Systems uses three types of specifications/procedures in addition to engineering and vendor drawings and topical reports.

The three types of documents employed are: test and/or assembly procedures, material specifications and process specifications. The latter two, of course, are only generated when there is

no equivalent commercial or Government specification.

Test and/or assembly procedures are product peculiar documents issued to delineate a sequence of events, the use of special equipment or facilities, data requirements not specified by drawings or added compliance criteria.

Material specifications are used to delineate minimum functional, physical, chemical, electrical or mechanical requirements of a material to assure design adequacy.

Process specifications are used to describe equipment, materials, processing requirements and quality assurance provisions required for an acceptable product.

The activities affecting the preparation, release and revision of these documents are spelled out in the "Engineering Documentation Standards" manual.

Test and/or assembly procedures will be generated in the design and test group of the Central Engineering Section. Material and process specifications will be originated by the Materials Engineering and Test Department.

7.4 Document Control

The document control function is to assure that all engineering documents including drawings, specifications and procedures are issued, properly reviewed and approved, distributed and revised in accordance with established procedures. These functions are achieved by the Central Engineering Section.

Engineering document release and revision procedures are specified in the "Engineering Documentation Standards" manual. The required document approval and document distribution list will be

as delineated by Engineering Program Directive.

The Quality Operations document control functions include change level documentation for end item traceability. These activities are delineated in Quality Directive 2.1, "Configuration Control."

3.5 Control of Purchased Material, Equipment and Services

Depending on the criticality of the item(s) to be purchased, and/or vendor performance history, Quality Pre-Award Surveys will be conducted as appropriate. Evaluations consider items such as manufacturing equipment, inspection tools, control procedures, and personnel qualifications in accordance with Quality Directive 8.1, "Procurement Documents - Quality Requirements." Receiving inspection will be conducted on purchased hardware and services to ascertain conformance to appropriate specifications and procurement documents in accordance with the requirements of Quality Directive 3.6, "Quality Control of Procured Materials." Accepted items will be tagged and stamped by the inspector denoting his acceptance. Non-conformances are documented in accordance with Quality Directive 3.3, "Teledyne Reporting System" and the discrepanct item withheld until approved written disposition is received, as discussed in Section 3.11.

3.6 Identification and Control of Materials, Parts and Components

Accepted materials and components will be identified, stored, released and fabricated in accordance with the controls of the Manufacturing Department Procedures manual and Quality Directive 3.4, "Quality Control of Energy Systems [redacted] Fabricated Material." Non-conformances that might develop during the fabrication process will be documented per the requirements of Quality Directive 3.3 and handled as discussed in Section 3.5 above.

3.7 Control of Special Processes

Special processes will be documented on book form drawings, if peculiar to a particular program, or Process Specifications if applicable to multiple programs. The control of these documents for release or revision is as discussed in Section 3.4. Periodically these processes will be audited to the requirements of Quality Directive 5.3, "Periodic Internal Quality Audits." Employee qualification for such skill areas as potting, soldering, penetrant inspection, leak detection, etc., are determined and documented in accordance with Quality Directive 9.1, "Employee Skill Certification."

3.8 Inspection

The Quality Operations Department Manager reports directly to the President of the Company as noted in Section 2.0. This arrangement establishes a Quality Control activity that is separate from the functional departments and provides a direct line of communication with upper management. The Quality Control function is controlled by established procedures as defined in this document and the Quality Manual (ES-265). This manual is made up of a number of Quality Directives which delineate the procedures used by the Quality Operations Department in conducting inspection and control functions. These directives are subjected to periodic audits in accordance with the requirements of Quality Directive 5.3.

The established procedures require that a Quality Certification log is used in the accumulation of the inspection history and shows the acceptance status of the various components and subassemblies contained therein. This log also contains the direction for mandatory inspection points, and the recorded results as appropriate.

Non-conforming parts or packages will be identified, tagged, and physically impounded, where practical, until written disposition by proper authority is received.

3.9 Control of Measuring and Test Equipment

A manufacturing and inspection equipment calibration and certification program will be maintained in accordance with Quality Directive 7.1, "Standards and Calibration," in order to schedule the calibration of inspection and test equipment used for determination of product acceptability.

3.10 Inspection, Test and Operating Status

Established procedures will be used for maintaining traceability and inspection status (acceptance, or rejection) and required test status of items used in the product. The traceability and status of the product is verified through the use of a Quality Certification Log which accompanies the related hardware through each step of its assembly and test. The log is basically a Quality plan that establishes the data collection and inspection requirements, in sequence, for the completed product.

3.11 Non-Conforming Materials, Parts, or Components

Established procedures, as defined in the Quality Manual will be used for identifying, and documenting discrepancies, segregating the hardware and withholding from use until authorized written disposition instructions are received. The responsible project engineer or his designee may disposition hardware as "return to supplier," "rework to specification," or "scrap." Dispositions of "use as is," or "repair," however, are additionally subjected to customer approval prior to implementation when specified by the contract specifications.

3.12 Corrective Action

The responsibility of the Project Engineer is to determine the cause of the discrepant event, and conduct or recommend special investigations and corrective actions as appropriate to preclude repitition of the event. Copies of the released nonconformance report (RS Tag) are distributed to appropriate individuals for information and appropriate action.

3.13 Quality Assurance Records

Quality Assurance Records for the product will be maintained throughout the service life of the product. These records will include design definition records (drawings, specifications, procedures, etc.); purchase orders plus appropriate test and material certifications; Quality inspection, acceptance, control, skill certification and audit records. Microfilm copies may be employed for record retention at the discretion of Teledyne Energy System.

3.14 Audits of Quality Assurance Plan

Compliance to this Quality Assurance Plan will be assessed by a team of three individuals approximately once per year. The team members will be selected from service groups within the company - typically from Control Engineering, Materials Engineering and Test, and Quality Operations. The audit will be conducted, using this plan, or a specially prepared check list as a procedure. Results of the audit will be reported to Management along with recommended corrective actions for noted deficiencies. Records of audit results will be maintained by the Quality Operations Department in accordance with established procedures.

APPENDIX I

Applicable Quality Directives

TABLE OF CONTENTS

TELEDYNE ISOTOPES

QUALITY DIRECTIVE

TITLE: PREPARATION OF QUALITY DIRECTIVES		
ORIGINATED BY: R. P. Wathen	DIRECTIVE NO. 1.1	REV B
REVISED BY: R. P. Bruno	REVISION DATE 11/22/72	
REVIEWED BY: R P Bruno	ORIGINAL ISSUE DATE 9/23/71	
APPROVED: T. I. Strock	PAGE 1 OF 5	

1. SCOPE

1.1 Summary

This document establishes the requirements governing the preparation, approval, issuance, and revision of Quality Directives.

1.2 Purpose

Quality Directives shall be used to document the Quality System established by Teledyne Isotopes, Energy Systems Division

1.3 Reference

This directive is authorized by ESD Quality Procedures 1.0 "Procedures" and 5.0 "Quality Engineering."

2. RESPONSIBILITIES

2.1 Quality Engineering

Quality Engineering shall be responsible for the issuance, coordination, and revision of Quality Directives. The originating or revising engineer is responsible for training personnel in the use of the Directive and its implementation.

3. REQUIREMENTS

3.1 General Content

In general, Quality Directives shall establish administrative instructions required for efficient operation of a quality assurance system designed to support the design and manufacturing effort of the Division. The Directives shall describe in sufficient detail the quality assurance methods implemented to meet customer requirements.

3.2 Text Arrangement

To the maximum extent practical Quality Directives shall be prepared in an orderly and logical arrangement. Quality Directives shall be arranged in a prescribed format so that users may expend minimum effort to locate needed information. Quality Directives shall be prepared in four basic sections, as follows:

(a) Section 1. SCOPE

(b) Section 2. RESPONSIBILITIES

(c) Section 3. REQUIREMENTS

(d) Section 4. NOTES/APPENDIX

3.2.1 Section 1. SCOPE - Section 1. shall contain brief statements that provide a clear and concise abstract of the coverage of the Quality Directive. A typical outline of Section 1. follows:

1. SCOPE

1.1 Summary

1.2 Purpose

1.3 References

3.2.1.1 The Summary statement should summarize the intent or end result accomplished by the execution of the Quality Directive.

3.2.1.2 The Purpose statement should define the need for the Quality Directive. Reference should be made to the contractual requirement, company policy or other requirement establishing the need for the Quality Directive.

3.2.1.3 The Reference statement should refer to the Quality Procedure that authorizes the issuance of the Quality Directive.

3.2.2 Section 2. RESPONSIBILITIES - Section 2. of Quality Directives shall be used to describe departmental responsibilities for activities defined by the Quality Directives. When Quality Directives define responsibilities of departments other than Quality, Quality Engineering should coordinate with the Manager of the affected department.

3.2.3 Section 3. REQUIREMENTS - All essential requirements and descriptions shall be stated in this section. Each paragraph shall be numbered and titled, and may have as many subparagraphs as necessary to accurately and completely describe each aspect of the requirement.

3.2.4 Section 4. NOTES/APPENDIX - This section shall contain information of a general or explanatory nature. No requirements shall appear herein to accomplish the scope of the Quality Directive. When necessary, definitions and figures shall be contained in Section 4.

3.3 Preparation

3.3.1 Initiation - Quality Engineering shall be responsible for initiation and coordination of new and revised Quality Directives.

3.3.2 Format - Preferably, Quality Directives shall be prepared in accordance with the format exhibited in this document.

1. SECTION

1.1 Paragraph

This paragraph ....

1.1.1 Subparagraph - This subparagraph ... has been .....

1.1.1.1 These statements under a subparagraph are:

(a) Separate
(b) Short
(c) Concise

3.3.3 Forms

3.3.3.1 Page 1 of Quality Directives shall be printed on Form NSD-22 and shall be completed as specified in Table I.

TABLE I. INSTRUCTIONS FOR COMPLETION OF FORM NSD-22

Block	Instructions
Subject	Assigned by Quality Engineering
Originated By	Originator's Typed Name
Revised By	Revisor's Typed Name
Reviewed By	Quality Engineering Supervisor, Signature
Appro.	Manager, Quality Operations, Signature
Directive Number	Assigned by Quality Engineering
Revision Letter	Letter Designation (starting with A for original)
Revision Date	Assigned by Quality Engineering
'Original Issue Date	Date Directive Initially Published

3.3.3.2 Pages 2 through the final page shall be identified by:

(a) QD Number and Revision Letter

(b) Page Number
(c) Latest Revision Date

3.3.4 Approval - Final approval of Quality Directives shall be by the Manager, Quality Cperations.

3.4 Revision Procedure

3.4.1 General - Quality Directives shall be periodically reviewed, and when necessary revised (re-issued), keeping current with company needs and industry trends. Recommendations are desired for improvements to issued Quality Directives. Comments should be forwarded to Quality Engineering.

3.4.2 Change Control - Changes to Quality Directives shall consist of complete re-issue of existing Quality Directives. When one page of a Directive is revised, the complete Directive shall be assigned the next revision letter. Changes may contain editorial corrections, technical changes, or both. To assist the user of the Quality Directive in locating these changes, a block bar may be used to identify the location of the change on the page.

3.5 Distribution

Distribution of new or revised Quality Directives shall be accomplished when required.

3.5.1 Quality Manuals - Quality Manuals which include all Quality Procedures and Directives shall be controlled and distributed by Quality Engineering in accordance with a Quality Manual Holders List approved by the Manger, Quality Operations.

3.5.2 Quality Directives - Revised Quality Directives shall be distributed upon release to all holders of a current Quality Manual. A current listing of all Quality Directives shall be published periodically and distributed for insertion in the Quality Manuals.

3.6 Quality Directive Familiarization

Quality Directives are Quality Assurance System documents and as such shall be understood and properly used by all affected personnel.

3.6.1 New Directives - New directives shall be implemented by an informal training session for all using personnel in the Quality Operations Department including Quality Engineers, Inspectors and Supervisors. Any questions concerning a Directive should be directed to the originator of the Directive.

3.6.2 Revised Directives - Directives which have been revised shall be read and understood by the Manual holders. A training session may be used to explain important revisions. Any questions concerning a revised directive should be directed to the Revisor of that directive. Revised directives shall be disseminated under a cover letter indicating the new directive revision and the old directive(s) to be replaced or destroyed.

3.6.3 Revision Control - A Revision Control Index, Form NSD 43, Figure 1, shall be inserted in the front of each Quality Manual indicating the revision status of all directives in the manual.

3.7 Quality Directive Audit

Quality Engineering shall audit each Quality Directive periodically. This audit shall include review of format and content for conformance to current requirements and specifications and to determine whether the directive is being implemented and used effectively. If deviations exist, revision of the directive or correction of implementation methods will be accomplished.

3.8 Government Coordination

Quality Directives and all revisions may be coordinated with the local Government Representative by Quality Engineering, when required by contract.

4. NOTES/APPENDIX

4.1 Figure

Figure 1. - Quality Manual Revision Control Index, Form NSD-43.

TELEDYNE ISOTOPES

QUALITY MANUAL REVISION CONTROL INDEX

REVISION ____ DATE _____

1. PURPOSE - The purpose of this Revision Control Index is to provide a means of controlling changes to the Quality Manual and to indicate the present status of the documents in the manual.

2. POSTING - Personnel posting this Index and Revisions thereto should read and take note note of any changes in the new or revised document before posting. Quality Personnel, only, are required to initial the 'Read By' block.

3. USE - This Index shall be replaced whenever a new Index is published and posted. All documents kept in the Manual shall agree with the latest posted Revision Control Index and the Revisions posted therein. Missing or revised documents can be obtained from Quality Engineering.

THIS INDEX POSTED BY _____ DATE POSTED _____

LISTING OF CURRENT DOCUMENTS _ _ _ _ _ _ _ _ _ _ New or Revised are noted by (*)

Procedure or Directive No.	REV	Revision Date	Title	Posted By	Read By

90001151

NSD 43

Figure 1. Quality Manual Revision Control Index

TELEDYNE ISOTOPES

QUALITY DIRECTIVE

TITLE: CONFIGURATION CONTROL		
ORIGINATED BY: J. K. Wenderoth (QD 2.001)	DIRECTIVE NO. 2.1	REV. C
REVISED BY: J. K. Wenderoth	REVISION DATE 11/22/72	
REVIEWED BY:	ORIGINAL ISSUE DATE 2/2/70	
APPROVED:	PAGE 1 OF 5	

1.0 SCOPE

1.1 Summary

This directive defines a method for recording and documenting drawing and specification changes applicable to deliverable end items.

1.2 Purpose

To assure that each delivered end item is traceable back to the drawings and specifications defining it, and to assure that the effectivity of changes is properly applied to each deliverable end item.

1.3 Reference

a. Quality Procedure 2.0, "Drawings and Specifications."

2. RESPONSIBILITIES

2.1 Engineering

Engineering is responsible for the preparation of drawings and specifications, and for subsequent changes including assignment of effectivity.

2.2 Administration

Administration is responsible for proper distribution of released drawings, specifications, and changes and for the maintenance of files containing all non-obsolete drawings, specifications and changes.

2.3 Quality Engineering

Quality Engineering is responsible for the maintenance of a Configuration Record documenting the effectivity of drawing and specification changes.

2.4 Quality Control

Quality Control is responsible for verifying product compliance with drawing and specification requirements.

90001152

2.5 Material Control

Subject to effectivity designations, Material Control is responsible for assuring that in-process and stocked items are upgraded to the appropriate change level.

3. REQUIREMENTS

3.1 Quality Engineering

Upon receipt of released technical documentation covered by an Engineering Job Sheet, Quality Engineering will perform the following activities:

3.1.1 Configuration Record - Prepare new or update existing Configuration Record Card (Figure 1) for each drawing or specification.

3.1.2 Reference Files - File copies of each released Drawing Change Notice in the Quality Engineering reference file and in each Quality Control reference book. File Engineering Job Sheets in numerical order in the Quality Engineering reference file. Out-of-sequence Engineering Job Sheet numbers indicate missing job sheets and changes.

3.1.3 Obsolete Documentation - Remove obsolete drawings from Quality Engineering Reference file.

3.1.4 Certification Log - The following steps shall be followed for fabricated items requiring a Certification Log.

3.1.4.1 Prepare a Configuration Record - Record of Assembly (CR-ROA) (Figure 2) sheet for each Certification Log. The CR-ROA shall list all special design items called out in the list of materials of the applicable assembly drawing.

3.1.4.2 Check the Configuration Record card file for each drawing listed on the CR-ROA sheets and enter applicable changes on the CR-ROA sheets.

3.1.4.3 Prepare and maintain a Certification Log Record identifying logs originated, change level, and date of issue.

3.1.4.4 When engineering changes are released after an affected Certification Log has been issued, locate the issued logs in the shop and update their CR-ROA sheets. When necessary, Quality Check Sheets in logs must be updated to record new/additional variables data or to certify special inspection activities.

3.2 Quality Control

Quality Control shall maintain product inspection reference files including up-to-date drawings and specifications.

During product inspection by Quality Control, documentation relative to configuration control will be processed in accordance with the following activities.

3.2.1 Non-Certification Log Items - Product inspection is to be accomplished in accordance with the drawing and specification requirements contained in Shop Folders.

3.2.1.1 Verify the configuration level of the part by comparing the shop folder with the current drawing.

3.2.1.2 Record the change level to which the part has been inspected on the piece part acceptance tag.

3.2.1.3 Piece parts found not to latest configuration level are to be returned to Material Control for rework or processed as nonconforming hardware as directed by Quality Directive 3.4.

3.2.1.4 The acceptance tag shall be updated or replaced when previously accepted piece parts have been reworked and reinspected to a higher configuration level.

3.2.2 Certification Log Items - Product inspection is to be accomplished in accordance with the drawing, specification, and Quality Check Sheet requirements contained in the Certification Log.

3.2.2.1 Transfer recorded configuration data of piece part acceptance tag to applicable log CR-ROA sheet.

3.2.2.2 Verify compliance with additional posted changes on CR-ROA sheet by comparison with the current file drawing and apply acceptance stamp and date in appropriate inspection block.

3.2.2.3 When inspected to a Certification log, hardware found not to latest configuration level is to be processed as nonconforming hardware as directed by Quality Directive 3.4.

3.2.3 Obsolete Hardware - Upon receipt of obsolete hardware, with applicable Engineering direction, Quality Control is to confiscate the obsolete hardware within the Quality Withholding Area and process it in accordance with Quality Directive 3.5.

3.3 Material Control

Upon receipt of DCN's or incorporated drawing changes delineating obsolete or updated hardware items, Material Control will perform the following activities.

3.3.1 Obsolete Hardware - Remove obsolete hardware from stockroom/production areas and submit to Quality Control with applicable Engineering direction.

3.3.2 Reworkable Hardware - When a drawing or specification change permits the rework of hardware, the item may be reworked by issuance of a shop folder and resubmitted to Quality Control for inspection to the higher change level.

4. APPENDIX

4.1 Figures

Figure 1, Configuration Record Card

Figure 2, CR-ROA Sheet

NEXT ASSEM.	SIZE	DWG. NO.

TITLE

REVISION LETTER		NAME	RELEASE DATE	PROGRESS TICKET NUMBER		RELEASED TO

Figure 1. Configuration Record Card

CONFIGURATION RECORD - RECORD OF ASSEMBLY

Drawing & Part No.	Quan.	Lot/Batch/ Ser. No./P.O.	Nonconformance Reports	Configuration Status							

Sh. ___ of ___

Nomenclature: _____ Inst. in Gen. S/N _____

Figure 2. CR-ROA Sheet

TELEDYNE ISOTOPES

QUALITY DIRECTIVE

TITLE: TELEDYNE ISOTOPES REPORTING SYSTEM		
ORIGINATED BY: W. Rowe	DIRECTIVE NO. 3.3	REV. B
REVISED BY: A. M. Konjura	REVISION DATE 5/1/72	
REVIEWED BY: R. P. Brund	ORIGINAL ISSUE DATE 5/21/69	
APPROVED: [signature]	PAGE 1 OF 5	

1. SCOPE

1.1 Summary

This directive provides the requirements to be met in completing the Teledyne Isotopes Reporting System Tag, Form No. NSD-16 (5-71).

1.2 Purpose

To define required documentation for reporting nonconforming items.

1.3 References

a. Quality Procedure 3.0, "Material Control"

b. Quality Procedure 6.0, "Data and Reports"

2. RESPONSIBILITIES

2.1 All Departments

Report incidences of nonconformance by completing the section of the Reporting System (RS) Tag which is enclosed within the heavy black border (Section "A" of Fig. 1) and forwarding the tag to Quality Control.

2.2 Quality Control

Quality Control will be responsible for verifying the proper completion of section "A" of the Reporting System Tag. Upon completion of Section "A," Quality Control will forward the RS tag to Quality Engineering.

2.3 Quality Engineering

Quality Engineering will be responsible for the proper completion of the section of the Reporting System tag which is not enclosed by the heavy black border (Section "B" of Fig. 1). Upon completion of the RS tag, Quality Engineering will distribute copies and file the master.

3. REQUIREMENTS

3.1 Individuals Responsible for Completion of the RS Tag

3.1.1 Initiator - The individual initiating the RS tag will complete all items in Section "A" of the RS tag with the exception of the following:

a. Quality Supervisor's signature

b. Quality Manager's signature

c. Acknowledgement signature

3.1.2 Quality Control Supervisor - The Quality Control Supervisor will be responsible for obtaining the signatures noted in 3.1.1 above and for forwarding the RS tag to Quality Engineering for disposition.

3.1.3 Quality Engineering - Quality Engineering will be responsible for completing Section "B" of the RS tag, including obtaining the Quality Manager's signature for approval of the final disposition.

3.2 Data Required for Completion of the RS Tag

3.2.1 Type of Data - The type of data required to complete the RS tag is explained by the block headings on the tag and/or the instructions on the reverse side of the hard copy of the RS tag. The following four block headings may require further clarification.

3.2.1.1 "Initial Rpt. No." is used to show the serial number of existing RS tags against the item currently being rejected and directly related to the discrepancy in question.

3.2.1.2 "Item" is used to differentiate between different types of defects when an RS tag is used to record rejections for more than one reason. Each rejection reason should have a different item number and should be correlated with part serial numbers in the "Description of Event" section of the tag.

3.2.1.3 "Total Qty." is used to represent the total number of parts in the inspection lot.

3.2.1.4 "Qty. Defect" is used to represent the total number of defective parts.

3.3 Supplementary Forms

3.3.1 RS Supplemental Page, Form No. NSD-15 (5-71) - The RS Supplemental Page (Fig 2) will be used as a continuation sheet for data which cannot be included on the face of the RS tag because of length.

3.3.2 Corrective Action Board Report, Form No. NSD-13 (5-71) - A Corrective Action Board Report (Fig. 3) will supplement the RS tag when the final disposition of a nonconformance is made by the Corrective Action Board rather than Quality Engineering.

4. NOTES/APPENDIX

4.1 Figures

Figure 1 - Teledyne Isotopes Reporting System Tag, Form No. NSD-16 (5-71)

Figure 2 - Teledyne Isotopes Reporting System Supplemental Page, Form No. NSD-15 (5-71)

Figure 3 - Teledyne Isotopes Corrective Action Board Report, Form No. NSD-13 (5-71)

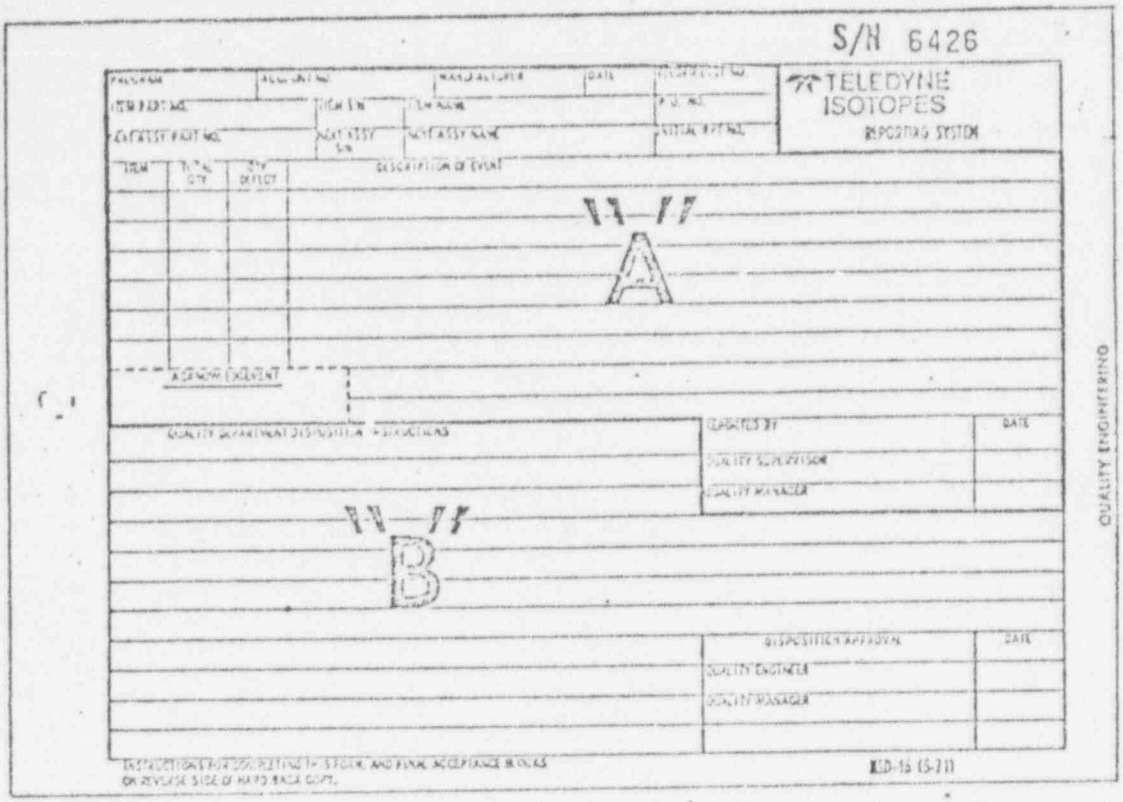


Fig. 1. Teledyne Isotopes Reporting System Tag

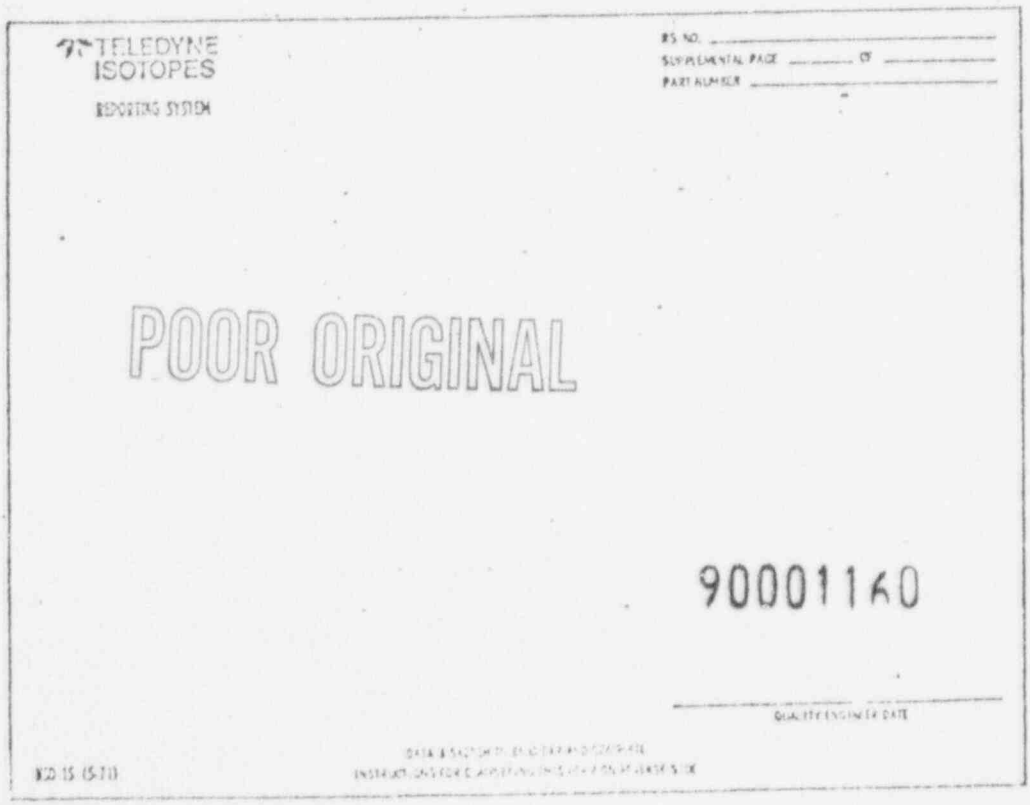


Fig. 2. Teledyne Isotopes Reporting System Supplemental Page

TELEDYNE
ISOTOPES

CORRECTIVE ACTION BOARD REPORT

RS NO. _____

PART NO. _____

PAGE _____ OF _____

CAB DISPOSITION APPROVAL	DATE
DESIGN ENGINEER	
RELIABILITY ENGINEER	
QUALITY ENGINEER	
CUSTOMER	

KSD-13 (5-71) INSTRUCTIONS FOR THE PREPARATION OF THIS FORM ON REVERSE SIDE.

Fig. 3. Teledyne Isotopes Corrective Action Board Report.

TELEDYNE ISOTOPES

QUALITY DIRECTIVE

TITLE: QUALITY CONTROL OF ENERGY SYSTEMS DIVISION FABRICATION MATERIAL		
ORIGINATED BY: A. M. Kaplan	DIRECTIVE NO. 3.4	REV C
REVISED BY: L. Siegrist	REVISION DATE 9/5/74	
REVIEWED BY: W R Lutton.	ORIGINAL ISSUE DATE 6/4/71	
APPROVED: A. A. McDonald	PAGE 1 OF 9	

1. SCOPE

1.1 Summary

This directive provides guidelines for the flow and Quality documentation of conforming and non-conforming hardware fabricated, processed and tested in-house.

1.2 Purpose

The proper execution of this directive assures the complete quality control of production material as required by contract and standard Quality practice.

1.3 Reference

a. Quality Procedure 3.0, "Material Control"

b. Quality Procedure 5.0, "Quality Engineering"

2. RESPONSIBILITIES

2.1 Quality Engineering

Quality Engineering shall prepare inspection instructions, evaluate defects, failures and other anomalies, and disposition material in accordance with procedures herein prescribed or which are contractually required.

2.2 Quality Control

Quality Control shall inspect to drawings, specifications, or specific instructions, and shall document actions, and carry out the disposition of material as directed below.

3. REQUIREMENTS

3.1 Quality Control Action

Quality Control personnel shall inspect parts and material to the applicable

3.1 make a determination of conformance or non-conformance. All items inspected will be identified and documented as required and defined herein.

3.1.1 Conforming Hardware - Conforming parts and assemblies shall be documented as follows:

3.1.1.1 Upon completion of inspection of hardware the inspector shall clear the Manufacturing Order by placing his "inspection stamp in the "Final" block of the Manufacturing Order (Figure 1). The date should be entered, and the number of acceptable parts entered in the "Accept" block.

3.1.1.2 When operations listed on the Manufacturing Order (M.O.) are completed and parts are acceptable, the inspector shall initiate a Material Acceptance Tag (Figure 2), stamp and attach or place completed tag with parts.

3.1.1.3 File the 3rd, or green copy of the completed M.O. by part number in the Quality Control File.

3.1.1.4 When additional operations are required by the "M.O." or engineering drawing after an inspection such as: Cleaning, Bake out, leak test etc.; the details of the completed inspections will be briefly described in the "General Notes" section of the "M.O." followed by the inspector's stamp.

3.1.1.5 When subsequent operations as described in 3.1.1.4 are to be performed after an inspection, the top half of the Material Acceptance Tag (Figure 3) shall be initiated by the inspector and stamped under the "Q.C." in the top part of the tag only.

3.1.1.6 Upon successful completion of the subsequent operations required to complete the "M.O.", the inspector shall stamp the appropriate "Q.C." block (s) in the bottom portion of the Material Acceptance Tag (Figure 3) and complete the M.O. per 3.1.1.1 and 3.1.1.3.

3.1.1.7 When inspecting a part which has a Quality Log, clear the Quality Log by stamping and dating the completed, acceptable operations. Stamped Acceptance Tags for all parts and subassemblies are to be ported in the Quality Log for each major assembly or end item at the time of the appropriate assembly inspection. Include in the Quality Log any required variables data.

3.1.1.8 Forward "Incomplete" Quality Logs with the parts to Material Control for subsequent operations.

3.1.1.9 When final inspection and acceptance is completed, check the Quality Log and shop folder for verification of completion of all operations, inspections and tests. Forward the complete Quality Log package to Quality Engineering for review and retention.

3.1.1.10 When the item is a completed part, subject to customer acceptance by contract requirement, submit the part to the Customer Representative for his review. Upon his acceptance, obtain customer stamp on the Acceptance Tag and the customer's signature on other documentation required by contract.

3.1.2 Non-Conforming Hardware - Parts or assemblies which are found during inspection to be defective or non-conforming shall be processed in a manner which will provide acceptable documentation of the occurrence and removal of the non-conforming item from acceptable production material.

3.1.2.1 Non-conforming parts require the initiation of a Reporting System (RS) Tag, NED-10 (Figure 4). The inspector shall complete the top half of the RS Tag, defining the part and the non-conformance, and:

a. Obtain the Quality Control Supervisor's signature.

b. The Quality Control Supervisor will obtain the Quality Manager's signature.

c. The Quality Control Supervisor will then obtain the Manufacturing Manager's (or his representative) signature in the Acknowledgment Block and give him the goldenrod copy of the RS Tag.

d. The white and green copies are to be forwarded to Quality Engineering for evaluation of the non-conformance and disposition of the item(s).

e. Attach to or place the hardback copy of the RS Tag with the questionable part or assembly and put them in the Quality Witholding Area to await resolution by Quality Engineering and further disposition instructions.

f. Carry out disposition instructions upon receipt of a completed, approved copy of the RS Tag. In the case of SCRAP items, Quality Engineering will handle the parts in accordance with Q.D. 3.5.

3.1.2.1 g. When disposition has been completed to "Repair" or "Use as is" and the item is accepted, process per Paragraph 3.1.1 and stamp the back of the hardback copy of the RS Tag. Obtain the Customer Representative' stamp, when required, in the space provided, date the Tag and forward it to Quality Engineering.

3.2 Quality Engineering Action

Quality Engineering personnel shall receive all RS Tags, review discrepancies, determine cause, propose corrective action and make an initial disposition (Rework/Scrap/Refer to Corrective Action Board). The RS Supplement Form, NSD-15 (Figure 5), may be utilized for documenting cause and suggested corrective action.

3.2.1 Rework - When rework action will correct the defect, detail the method of rework and process the RS Tag as follows:

a. Complete RS Tag, obtain proper authorizing signatures and distribute xerox copies to:

Corrective Action Board
Material Control
Originator
Others as required by program

b. Upon completion of rework and acceptance, the RS Tag hard copy will be stamped by Quality Control and returned to Quality Engineering. File the RS Tag hard copy and original (white) with attached data and supplements.

3.2.2 Scrap - When rework cannot be accomplished or item is damaged and otherwise unusable, it will be scrapped. Proceed as follows:

a. Complete RS Tag and indicate: "Scrap"

b. Obtain signature of Quality Control Supervisor and Quality Manager.

c. Remove affected hardware from Quality Witholding Area and place it in Bonded Scrap Crib. Place hardback copy of RS Tag with or attached to the part(s).

3.2.2 Scrap - (Cont'd)

d. Distribute xerox copies of the RS Tag per Paragraph 3.2.1 (a).

e. See Q.D. 3.5 for further scrap control instructions.

3.2.2.1 Items declared "Scrap" by Engineering change shall be confiscated and placed in Bonded Scrap Crib after coordination with Material Control. Document scrappage on an RS Tag as in Paragraphs (a) and (b) above.

3.2.3 Refer to Corrective Action Board - Items that are not dispositioned by Quality Engineering as "Rework" or "Scrap" shall be submitted to the CAB for action and disposition. Upon receipt of CAB disposition instructions, the Quality Engineer will complete the RS Tag as follows:

a. Obtain signatures of Quality Engineering Supervisor and Quality Manager.

b. Distribute copies of the RS Tag in accordance with Paragraph 3.2.1 (a) above.

c. Upon completion of disposition instructions, receive the hardback copy of the RS and file it with the RS original and a copy of the CAB Report, NSD-13 (Figure 6).

4. NOTES/APPENDIX

4.1 Figures

Figure 1 - Manufacturing Order, Form ESD-209
Figure 2 - Material Acceptance Tag, NSD-33
Figure 3 - Material Acceptance Tag (large)
Figure 4 - Isotopes Reporting System (I.S), Form NSD-16
Figure 5 - RS Supplement, Form NSD-15
Figure 6 - CAB Report, Form NSD-13

POOR ORIGINAL

MANUFACTURING ORDER

CUST. NO. 4000	NAME/DESCRIPTION	PART NO.	DCN	QTY
		N/A	CTL.PT	SUB TASK
	P.O. NO.			

DATE | SHIP: FROM: TO: DATE: NAME: | ACCOUNT NO. | INSP. REQ.? YES ☐ NO ( )

OPERATION	EST. HRS.	ACTUAL HRS.	SCHED DATE	COMPL DATE	NOTES
			QTY. COMPL.		

GENERAL NOTES:

ACCEPT	REJECT

INSP.	DATE

FINAL	DATE

ROUTE TO:

OPERATIONS CODE

L=LATHES
M=MILLS
JB=JIGBORE
EDM=ELEC DISC. MACH.
SM=SHEET METAL
W=WELD
MA=MECH ASSY.
AT=ASSY/TEST
SR=STOCK ROOM
CP=CLEAN/PAINT
OV=OUTSIDE VENDOR

M.O.NO.

Figure 1

9000167

Q.P. 3.4.C
Page 6
9/5/84

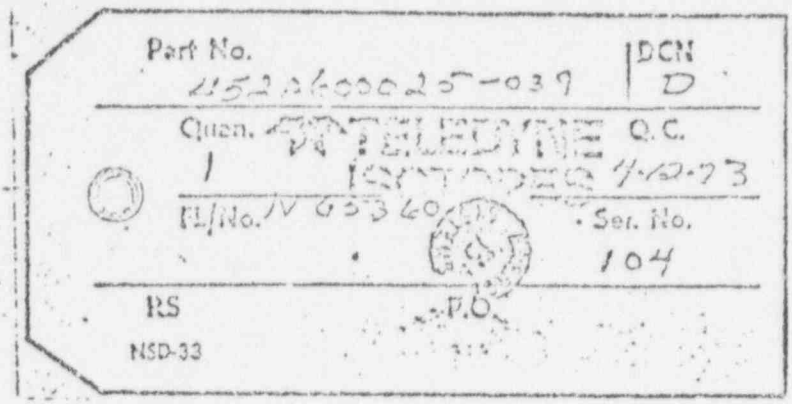


Figure 2

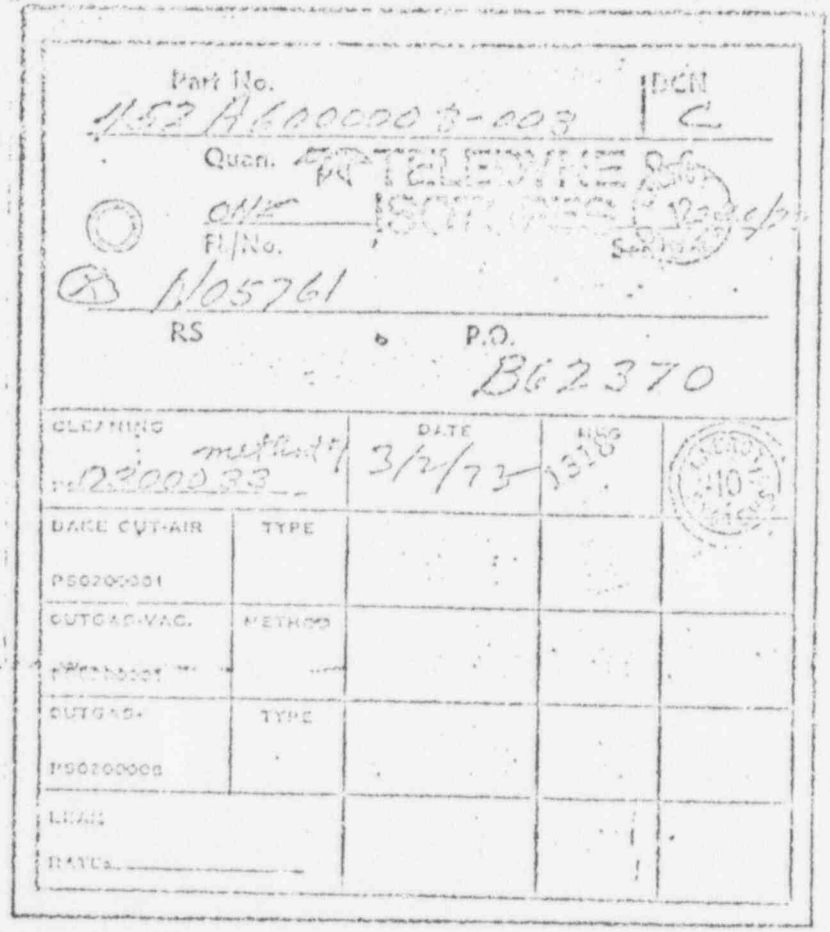


Figure 3

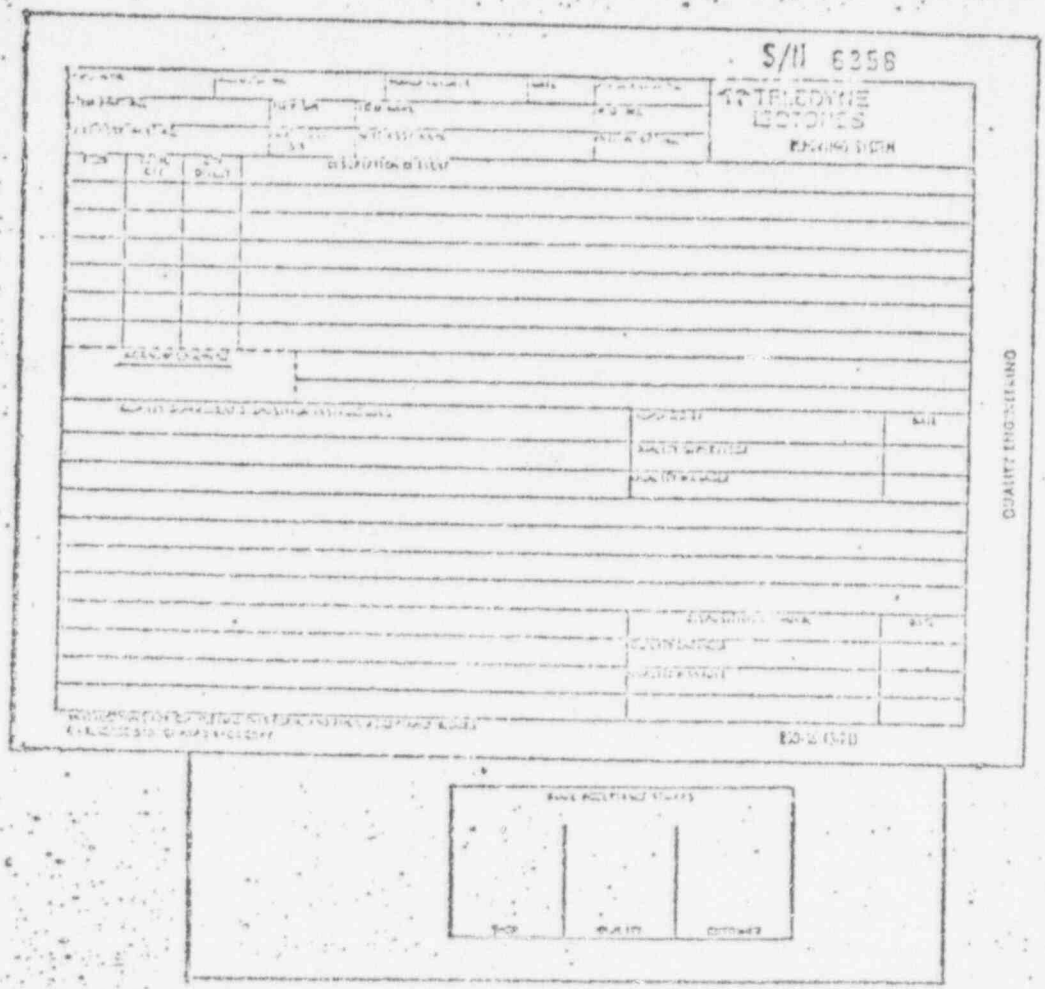


Figure 4

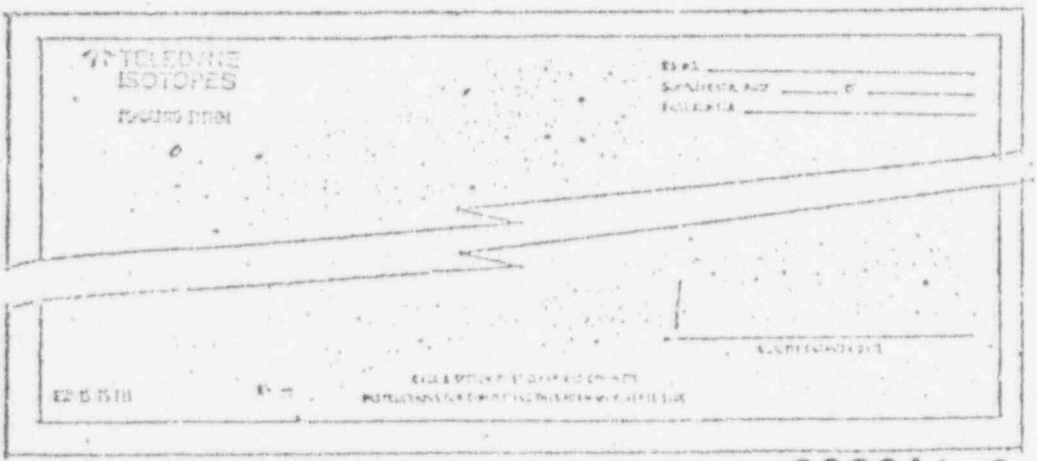


Figure 5

TELEDYNE
ISOTOPES

CORRECTIVE ACTION BOARD REPORT

ESD NO. _____
PART NO. _____
PAGE _____ OF _____

CAB DISPOSITION APPROVAL	DATE
DESIGN ENGINEER	
RELIABILITY ENGINEER	
QUALITY ENGINEER	
CUSTOMER *	

FORM 13-1210 INSTRUCTIONS FOR THE PREPARATION OF THIS FORM ON REVERSE SIDE

Figure 6

Note: *Obtain customer signature when required by contract.

TELEDYNE ISOTOPES

QUALITY DIRECTIVE

TITLE: QUALITY CONTROL OF PROCURED MATERIAL		
ORIGINATED BY: A. Konjura	DIRECTIVE NO. 3.6	REV. B
REVISED BY: M. J. Kaplow	REVISION DATE 5/1/72	
REVIEWED BY: R. P. Bruno	ORIGINAL ISSUE DATE 6/4/71	
APPROVED: G. T. Hood	PAGE 1 OF 11	

1. SCOPE

1.1 Summary

This directive provides guidelines for the flow and Quality documentation of conforming and non-conforming procured material.

1.2 Purpose

To assure control and adequate quality documentation of procured material as required by contract and standard quality practice.

1.3 References

a. Quality Procedure 3.0, "Material Control."

b. Quality Procedure 5.0, "Quality Engineering."

c. Quality Procedure 6.0, "Data and Reports."

2. RESPONSIBILITIES

2.1 Quality Engineering

Quality Engineering shall evaluate defects, failures, and other anomalies concerning procured material, coordinate and resolve problems with vendors, and disposition material in accordance with procedures herein prescribed or which are contractually required.

2.2 Quality Control

Quality Control shall inspect and process procured materials in accordance with requirements of the purchase orders, drawings, specifications, or special instructions and shall document actions as directed herein.

2.3 Purchasing

Purchasing is responsible for vendor or supplier coordination and liaison and negotiations regarding procured material discrepancies and vendor corrective action.

3. REQUIREMENTS

3.1 Receiving Inspection

Inspection personnel shall inspect parts to verify conformance to the purchase order, applicable drawings, special requirements and specifications, and document the procured material as required and defined herein.

3.1.1 Material Inspection, General - Upon receipt of procured material, parts or equipment, and four (4) copies of the Receiving Report from Material Control, the inspector will pull the purchase requisition/purchase order (PR/PO) package from the Receiving Inspection Control File. Upon review of the purchase order, the inspector will obtain any drawings or specifications required to inspect the material and proceed as follows:

3.1.1.1 Check the vendor's packing slip, included data, and certifications for compliance with the purchase order requirements.

3.1.1.2 Inventory and verify that the material is that which is listed on the purchase order and is correctly marked and/or labeled.

3.1.1.3 Note any damage to material caused by shipping. When damage is found, initiate Reporting System Tag (RS) NSD-16 (Fig. 5) and immediately notify Material Control for coordination with the carrier. Note all damage on the RS tag, photograph if necessary, and notify Quality Engineering for a packaging evaluation, if packaging method appears defective.

3.1.1.4 Physically inspect the material for compliance with the drawings. Use an approved Sampling Plan, when permissible, for large lots of material (see Quality Directives, Series 4.X).

3.1.1.5 When required, other inspections, tests and verifications, such as electrical, chemical, x-ray, etc., shall be accomplished as indicated on the Receiving Inspection Instruction, Form NSD-42 (Fig. 1), and stamped off and dated when accomplished. Test and verification data sheets shall be attached to the Receiving Inspection Instruction for filing.

3.1.2 Conforming Material - When material meets all listed requirements, data will be processed as detailed below.

3.1.2.1 Clear purchase order by entering pertinent receiving inspection information, inspection stamp, and date on the four (4) copies of the Receiving Report.

3.1.2.2 Complete the Receiving Inspection Instruction, when applicable.

3.1.2.3 Clear the Quality Log when the part was sent outside for a controlled operation. Forward the Quality Log to Quality Engineering when complete. When incomplete, forward Quality Log with material to Material Control.

3.1.2.4 Make entry on the vendor Receiving Inspection, Form Q-318 (Fig. 3).

3.1.2.5 Forward to Quality Engineering the Quality copy of the Receiving Report with the PO/PR, Certification Test Reports, and attach a signed report copy of the Receiving Inspection Instruction (Report Copy, Fig. 1), when applicable.

3.1.2.6 Prepare an Acceptance Tag (Fig. 4) and attach or place with parts. When required by contract, the Customer Representative will stamp the Acceptance Tag.

3.1.2.7 Route accepted parts with three (3) copies of the signed-off Receiving Report to Material Control.

3.1.3 Non-Conforming Material - Initiate an RS Tag (Fig. 5) for discrepant procured material, process the RS Tag and material as defined in Quality Directive 3.3 and detailed below.

3.1.3.1 The Quality Control Supervisor will contact Purchasing and obtain buyer's signature on the RS Tag to signify acknowledgement of the discrepant condition. Submit the goldenrod copy of the RS Tag to Purchasing.

3.1.3.2 Attach or place the hard copy of the RS Tag with the discrepant material and move the material to Procurement Withholding Area.

3.1.3.3 The white and green copies of the RS Tag are forwarded to Quality Engineering for evaluation of the discrepancy and material disposition.

3.1.3.4 Quality Control shall transfer discrepant items to Material Control upon receipt of RS Tag instructions from Quality Engineering.

3.1.3.5 Stamp (accepted material) or sign (rejected material) the hardback copy of the RS Tag to indicate completion of disposition instructions and forward it to Quality Engineering.

3.2 Quality Engineering

Quality Engineering shall review non-conforming items and, as such, will receive all RS forms, review discrepancies, make disposition, determine cause, and propose corrective action. The green copy of the RS Tag is immediately filed upon receipt as a record copy while disposition and evaluation is being accomplished utilizing the Master (white) copy.

3.2.1 Documentation Discrepancies - Shortages or errors in documentation, such as missing certifications, analyses, manuals or other data, may be resolved by initiating a Supplier Corrective Action Request (SCAR), Form NSD-17 (Fig. 6). The SCAR shall define the shortage or error and request vendor correction by supplying the corrected or missing document(s) and corrective action to be taken to prevent recurrence.

3.2.1.1 Obtain approval signature of the Quality Manager, forward a copy of the SCAR to Purchasing (the buyer) with a Xerox copy of the dispositioned RS Tag, and place the original of the SCAR with the RS Tag master awaiting action by the vendor.

3.2.1.2 Purchasing shall submit the SCAR to the vendor requesting action and the return of the SCAR with the correct documentation to Quality Engineering.

3.2.1.3 Upon receipt of the correct documentation from the vendor, Quality Engineering shall review the documentation and complete the RS Tag master.

3.2.1.4 Forward the received vendor documents to Inspection for attachment to the Receiving Report package.

3.2.1.5 Forward a copy of the completed RS Tag to Inspection for clearance of the material being held.

3.2.1.6 Receive the hardback copy of the RS Tag upon release of the material and file it with the RS Tag master.

3.2.2 Return to Vendor - Material which cannot be accepted without Vendor rework or replacement shall be returned to the Vendor.

3.2.2.1 Complete the RS Tag and disposition and material to be "Returned to the Vendor." Cause and suggested corrective action may be added when evident.

3.2.2.2 Prepare a Supplier Corrective Action Request (SCAR) (Fig. 6) describing the problem. Forward an approved copy of the SCAR to Purchasing along with a Xerox copy of the RS Tag. A requested reply date shall be applied commensurate with the nature and criticality of the non-conformance (10-30 days).

3.2.2.3 Distribute Xerox copies of the RS Tag to the following:

Purchasing
Material Control
Originator
Receiving Quality Control
Others as required by program

3.2.2.4 Receive hardback copy of RS Tag upon completion of disposition and file with the RS Tag master.

3.2.2.5 When corrective action (SCAR) is received from the Vendor, review same and, if acceptable, sign, attach a copy to the original with the RS Tag master, and file.

3.2.3 Hold Material for Vendor Review - Material to be held awaiting shipping instructions or vendor review shall be kept in the Procurement Withholding Area.

3.2.3.1 Complete RS Tag and SCAR and process as in Paragraph 3.2.2.2.

3.2.3.2 At the joint discretion of the Quality Engineer and the Buyer, and with the approval of the Manager, Quality Operations, non-conforming materials may be held for a reasonable period (thirty days) in the Procurement Withholding Area for Buyer/Vendor disposition.

3.2.3.3 Upon disposition to have material returned to Vendor, process as in Paragraph 3.2.2.

3.2.3.4 At the end of the thirty-day holding period, if the discrepancy has not been resolved because of vendor negligence in reviewing the material, the RS Tag may be dispositioned "Return to the Vendor." (Process per 3.2.2)

3.2.3.5 When Vendor agrees to repair or scrap material at Vendor expense, process and disposition the RS Tag per Q.D. 3.4, Paragraph 3.2.1 or 3.2.2.

3.2.3.6 Complete RS Tag including disposition instructions and distribute Xerox copies per Paragraph 3.2.2.4. Include copies of the completed SCAR with each RS Tag.

3.2.3.7 Receive the hardback copy of the RS Tag upon completion of the disposition of material and file it with the RS Tag master.

3.2.3.8 File the Receiving Report package in the Purchase Order Control File.

4. NOTES/APPENDIX

4.1 Notes

Non-conforming items which cannot be placed in the Withholding Area or Bonded Scrap Crib because of size, thermal and/or radiation characteristics, etc., may remain in any other safe location provided the RS tag is prominently displayed. Items of this type are to be dispositioned expeditiously to minimize the amount of time that discrepant items are held outside of a bonded area.

4.2 Figures

Figure 1 - Receiving Inspection Instruction, NSD-42

Figure 2 - Receiving Inspection Instruction Continuation Sheet, NSD-42A

Figure 3 Vendor Receiving Inspection Record, Form Q-318

Figure 4 Acceptance Tag

Figure 5 Reporting System Tag, NSD-16

Figure 6 - Supplier Corrective Action Request, NSD-17

TELEDYNE ISOTOPES

RECEIVING INSPECTION INSTRUCTIONS

QUALITY REPORT

PART NUMBER _____ DESCRIPTION _____

PURCHASE ORDER # _____ RECEIVING REPORT # _____ PART S/N _____

SPECIAL REQUIREMENTS - CHECK APPLICABLE BLOCKS:

DOCUMENTATION	YES	NO	VERIF.	MARKING	YES	NO	VERIF.
SPECIFICATIONS/MATERIALS				TRAD PART NUMBER			
CERTIFICATES				MFG. PART NUMBER			
TEST RESULTS				MFG. PART NUMBER SUBSTITUTE			
MATERIAL ANALYSIS				SERIALIZED ITEM			
SOURCE INSPECTION EVIDENCE				FEDERAL STOCK NUMBER			
CALIBRATION DATA				SHELF LIFE CONTROL DATE			
TRACEABILITY				INSPECTION MARKS/STAMP			

NOTE: Review required certifications or data to assure conformance with requirements. Verify by indicating "YES" or "NO" in VERIF.block.

SPECIAL INSTRUCTIONS: _____

CHARACTERISTICS TO INSPECT	INSP. STAMP	DEFECT CLASS MAJ.	DEFECT CLASS MINOR	INSTRUMENT OR GAGE

NSD-42 (9/71)

Inspected By _____, Date _____

Figure 1

RECEIVING INSPECTION INSTRUCTIONS

QUALITY REPORT

CONTINUATION SHEET

PART NUMBER _____ DESCRIPTION _____

CHARACTERISTICS TO INSPECT	INSP. STAMP	DEFECT CLASS MAJ.	DEFECT CLASS MINOR	INSTRUMENT OR GAGE

NSD - 42A (9/71)

Inspected By _____, Date _____

Figure 2

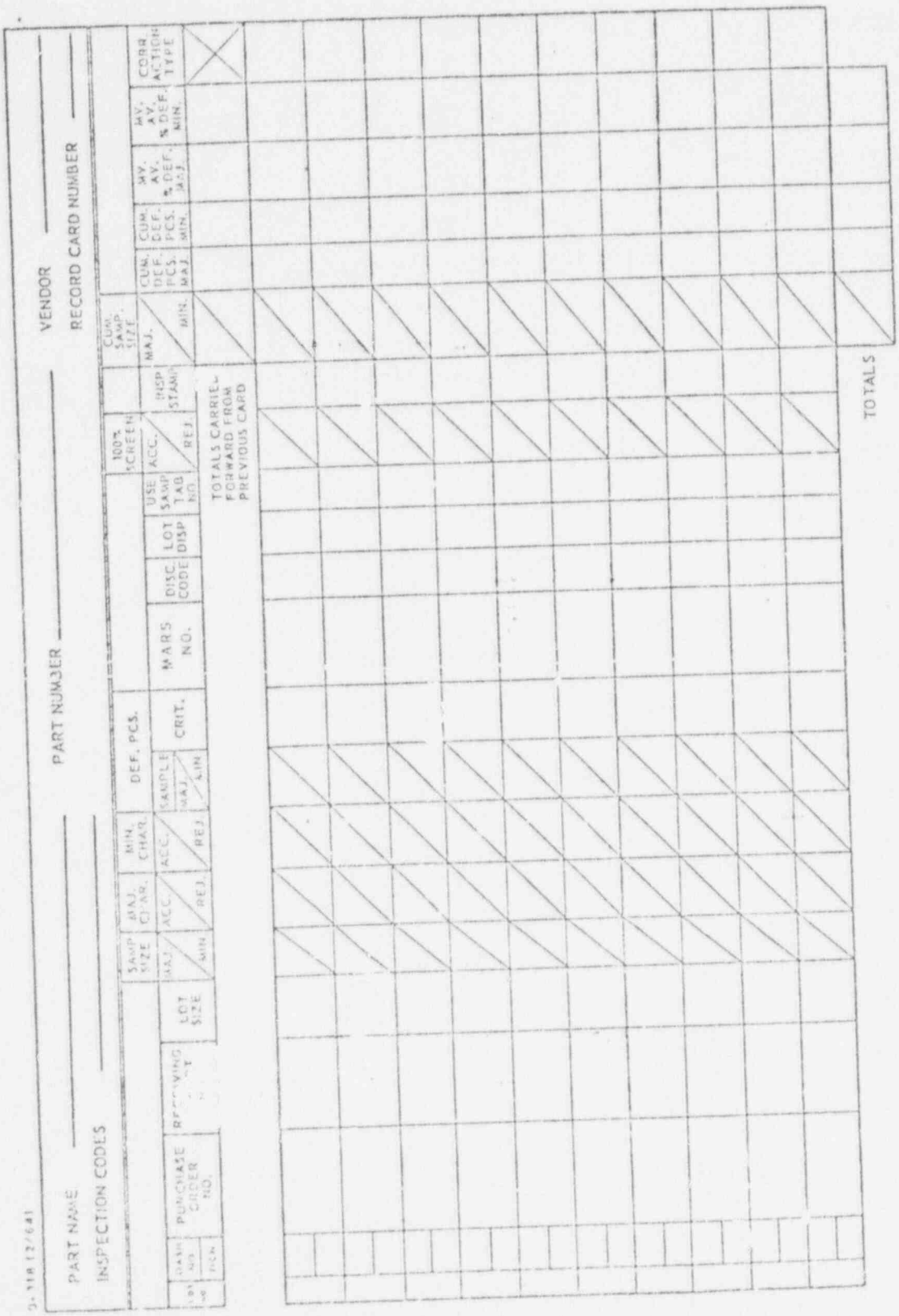
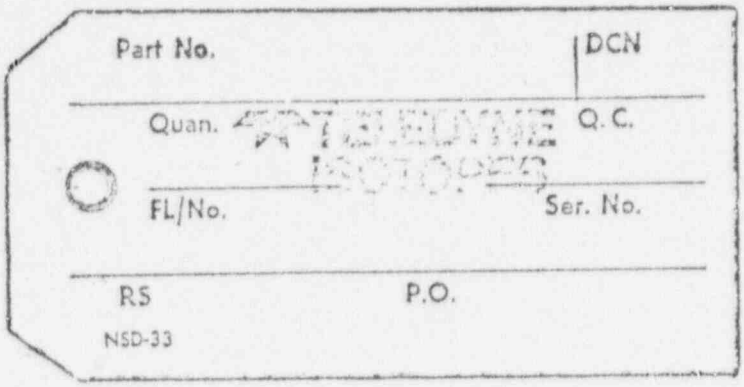


Figure 3



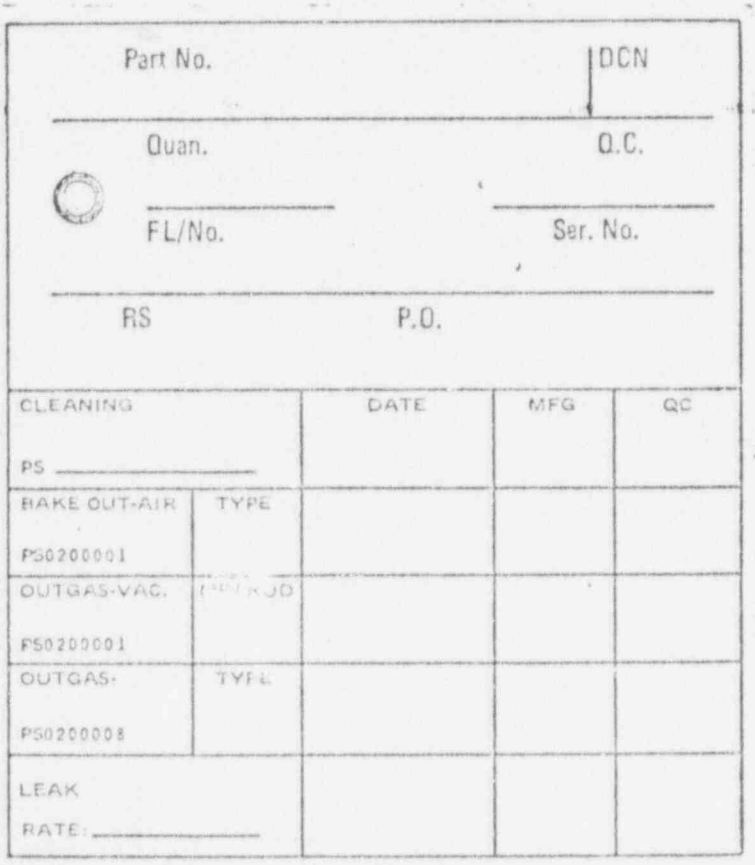


Figure 4. Acceptance Tags

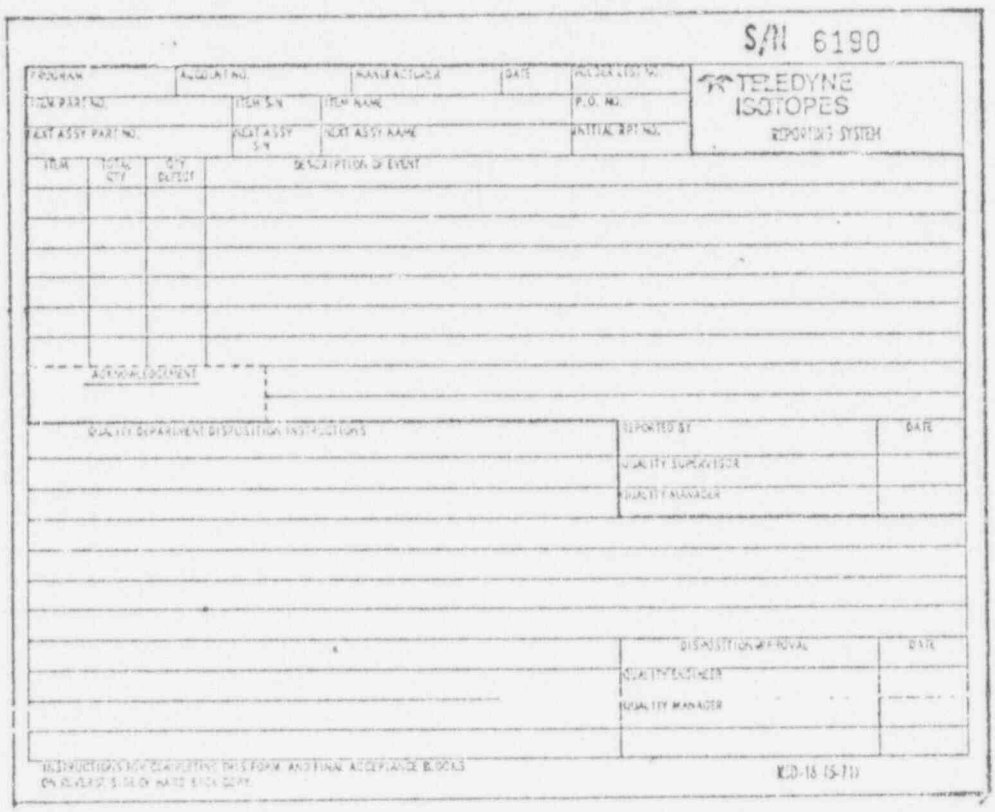


Figure 5

TELEDYNE ISOTOPES

SUPPLIER CORRECTIVE ACTION REQUEST

SCAR NO. _____

PART NO.	PART NAME		SUPPLIER NAME AND ADDRESS
BUYER	P.O. NO.	QTY. REJ.	

DESCRIPTION OF DISCREPANCY OR PROBLEM

☐ INFORMATION ONLY ☐ FORMAL REPLY REQUIRED BY (DATE)

ORIGINATION SIGNATURE	DATE	APPROVAL SIGNATURE	DATE

"YOU ARE REQUIRED TO CONDUCT A COMPLETE INVESTIGATION OF THE LISTED DISCREPANCIES AND SUBMIT A WRITTEN REPORT LISTING REASONS, CAUSES AND CORRECTIVE ACTION. WHEN GOVERNMENT SOURCE INSPECTION APPLIES, YOUR INVESTIGATION AND REPLY MUST BE SIGNED BY THE GOVERNMENT QUALITY REPRESENTATIVE AT YOUR PLANT. REPORT MUST BE SIGNED BY A RESPONSIBLE MEMBER OF YOUR MANAGEMENT, AND SUBMITTED TO TELEDYNE ISOTOPES NSD. ITEMIZE ANSWERS BELOW. INSPECTION OF SUBSEQUENT RECEIPTS FOR PURPOSES OF ACCEPTANCE OR REJECTION WILL DEPEND UPON THE TIMELY RECEIPT AND APPROVAL OF YOUR REPORT BY TELEDYNE ISOTOPES NSD QUALITY."

POSITIVE CORRECTIVE ACTION

CAUSE (STATE SPECIFIC CAUSE OF DISCREPANCY OR PROBLEM)

ACTION (STATE SPECIFIC ACTION TAKEN TO PREVENT RECURRENCE OF THE DISCREPANCY OR PROBLEM)

EFFECTIVITY _____ DATE AND OR _____ UNIT SERIAL NO.

	TELEDYNE ISOTOPES NSD QUALITY REPRESENTATIVE (SIGNATURE)
SUPPLIER'S Q.C. MANAGEMENT (SIGNATURE) DATE	☐
	GOVERNMENT QUALITY REPRESENTATIVE (SIGNATURE)
	☐

NSD-17 (5-71) INSTRUCTIONS FOR COMPLEETING THIS FORM ON REVERSE SIDE

Figure 6

TELEDYNE ISOTOPES

QUALITY DIRECTIVE

TITLE: PERIODIC INTERNAL QUALITY AUDITS			
ORIGINATED BY: A. M. Konjura (Q.D. 5.003)		DIRECTIVE NO. 5.3	REV. A
REVISED BY: A. M. Konjura		REVISION DATE 5/1/72	
REVIEWED BY: R P Bund		ORIGINAL ISSUE DATE 9/29/70	
APPROVED: T E Brock		PAGE 1 OF 6	

1. SCOPE

1.1 Summary

This document defines the method and timing for accomplishing internal audits of fabrication, test, storage processes, facilities, and Quality operations.

1.2 Purpose

To assure adherence to internal operating specifications.

1.3 Reference

a. Quality Procedure 5.0, "Quality Engineering"

2. RESPONSIBILITIES

2.1 Quality Engineering

Quality Engineering will define which areas/processes will be audited, the timing and frequency of audits, maintain all documentation associated with the audits, and participate as an audit team member, when required.

2.2 Quality Control

Quality Control will conduct audits as specified by Quality Engineering, report audit results, and pursue corrective action follow-up activities.

2.3 All Departments

All departments will be required to furnish personnel to serve as audit team members upon the request of Quality.

2.4 Quality Manager

The Quality Manager will approve both the audit plans and those individuals responsible for conducting audits.

3. REQUIREMENTS

3.1 Audit Types

Audits will include as a minimum, but will not necessarily be limited to items such as Quality functions, Manufacturing processes, and areas such as fabrication, test, and storage facilities.

3.1.1 Quality Audits - Quality functions, as described in Quality Directives, will be audited to determine compliance with the requirements of the applicable documents.

3.1.2 Process Audits - The Manufacturing department will be audited to determine compliance with the requirements of the pertinent Process Specification.

3.1.3 Fabrication and Test Area Audits - Fabrication and testing areas such as the thermoelectric area, plating and finishing area, generator assembly area, generator testing area, etc., will be audited to verify fulfillment of contract requirements including adherence to processes, procedures, and specifications, adequacy of log control and data recording, and general housekeeping.

3.1.4 Storage Area Audits - Stockrooms will be audited for items such as identification of material and parts, adequacy of storage facilities, adherence to applicable storage requirements, and general housekeeping.

3.2 Frequency of Audits - Audits will be conducted bi-monthly. Audit items selected by Quality Engineering and approved by the Quality Manager will be based upon current experience factors.

3.3 Audit Planning - Audit plans will be prepared by Quality Engineering and approved by the Quality Manager prior to the initiation of an audit.

3.4 Notification of Audit - Audit plans will be submitted to the affected area Manager at least 24 hours prior to the start of the audit.

3.5 Auditing Personnel - All audits will be conducted by personnel approved by the Quality Manager.

3.6 Reporting Audit Results - A memorandum, supplemented if required by the use of forms shown in Figures 1 and 2, will be issued describing the findings of all audits. Distribution of all audit reports will be as follows:

a. Quality Manager

b. Manager, department audited

c. Responsible Supervisor

d. Quality Engineering file

3.7 Discrepant Audit Items - The responsible department will be required to take corrective action on discrepant audit items within an appropriate time period.

3.8 Corrective Action Reporting - The department responsible for audit corrective action defines the corrective action taken by completing the Audit Reply (Figure 3) form and forwarding it to the Quality Manager.

3.9 Corrective Action Follow-Up Audits - The pertinent audit team will conduct a follow-up audit on discrepancies noted during the original audit to determine the effectiveness of the corrective action.

4. NOTES/APPENDIX

4.1 Figures

Figure 1 - Manufacturing/Test Area Audit Form

Figure 2 - Stockroom Audit Form

Figure 3 - Audit Reply

Audit No. _____

MANUFACTURING / TEST AREA AUDIT FORM

Area Audited: _____ Date of Audit: _____ Area Supervisor: _____

Check List	Status
1. General Housekeeping	
2. Equipment Calibration	
3. Evidence of Acceptable Parts	
4. Adherence to Procedures	
5. Adequacy of Data Recording	
6. Material Handling & Storage	

Auditors _____

_____

Figure 1

STOCKROOM AUDIT FORM

Date of Audit: _____ Responsible Supervisor: _____

Check List	Status
1. General Housekeeping	
2. Shelf Life Items within allowable limits	
3. Evidence of Acceptance Inspection	
4. Check Parts for corrosion, damage and contamination.	
5. Parts identified properly	
6. Bin identification	
7. Segregation of parts to avoid mixing	
8. Parts stored in a manner to prevent damage	
9. Random check of records	

Auditors _____

_____

Representative (Area audited) _____

Figure 2

AUDIT REPLY

Area Audited _____ Date of Audit _____

Corrective action taken: _____

_____

_____

_____

_____

_____

_____

Action taken to prevent recurrence: _____

_____

_____

_____

_____

_____

_____

_____

_____ _____
Manager Date

Figure 3

TELEDYNE ISOTOPES

QUALITY DIRECTIVE

TITLE: UTILIZATION OF LIAISON CALL SHEET		
ORIGINATED BY: R. Wathen	DIRECTIVE NO. 5.4	REV. A
REVISED BY:	REVISION DATE: Original	
REVIEWED BY: R. P. Bruno	ORIGINAL ISSUE DATE: 12/8/71	
APPROVED: G. F. Brook	PAGE 1 OF 7	

1. SCOPE

1.1 Summary

This directive describes the usage of the Liaison Call Sheet by Quality personnel to effect documented communication to resolve technical problems.

1.2 Purpose

The proper use of the Liaison Call Sheet provides documentation and a method of follow-up for formal communication between Quality Operations and other departments for the resolution of problems concerning safety, drawings, technical documents, methods, procedures, etc.

1.3 References

This directive is authorized by Quality Procedures 2.0 "Drawings and Specifications," 5.0 "Quality Engineering," and 11.0 "Corrective Action."

1.4 Applicability

This directive has been prepared to conform with:

Agency	Quality Specification	Conformance Partial	Conformance Complete
AEC	SNAP-1, and -2		X
AEC	SNS-1		X
NASA	5400.4 (1b)		X
DOD	MIL Q-9858 A		X

1.5 Limitations

1.5.1 The Liaison Call Sheet is not an official Quality record and must not be used for deviation, variation or repair records.

90001188

1.5.2 A Liaison Call Reply is not to be used as an acceptance criteria. It may, however, be used as supplemental information to be attached to a change notice, R.S. Tag or other document or to communicate that a documented change has been, or is being, accomplished.

1.5.3 The Liaison Call Sheet is a division-wide document; however, this directive is concerned only with LCS's originated by Quality Operations and/or those answered by Quality Engineering.

1.5.4 These limitations apply only when QD 3.4 "Quality Control of INSD Fabricated Material," is implemented by program requirement.

2. RESPONSIBILITIES

2.1 Originator

2.1.1 Quality Operations - The initiation or generation of a Liaison Call Sheet is the responsibility of any Quality personnel who requests or requires Engineering or Manufacturing coordination, action or help in resolving or correcting an error, omission or problem which affects the acceptability of the product being manufactured, tested or inspected.

2.1.2 Quality Engineering - Quality Engineering shall review the answers on all LCS's originated by Quality personnel. Action should be taken by Quality Engineering for prompt follow-up and corrective action.

2.2 Engineering/Manufacturing/Quality Engineering

The assigned respondent of a Liaison Call Sheet shall be responsible for timely attention, action and/or resolution of the situation or request and to return to the originator an adequate and acceptable answer within a reasonable time frame.

3. REQUIREMENTS

3.1 Situations Requiring Use of the Liaison Call Sheet

Liaison Call items include requests to:

a. Correct an error or deficiency in the design of a part or tool;

b. Clarify or correct a drawing notation, process, plan or specification; and

c. Correct a condition affecting personnel or equipment safety.

3.2 Form Used

Liaison Call Sheet, Form I-E-123 (Fig. 1).

3.3 Origination of a Liaison Call

A Liaison Call is originated using the Liaison Call Sheet when a problem item requires the immediate action of another department.

3.3.1 Quality Personnel Action - When the Liaison Call is warranted, Quality personnel shall:

3.3.1.1 Prepare a Liaison Call Sheet, in triplicate, in sufficient detail as to be self-explanatory and to prevent delay in acting on the subject. (See Appendix, para. 4.1, LCS Preparation Instructions).

3.3.1.2 Distribute the Liaison Call Sheet as follows:

a. The white (Liaison) and the pink (design) copy are sent to the Liaison coordinator for assignment to proper department and individual for an answer.

b. The green (originator) copy is placed in the LCS Book as a record until the white (Liaison) is returned.

c. The hardback copy may be retained by the originator until he receives the white (Liaison) with the signed reply.

3.4 Liaison Action

The personnel assigned to reply to a Liaison Call Sheet by the Liaison Call coordinator will answer and act on each Liaison Call in a timely manner.

3.5 Follow-up Action

Reply detail should answer the question, indicate the action taken, or define the proposed action to resolve the problem.

3.5.1 LCS Originator Action: When the reply is received, the Liaison Call Sheet originator should review the answer, forward it to Quality Engineering, and, if necessary, discuss reply action with Quality Engineering.

3.5.1.1 A Quality Engineer will sign the reply in the originator's concurrence block, indicating acknowledgment of a satisfactory answer.

3.5.1.3 When the reply is unsatisfactory, the originator, with Quality Engineering concurrence, shall make a notation under the reply portion of the Liaison Call Sheet stating that "Reply is Not Satisfactory" and give reason. If coordination with the assigned engineer cannot resolve the problem, refer the Liaison Call to the section supervisor or next higher authority, as required, to act on the condition until resolution of the item is achieved.

3.5.1.4 Copies of all replies and correspondence concerning a Liaison Call Sheet will be filed by LCS Sheet number in the Liaison Call Book.

3.6 Preparation of Liaison Call Sheet (Originator)

The originator shall complete all applicable blocks in upper part of the Liaison Call Sheet except 10, 11 and 13 through 16 and 21 through 23 as follows. Only one item or trouble should be described on each Liaison Call Sheet.

(1) Model - Name of item of equipment concerned, such as: SNAP-19, Pioneer, Viking, etc.

(2) Order No. - Specify INSD account number for program.

(3) Control Point - The Control Point Number concerned may be indicated in this block (see below):

Control Point Number	Area of Concern
10	Administration
20	Quality Control
30	Fabrication and Assembly
40	Testing
50	Fuel Capsule
60	Safety
70	Aerospace Ground Equipment (AGE)
80	Quality Engineering

(4) Book No. - Indicate the Liaison Call Book number in which the LCS will be filed by the originator.

(5) Sheet No. - Indicate the next sheet number in the Liaison Call Sheet Book Log and indicate the originator's name and program next to that number in the LCS Book Log.

(6) Drawing No(s). or Tool No(s). - List the complete drawing or tool number(s); add additional numbers in section (24) as an extension of (6).

(7) Originator - Print originator's name (first initial and last name) in this block.

(8) Extension No. - Indicate INSD telephone extension number.

(9) Location - Indicate section of originator, i.e., Quality Engineering (QE), Quality Control (QC).

(12) Date - Enter the date the trouble or LCS originated.

(17) Work Stoppage - Place "X" in applicable block.

(18) Recommended Effect - Indicate serial numbers of affected units, if known.

(19) Articles Requiring Rework - Indicate quantity of, or serial numbers, of, items requiring rework, if applicable.

(20) Articles TCO - List quantity of, or serial numbers of, items "Taken care of" or which have had the operation or rework completed as of time that LCS is written.

(24) Description of Trouble - Describe in sufficient detail the problem or request and urgency of situation, if warranted. Include page, paragraph or area of a drawing affected or nomenclature of part or equipment, etc., which requires the evaluation and reply. Write specific questions and list exact detailed requirements, sketches, etc., so as to prevent delaying questions by the person assigned to answer the Liaison Call Sheet. Other information may be attached by using additional forms.

(25) Reason for Change - In simple language, specify reason for Liaison Call Sheet, such as "omission, error, clarification, fit, etc.".

(11) Supervisor's Signature - Upon completion of above blocks, obtain the Quality Control or Quality Engineering supervisor's signature, as applicable.

4. APPENDIX

4.1 Figures

Figure 1, Liaison Call Sheet, Form I-E-123.

LIAISON CALL SHEET

(1) MODEL	(2) ORDER NO.	(3) CONTROL PT.	(4) BOOK NO.	(5) SHEET NO.	(13) ENGRG JOB NO.
(6) DWG. NO. (S) & OR TOOL NO. (S)		(7) ORIGINATOR	(8) EXT NO.	(9) LOCATION	(14) ASSIGNED BY
(10) MFG LIAISON REP.		(11) SUPERVISOR'S SIGNATURE	(12) DATE	(15) EXT.	(16) DATE

(17) WORK STOPPAGE	(18) RECOMMENDED EARLIEST (INCLUDE RETROFIT)	☐ ENGRG LIAISON (21)
☐ YES	(19) ARTICLES REQUIRING REWORK	☐ MFG LIAISON
☐ NO	(20) ARTICLES TOO (INCLUDE RETROFIT)	☐ SAFETY

(24) DESCRIPTION OF TROUBLE	(22) MFG. STAMP	(23) QUAL. STAMP

(25) REASON FOR CHANGE

(26) ANSWER

(27) CO-SIGNATOR'S CONCURRENCE	(28) FOR UNIT NO./VESSEL NO.	(29) CHANGE LETTERS	(30) INVESTIGATOR'S SIGNATURE	(31) DATE

I-E-123 LIAISON

I-E-123 DESIGN

I-E-123 ORIGINATOR

I-E-123 ORIGINATOR Fordback Copy

Figure 1

TELEDYNE ENERGY SYSTEMS

QUALITY DIRECTIVE

TITLE: QUALITY PLANNING			
ORIGINATED BY: J. Wenderoth/M. Kaplow		DIRECTIVE NO. 5.5	REV. B
REVISED BY: G. Chryst		REVISION DATE 3/7/79	
REVIEWED BY: [signature] 7Mar79		ORIGINAL ISSUE DATE 5/1/72	
APPROVED: W. A. McDonald 3/7/79		PAGE 1 OF 2	

1. SCOPE

1.1 Summary

This directive delineates the planning functions performed by Quality Engineering.

1.2 Purpose

To assure that:

a. The functions of the Quality Program that must be performed to fulfill the contractual requirements of product control, product documentation and product acceptance, are identified.

b. Quality Control is provided with the software they require to accomplish their share of those functions.

1.3 Reference

a. Quality Directive 2.1, "Configuration Control".

2. RESPONSIBILITY

2.1 Quality Engineering

Quality Engineering has sole responsibility for the accomplishment of the requirements of this Directive.

3. REQUIREMENTS

3.1 Quality Engineering Action

3.1.1 Technical Documents

Upon receipt (from the Engineering Release System) of new or revised drawings, procedures, specifications and changes thereto, Quality Engineering shall promptly forward copies to Quality Control.

3.1.2 Inspection and Test Instructions/Plans

Quality Engineering shall:

a. Review the Technical Documents to identify the acceptance requirements applicable to the Program.

b. Provide Quality Control with written inspection and test instructions (Certification Logs) as required.

The Certification Logs shall be designed to collect and document objective evidence of product compliance and quality acceptance.

3.1.3 Records Retention

Quality Engineering shall record and file for retention, the documents and evidence of product compliance and quality acceptance in accordance with contractual obligations and/or Company needs.

Such documentation shall include Certification Logs, Manufacturing Orders and Purchase Orders.

3.1.4 Configuration Records

Quality Engineering shall prepare and maintain Configuration Records from Engineering Releases for deliverable products and record the applicable changes in the appropriate Certification Logs for verification by Quality Control.

These activities are detailed in Quality Directive 2.1, "Configuration Control".

3.1.5 Quality Forms and Instructions

Quality Engineering shall:

a. Originate or revise the Quality Department forms and form instructions.

b. Supply such forms to the users as needed.

TELEDYNE ISOTOPES

QUALITY DIRECTIVE

TITLE: STANDARDS AND CALIBRATION			
ORIGINATED BY:	J.K. Wenderoth	DIRECTIVE NO. 7.1	REV. C
REVISED BY:	C.W. Rowe	REVISION DATE 4-8-74	
REVIEWED BY:	C. W. Rowe	ORIGINAL ISSUE DATE 7-10-69	
APPROVED	W. A. McDonald 4/10/74	PAGE 1 OF 9	

1. SCOPE

1.1 Summary

This directive defines a system for controlling the calibration of measurement and test equipment used for determination of product acceptability.

1.2 Purpose

To provide guidelines for the operation of a calibration program that will both insure conformance to contractual requirements and promote a high degree of accuracy in measurement and test data.

1.3 Reference

a. Quality Procedure 7.0, "Standards and Calibration."

b. Military Specification: "Calibration System Requirements," MIL-C-45662A, 1962

2. RESPONSIBILITIES

2.1 Quality Engineering

Quality Engineering will prepare and maintain an equipment listing defining all equipment requiring calibration and the applicable calibration interval.

2.2 Quality Control

Quality Control will be responsible for maintaining and calibrating, within the predetermined calibration interval, all equipment specified by Quality Engineering; maintaining measurement standards; and, maintaining documentation associated with the operation of the calibration system.

2.3 Other Departments

All other departments will be responsible for verifying that new equipment under their cognizance is calibrated before use and for verifying that old equipment under their cognizance is within the stated calibration period.

3. REQUIREMENTS

3.1 Determination of Calibration Intervals

Quality Engineering will establish the calibration intervals for both existing and newly purchased equipment.

3.1.1 Calibration Cycles for Existing Equipment - The calibration intervals for existing equipment will be based on knowledge of equipment history and limitations, and review of vendor literature.

3.1.2 Calibration Cycles for New Equipment - Calibration requirements will be established upon receipt of new equipment and will be based on experience with similar equipment and vendor literature.

3.2 Adjustments to Established Calibration Cycles

Quality Control may alter the established calibration cycle for a specific piece of equipment with Quality Engineering approval, on the basis of the calibration history of that piece of equipment.

3.2.1 Increased Calibration - The calibration cycle for a piece of equipment may be shortened when that equipment has required adjustment during two consecutive calibrations.

3.2.2 Decreased Calibration - The calibration cycle for a piece of equipment may be lengthened when that equipment has completed four consecutive calibrations without an adjustment.

3.3 Recall System

Quality Control will establish and operate a recall system which will insure the timely calibration of all equipment.

3.3.1 Equipment History File - A card file (Fig. 1) will be maintained on each piece of equipment and will include, as a minimum, the required calibration dates and the calibration history of the equipment.

3.3.2 Recall Notification - A memorandum will be forwarded to the user of a piece of equipment before that equipment is due for calibration.

3.3.3 Overdue Notification - A memorandum will be written to the cognizant department head when equipment due for calibration is not turned in to Quality Control by the recall date.

3.4 Extension of Calibration Certification

Quality Engineering may extend an existing calibration certification for a period not to exceed two weeks. This extension will be granted in cases where there is a critical need for the particular piece of equipment and there is evidence that a calibration delay will not adversely affect the product.

3.5 Calibration Procedure

Quality Control will perform actual calibration of equipment or will assume responsibility for calibration at a recognized calibration laboratory. All calibration will be in accordance with the requirements of MIL-C-45662A.

Adequacy of Standards - Standards established by the contractor for calibrating the measuring and test equipment used in controlling product quality shall have the capabilities for accuracy, stability and range required for the intended use.

3.5.1 In-House Calibration - In-house calibration will be performed in accordance with standard calibration practices. Written procedure will be prepared and utilized for calibration of all measuring and test equipment and measurement standards used to assure the accuracy of measurements involved in establishing product conformance. Measuring and test equipment and measurement standards will be calibrated and utilized in an environment controlled to the extent necessary to assure continued measurements of required accuracy giving due consideration to temperature, humidity, vibration, cleanliness, and other controllable factors affecting precision measurement.

3.5.1.1 Upon completion of calibration, complete the equipment history card and affix a stamped calibration sticker (Fig. 2) to the equipment.

Equipment found to be out-of calibration is immediately brought to the attention of Quality Control. So that reinspection of material will be taken on all materials that may have been accepted by the equipment out-of calibration.

3.5.1.2 Calibrated mechanical equipment unused during a calibration cycle may be integrity inspected in lieu of recalibration.

3.5.2 Vendor Calibration - Equipment which cannot be calibrated in-house will be sent to an approved (by Quality Engineering) calibration laboratory.

3.5.2.1 An Equipment Service Request (ESR) tag (Fig. 3), signed by Quality Control, will be attached to the equipment requiring calibration.

3.5.2.2 A Work Release (Fig. 4) will be completed for each piece of equipment requiring calibration and will be forwarded to the calibrating agency.

3.5.2.3 Upon return of calibrated equipment, review calibration certificate for completion, sign Work Release and forward to Procurement, complete equipment history card, and assure that the equipment contains a valid calibration sticker.

3.5.3 Sealing of Calibrated Equipment - Calibrated equipment will be sealed (if reasonable) with a tamper-proof seal to prevent unauthorized entry/ adjustment.

3.5.4 Calibration of Reference and Transfer Standards - A purchase requisition will be initiated to obtain calibration of standards. This purchase requisition will include the requirement for a certificate of compliance attesting to the date, accuracy, and conditions under which the results furnished were obtained. Calibration source-measuring and test equipment shall be calibrated utilizing reference standards whose calibration is certified as being traceable to the National Bureau of Standards.

3.6 Functional Checking of Equipment

Equipment that is not required to assure conformance of product but is necessary for overall efficient plant operation will be functionally checked upon request of the user.

3.7 Verification of Calibration Status

All users of measurement/test equipment will verify that the equipment is within calibration (as denoted by the attached sticker) and verify that the integrity seals are intact.

3.7.1 Out-of-Calibration/Malfunctioning Equipment - Out of calibration/malfunctioning equipment will be reported to Quality Control who will place an Out of Service (Fig. 5) tag on the equipment pending calibration or repair.

All out-of service equipment and equipment not in daily use with exception of large test equipment, consoles,etc., shall be segregated in specific equipment holding areas.

3.7.1.1. Product that has been manufactured/tested with discrepant equipment as noted above, will be documented on an RS tag for final disposition.

4. NOTES/APPENDIX

4.1 Figures

Figure 1 - Equipment Calibration History Card, Form 060306 (Rev. 1-64)

Figure 2 - Calibration Sticker, Form I-Q-401

Figure 3 - Equipment Service Request and Calibration Notice, Form TE-267 (1962)

Figure 4 - Work Release Form

Figure 5 - Out of Service Tag, Form I-M-303

1. INTERVAL
2. EQUIPMENT NAME
3. CUSTODIAN
4. LOCATION
5. EQUIPMENT NO.
6. SERIAL NO.
12. MASTER
13. PROD.
7. REMARKS
CALIBRATED/INSPECTED
8. DATE
9. STAMP
10. CUST.
11. DUE DATE

VISUAL INSPECTION RECORD ATTRIBUTE DATA 060306 REVISED 1-64

90001202

Figure 1

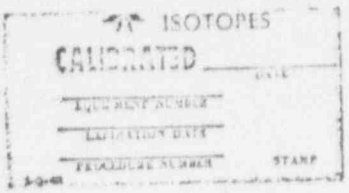


Figure 2

JOB NO. _____

EQUIPMENT SERVICE REQUEST AND CALIBRATION NOTICE

ACCOUNTABLE TO	NAME		PHONE
DATE	EQUIP. NO.	EQUIPMENT NAME	JOB NO.
EQUIP. MODEL NO.	EQUIPMENT NUR.		E. S. R. ORIGINATOR
USING DEPT.	LOCATION	PHONE	SUPERVISOR	CALIB. DUE DATE
CALIB. REQ'D		MAINT. REQ'D		EQUIP. PERFORMANCE NORMAL	
ACCOUNT NUMBER		CHARGED TO	NAME	BADGE

DESCRIPTION OF MALFUNCTION _____

EQUIPMENT CONTROL CRIB

DATE RECD.	CRIB NO.	CRIB ATTENDANT			LOCATION	PHONE	
INSTD. CALIB. REQ'D	YES	NO	QUAL. SURV. REQ'D			YES	NO
EQUIP. COND'L.		LAST CHANGE	LTR.	TDD	PHYSICAL DAMAGE	YES	NO

CALIBRATION CENTER

DATE RECD.	WITHIN SPEC.	YES	NO	DATE COMPL.	NEXT CAL'B. DUE
TECHNICIAN		W. C.	EQUIPMENT CONDITION CODE		

CORRECTIVE ACTION TAKEN: _____

STAMP

TE-567 (1952)

ORIGINATOR

Figure 3

ISOTOPES WORK RELEASE

PURCHASE ORDER

No:

THIS ORDER NUMBER MUST APPEAR ON ALL CORRESPONDENCE, INVOICES, PACKAGES AND SHIPPING PAPERS.

Date:

To:

Ship To:

SHIP VIA	F.O.B.	TERMS	DELIVERY REQUIRED

QUANTITY	DESCRIPTION	PRICE	AMOUNT

By: _____

90001204

Figure 4

OUT OF SERVICE

RECALIBRATE INSTRUMENTATION IN ACCORDANCE WITH O/P NO. _____

BEFORE
RETURNING TO SERVICE

I-M-303 SIGNED	EXT.	DATE

90001205

Figure 5

TELEDYNE ENERGY SYSTEMS

QUALITY DIRECTIVE

TITLE: PROCUREMENT DOCUMENTS - QUALITY REQUIREMENTS		
ORIGINATED BY: W. E. White	DIRECTIVE NO. 8.1	REV. C
REVISED BY: W. R. Seetoo	REVISION DATE 2/4/76	
REVIEWED BY: [signature]	ORIGINAL ISSUE DATE 2/18/71	
APPROVED: W. A. McDonald	PAGE 1 OF 7	

1. SCOPE

1.1 Summary

This directive specifies the quality requirements that are applicable to the preparation of procurement documents to ensure the receipt of high quality materials.

1.2 Purpose

This directive is issued to define the procedures and documentation methods by which Quality personnel will review and approve procurement documents to insure compliance with contractual requirements.

2. RESPONSIBILITIES

2.1 Quality Engineering

Quality Engineering will review and sign all Purchase Requisitions (PR) ES-49 (10/75) (Figure 1).

3. REQUIREMENTS

3.1 Quality Engineering

Quality Engineering will, upon receipt of a Purchase Requisition:

3.1.1 Review - Review the requisition to determine whether there is sufficient information to order the required material(s). Such information will be obtained from drawings, specifications, parts lists, catalogs, etc.

3.1.2 Requirements - Determine the Quality requirements that are necessary to assure product conformance with the contract specifications, Teledyne Energy Systems specifications and applicable drawings, and make entries on the PR as defined below.

3.1.2.1 Inspection requirements to be listed (if required):

(a) Standard requirements as indicated on NQ-341 (Figure 2) "Quality Assurance Provisions of Purchase Orders."

(b) Additional requirements which are non-standard.

3.1.2.2 Enter in code blocks provided on PR the standard Quality requirements as indicated on NQ-341 (3/76), "Quality Assurance Provisions of Purchase Orders," as determined in 3.1.2. If N-9 (Quality Pre-Award Survey) is entered, Procurement shall not place the order until the survey is complete.

3.1.2.3 The "Insp Area" block will be coded "X" for "No Inspection Required" or "R" for "Receiving Inspection Required."

3.1.2.4 "Insp. Type" block will be coded "R" for Normal Receiving Inspection or "S" for Special Requirements and "X" for "No Inspection Required."

3.1.2.5 Specific detailed requirements not covered in Items 3.1.2.1 above will be noted in "Special Notes" block of PR.

3.1.2.6 When special or critical characteristics are to be checked and/or reported, such requirements shall be forwarded on Receiving Inspection Report (ES-428) (Figure 3) as required, to Quality Control who shall attach the copy to the PO/PR package.

3.1.2.7 Sign and date PR in Quality Control block.

3.1.2.8 Send the Quality copy of the PR to Quality Control, coded for inspection requirements, and Quality Control shall file it in the Purchase Order Control file awaiting attachment to the PO.

3.1.2.9 Forward PR to Administration Department for signature and further processing.

3.2 Quality Control

3.2.1 Review of Purchase Order - Quality Control will, upon receipt of the Quality copy of the Purchase Order (ES-37) (Figure 4):

3.2.1.1 Remove copy of PR from Purchase Order Control File.

3.2.1.2 Compare the PO with the PR to assure that PR inspection requirements are listed on the PO.

3.2.1.3 Where a discrepancy affecting Quality exists between the PR and PO, return the PO to Procurement for correction.

3.3 Quality Control/Receiving Inspection

3.3.1 File PR/PO - Quality Control will place the documents in numerical order by PO number in the Receiving Inspection Control file to await receipt of material from vendor.

4. NOTES/APPENDIX

4.1 Figures

Figure 1 - Purchase Requisition, ES-49

Figure 2 - Quality Assurance Provisions of Purchase Orders, NQ-341

Figure 3 - Receiving Inspection Report, ES-42R

Figure 4 - Purchase Order & Receiving Report (Lower Section), ES-37

4.2 Interface

This Quality Directive interfaces with the processing of procurement documents as defined in the Procurement Manual, Index numbers:

2.9 Requisition of Material

2.11 Purchase Request - Processing

2.12 Purchase Orders and Subcontracts

PURCHASE REQUISITION

DATE _____ PAGE _____ OF _____

TELEDYNE
ENERGY SYSTEMS
110 W. TIMONIUM RD., TIMONIUM, MD. 21093
PHONE: 301-252-8220 TELEX: 87-780 CABLE: TELISES

PURCHASE REQUISITION NUMBER: 41737

PURCHASE ORDER NUMBER:

BLANKET NUMBER | RELEASE NO

IMPLANT LOCATION

NAME

PHONE | MAIL NO.

SHIP TO:

CODES

DISP. AREA | DISP. TYPE

GOVT. CONTRACT NO. | D.O. RATING | TERMS | F.O.B. | EXEMPT FROM MD. SALES & USE TAX | SHIP PREPAID VIA

SHIP DATE | DATE DEL'Y. REQ'D. | ULTIMATE USE | ACCOUNT NO. | GOVT. PROPERTY YES ☐ NO ☐

NOTE: IF DRAWINGS ARE REQUIRED ATTACH FOUR (4) COPIES

ITEM NO	QUANTITY	PART CODE	COMPLETE DESCRIPTION, INCLUDING SIZE, COLOR, WEIGHT, SPEC.–WITH NOUN FIRST	UNIT PRICE	TOTAL

ESTIMATED PRICE: _____

REMARKS: _____

SPECIAL NOTES: | TOTAL

CONFIRMING PHONE ☐ TWX ☐ ORAL ☐ ORDER

DATE

ORIGINATOR & TEL. EXT.	PROGRAM MANAGER	DEPT. MANAGER	FINANCE	QUALITY CONTROL	BUYER

ES-40 (10.75)

REVISION TO ORIGINATOR

90001209

TELEDYNE
ENERGY SYSTEMS

QUALITY ASSURANCE PROVISIONS OF PURCHASE ORDERS

Buyer hereinafter shall mean Teledyne Energy Systems. Notwithstanding any other provisions, all articles furnished hereunder are subject to the Inspection Clause of the General Provisions of the Purchase Order and the following Special Inspection Clause(s) when indicated by clause number(s) in the schedule of the Purchase Order.

Articles defined in the schedule of the Purchase Order will not be accepted by Buyer if the Seller fails to submit certification, documentation, test data and reports specified herein.

N-1 Energy Research & Development Admin'n

Energy Research & Development Administration (ERDA) or their designated authority inspection is required prior to shipment from your plant. Three (3) copies of this contract have been furnished to the cognizant Government agency. These copies will be forwarded to the appropriate Government office having cognizance at your plant.

N-2 Shipment to Buyer Contractor/Agency

As material ordered hereunder is to be shipped direct to a Buyer designated contractor/agency, copies of the data required by this contract shall accompany the shipment and shall also be mailed to Buyer, " ttention: Quality Receiving Inspection" the same date the shipment is made.

N-3 Certificate of Compliance

A certificate or statement of material and process conformance is required covering the articles contracted for hereunder. This certificate or statement of conformance must stipulate that the items contracted for meet all drawings, specifications and other applicable documentation. An example of an acceptable certificate or statement of conformance is as follows:

"This is to certify that all items noted on Purchase Order Number AXXXX are in conformance with the Contract Purchase Order, drawings, specifications and other applicable documentation."

This certificate or statement shall be validated by an authorized representative of the Seller's Quality Department or validated by a notary public. This certificate must be attached to the packing sheet and accompany each shipment to be delivered hereunder.

N-4 Buyer Inspection at Destination

Articles defined in the schedule of this contract are subject to Buyer Inspection at destination and will not be accepted by Buyer if the Seller fails to submit the certification, documentation, test data, and reports specified in the Contract.

N-5 Source Inspection

Buyer source inspection shall be conducted at the Seller's facilities or where designated in this Contract, prior to shipment. When the items are ready for inspection, or if practicable ten (10) days in advance thereof, notify the Buyer Quality Representative or the Buyer area Quality office.

Drawings and/or other pertinent data which may be required for adequate inspection shall be made available to the Quality representative.

N-6 Chemical and Physical Test Reports

Actual chemical and/or physical test reports, one (1) copy as required by specification for each lot, batch or heat, whichever is applicable, must be attached to the packing sheet and accompany each shipment to be delivered hereunder.

N-7 Drawing Requirements

Drawing or sketch and specification sufficient to inspect and/or test this material must accompany first shipment of this Contract and be attached to the packing sheet.

N-8 Buyer Parts Procured to Seller Part Number

Articles defined by Seller's part number in this Contract will be inspected by Buyer for conformance to the referenced Buyer specification.

N-9 Quality Pre-Award Survey

Buyer shall survey Seller's facility to evaluate Seller's capabilities. Evaluation shall include, but not be limited to, manufacturing equipment, inspection department, ability to meet schedules, personnel qualifications, etc. The survey may take place prior to actual fabrication, if delay of of order placement jeopardizes schedule or cost (Pre-fabrication Survey).

Figure 2

TELEDYNE
ENERGY SYSTEMS

RECEIVING INSPECTION REPORT

Purchase Order No. _____

Report No. _____

Specifications	1		Req'd Certifications/Reports	6	
Teledyne Part & Dash Number	2		Special Provisions of Receiver	7	
Manufacturer's Part Number	3		Source Inspection Evidence	8	
Manufacturer's Name/Trade Mark	4		Workmanship/Damage	9	
Serialized Item	5		Sampling - Table No. _____	10	

Instructions for completion of this report:
The ten inspection characteristic blocks must be completed "YES" or "NO", inserted in the block following the numeral. All "YES" items will be supported by recording pertinent data in the field of this report. In addition, all inspection characteristics verified must be recorded - measurements, drawing notes, etc.

6. Verify that all certifications or data required by drawing, specifications or purchase order are received.

Review required certifications and data to assure conformance with requirements.

Signature _____ Date _____ Stamp _____

PURCHASE ORDER & RECEIVING REPORT (LOWER SECTION)

PURCHASE ORDER

PAGE ____ OF ____

TELEDYNE ENERGY SYSTEMS
110 W. TIMONIUM RD. TIMONIUM, MD. 21093
PHONE: 301-252-8220 TELEX: 87-780 CABLE: TELISES

PURCHASE ORDER NO.	DATE	AMENDMENT NO.
ABOVE NUMBER MUST APPEAR ON ALL INVOICES, PACKAGES, PACKING SLIPS, CORRESPONDENCE, ETC. INVOICE IN TRIPLICATE TO ACCOUNTING DEPT.		

TO

SHIP TO: TELEDYNE ENERGY SYSTEMS
110 W. TIMONIUM ROAD
TIMONIUM, MARYLAND 21093

PRIME CONTRACT NO.	PRIORITY	TERMS	F.O.B.	TAX EXEMPT NO. A78190 ☐ YES ☐ NO	SHIP PREPAID VIA
SELLER'S SHIP DATE	REC. DATE	INSPECTION	ORIGINATOR	ACCOUNT NO.	REQ'N NO.

ITEM NO.	QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
		Confirming telecon order of _____ to _____		

POOR ORIGINAL

THE ATTACHED GENERAL PROVISIONS _____ IS APPLICABLE TO AND BECOMES PART OF THIS PURCHASE ORDER.

OTHER FOLLOWING ARTICLES AND OR CODES ATTACHED ARE INCORPORATED IN THIS PURCHASE ORDER

PURCHASE ORDER VALUE ——▷

90001212

BUYER: _____

RECEIVING AND INSPECTION REPORT

REF NO.	ITEM	QUANTITY IN STOCK UNIT OF MEASURE						VENDOR'S P.N.		DATE RECV'D	M.S. NO.	REMARKS
		ORDERED	U/M	RECEIVED	U/M	ACCEPTED	REJECTED	ACCEPT	REJ			

RECEIVING REPORT - QUALITY CONTROL

TELEDYNE ENERGY SYSTEMS

QUALITY DIRECTIVE

TITLE: EMPLOYEE SKILL CERTIFICATION			
ORIGINATED BY:	W. J. Coleman	DIRECTIVE NO. 9.1	REV E
REVISED BY:	E. T. Charyszyn	REVISION DATE 3/7/79	
REVIEWED BY:	W. J. Coleman	ORIGINAL ISSUE DATE 2/16/70	
APPROVED	W. A. McDonald	PAGE 1 OF 5	

1. SCOPE

1.1 Summary

This directive provides a system for employee skill certification.

1.2 Purpose

To identify the skills requiring certification, to establish a procedure for certifying employees, and to control the issuance of skill certification cards.

2. RESPONSIBILITIES

2.1 Quality Engineering

Quality Engineering shall schedule and direct implementation of the employee skill certification program, and shall be responsible for maintaining the records associated with the operation of the skill certification program.

2.2 Quality Control

Quality Control shall be responsible for the identification of employees performing operations requiring skill certifications and shall monitor the preparation of samples when required in the certification program.

2.3 Personnel

Personnel shall arrange to have vision tests administered to those employees specified by Quality Engineering. These vision tests shall be administered on a yearly basis.

2.4 Engineering/Manufacturing

Engineering and/or Manufacturing shall be responsible for identifying those processes which require the use of a certified operator in the applicable drawing and/or process specification.

2.5 Department Supervisor

Each department supervisor having certified personnel reporting to him shall be responsible for maintaining cognizance of employee workmanship and activity in the certified skill; and shall participate in the review of employee certifications with Quality Engineering.

3. REQUIREMENTS

3.1 Quality Engineering

3.1.1 Skill Certification Requirements

Establish requirements for obtaining initial skill certification which may include some or all of the following:

a. On the job training

b. Preparation of sample specimens

c. Completion of written examination

d. Vision test

3.1.1.1 Define type and number of sample specimens required and evaluate their acceptability upon completion.

3.1.1.2 Prepare required written examinations and evaluate results.

3.1.1.3 Arrange in coordination with the Personnel Department for the completion of necessary vision tests.

3.1.1.4 Establish requirements for recertification as applicable (eg: Welding Qualification).

3.1.2 Recertification Requirements

Monitor operations to determine need for recertification based on any of the following:

a. Poor workmanship

b. Initiation of new methods

c. Inactivity in excess of the allowable time period.

d. Established recertification requirements

3.1.2.1 Periodically review work status of certified employees with their Supervisor to determine if inactivity limits have been exceeded and if acceptable workmanship levels have been maintained.

3.1.2.2 Review new and/or revised process specifications for possible changes affecting skill certifications.

3.1.3 Skill Certification Cards

Issue skill certification cards (see Figure I) to those employees who have successfully completed the certification requirements of a particular skill. These skills include: packing insulation, welding, potting, crimping, soldering, penetrant inspection, welding inspection, soldering inspection, etc.

3.1.4 Periodic Certification Review

Review employee skill certification and update status at specified intervals (see Figure 2).

3.1.5 Certification Records

Maintain records of the skill certification status of employees.

3.2 Quality Control

3.2.1 Requests for Certification

Submit requests for employee certifications to Quality Engineering.

3.2.2 Preparation of Samples

Monitor preparation of sample specimens for certification tests when directed by Quality Engineering.

3.2.3 Workmanship

Report incidences of poor workmanship to Quality Engineering.

4. NOTES / APPENDIX

4.1 Figures

Figure 1 - Teledyne Energy Systems Certificate of Qualification

Figure 2 - Employee Skill Certification Review Record

TELEDYNE ENERGY SYSTEMS HSD-1

CERTIFICATE OF QUALIFICATION

(IF GLASSES ARE REQUIRED - SPECIFY HERE)

THIS IS TO CERTIFY THAT

HAS SUCCESSFULLY COMPLETED REQUIREMENTS AS PRESCRIBED BY SPECIFICATION AND/OR CERTIFICATION TEST FORM AND IS QUALIFIED TO PERFORM THE SPECIFIED SKILLS AS INDICATED HEREON.

SIGNATURE OF CERTIFIED PERSONNEL

SEE QUALITY DIRECTIVE # 701 FOR CERTIFICATION PROCEDURE

(SKILL TITLE)

SPECIFICATION OR CERTIFICATION TEST FORM NO.

RECERTIFICATION DUE EVERY

DATE AUTHORIZED REPRESENTATIVE - SIGNATURE

(SKILL TITLE)

SPECIFICATION OR CERTIFICATION TEST FORM NO.

RECERTIFICATION DUE EVERY

DATE AUTHORIZED REPRESENTATIVE - SIGNATURE

90001216

Fig. 1. Teledyne Energy Systems Certificate of Qualification

EMPLOYEE SKILL CERTIFICATION REVIEW RECORD

EMPLOYEE NAME _____ _____

SKILL TITLE AND NUMBER	ACTIVE IN SKILL IN PRECEDING 6 MOS.		SATISFACTORY WORKMANSHIP		COMMENTS	DEPT SUPERVISOR RESPONSIBLE FOR REVIEW	QUALITY ENGINEERING ACKNOWLEDGEMENT	DATE
	YES	NO	YES	NO				

Fig. 2 Employee Skill Certification Review Record

TELEDYNE ENERGY SYSTEMS

QUALITY DIRECTIVE

TITLE: INSPECTION STAMPS		
ORIGINATED BY: C. W. Rowe	DIRECTIVE NO. 10.1	REV. C
REVISED BY: J. K. Wenderoth	REVISION DATE 1/27/76	
REVIEWED BY: C. W. Rowe	ORIGINAL ISSUE DATE 11/17/69	
APPROVED: W. A. McDonald	PAGE 1 OF 3	

1. SCOPE

1.1 Summary

This document defines the system for procurement, issuance, control, use, and return of inspection stamps.

1.2 Purpose

To provide a method that assures the proper usage of inspection stamps by qualified Quality Department personnel.

1.3 Reference

a. Quality Procedure 10.0, "Quality Stamps"

2. RESPONSIBILITIES

2.1 Quality Engineering

Quality Engineering is responsible for the control of stamp design, purchase, and issuance.

2.2 Quality Control

Quality Control is responsible for the proper care and use of issued stamps.

3. REQUIREMENTS

3.1 Quality Engineering

3.1.1 Procurement of Stamps - Upon receipt of request for a new or revised stamp, review with Quality Manager for approval. Prepare purchase requisition, including stamp design, for new stamp requirement. Follow up for receipt of stamps and deliver to Quality Engineering Supervisor.

NOTE: Stamp design must not conflict with the design of other company issued stamps and they shall not contain customer designations.

3.1.2 Issuance - Issue new or replacement stamps to qualified personnel. Maintain distribution control; list stamps by type, serial number and personnel to whom assigned.

3.1.3 Return - Receive stamps returned by Inspectors due to termination, stamp deterioration, etc. Assure return when need no longer exists.

3.1.3.1 Immediately confiscate and destroy stamps in deteriorated condition.

3.1.3.2 Hold useable stamps for six month period before reissuance.

3.2 Quality Control

3.2.1 Request for Stamps - The Quality Control Supervisor shall notify Quality Engineering of any need for a new stamp or revision to an existing stamp, noting the purpose for the stamp.

3.2.2 Care of Stamps - Quality Control shall exercise care to prevent loss of stamp to preclude unauthorized or improper use by any person other than assignee.

3.2.2.1 Maintain stamps so as to provide legible markings or impressions when affixed to articles or documentation.

3.2.2.2 Use black ink for stamping documents.

3.2.2.3 Notify Supervisor immediately if a stamp is lost or if unauthorized use of a stamp is suspected.

3.2.3 Instructions for Use of Stamps - Use assigned personal stamp to identify acceptance/status of material or articles which have undergone source or receiving inspection, in-process inspection, end item inspection, testing, storage or shipment, and to validate calibration records and seals.

3.2.3.1 . non-logged items, stamps may be applied directly to articles or materials except when this is impractical due to physical limitation or when such application will compromise their quality. In such cases, stamps shall be applied to identification tags or labels attached to articles or their containers.

3.2.3.2 When a stamp is used to indicate acceptance of a test on a non-logged item, note the test and any applicable test result adjacent to the stamp on the identification tag (i.e., hardness check, penetrant inspection, leak test, etc.).

3.2.3.3 For logged items, stamps shall be affixed in the appropriate block for the inspection step performed.

3.2.3.4 An Inspector shall, when necessary, void his original stamp by writing "VOID" across the face of stamp. The Quality Control Supervisor will be contacted if other inspectors' stamps require cancellation.

3.3 Types of Stamps

3.3.1 Rubber - Used to stamp material or parts when use will not be harmful to stamped article, and to stamp documents or forms, decals, torque markings, calibration records, seals, etc.

3.3.2 Impression - Used to stamp lead seals, parts when permissible, and tools.

APPENDIX B

EQUIPMENT MANUFACTURERS' DATA SHEETS

APPENDIX B CONTENTS

I. MOYNO AND ROPER PUMPS

NOMENCLATURE EXPLANATION

Moyno Pump constructions are described and identified by TYPE and FRAME.

This identification is for sales literature and quotations only and is not sufficiently accurate for the supplying of service parts. For a complete identification of a pump in service always give SERIAL NUMBER found on the nameplate.

EXPLANATION OF TYPE

PUMP TYPE is indicated by a group of three letters describing the grade and kind of material used in constructing three basic parts of the pump.

(a) MAIN FRAME OR BODY CASTING - the first letter always refers to the kind and grade of material used in constructing the main body of the pump.

(b) ROTOR - the second letter always refers to the kind and grade of material used in constructing the rotor and may or may not identify other internal machined parts, such as drive shaft, connecting rod, etc.

(c) STATOR - the third letter always refers to the kind and grade of material used in the construction of the stator.

The identifying letters are ALWAYS grouped in the above order.
The following letters have been assigned for use in the type designation of materials most commonly used:

Type Letter	Material
A -	Aluminum
B -	Bronze (88% Cu, 10% Sn, 2% Pb)
C -	Cast Iron.
D -	Tool Steel (High Carbon - High Chrome)
E -	Durimet or Carpenter #20.
G -	Stainless Steel Type #416
H -	Hastelloy
J -	
K -	
L -	Melmac (Melamine Resin)
M -	Monel
N -	
P -	
Q -	Ameripol Synthetic Rubber - Hard (70 Durometer Hardness Hycar)
R -	Natural Rubber - Soft (47 Durometer Hardness)
S -	Stainless Steel Type #316
T -	Aluminum Bronze (84.6% Cu, 11.3% Al, 3.7% Fe, 0.4% Special Agents)
U -	
V -	Bakelite (Phenolic Base)
W -	Cast Steel

EXAMPLES OF TYPE DESIGNATION

A standard basic pump with (a) cast iron castings, (b) carbon steel internal parts including a hardened tool steel rotor, (c) 47 durometer soft natural rubber stator, is known as Type CDR.

A pump constructed of (a) #316 stainless steel castings, (b) #316 stainless steel internal parts including the rotor, (c) 70 durometer hard Ameripol synthetic rubber stator, is known as Type SSQ.

A pump containing (a) cast steel castings, (b) carbon steel internal parts including a hardened tool steel rotor, (c) bakelite stator, is known as Type WDV.

PUMP FRAME EXPLANATION

CURRENT PRODUCTION - L, M, F, G and H frames are available. Pump frame is essentially an indication of size. It consists of:

A NUMBER, a LETTER, and a NUMBER, in which case the first number indicates the number of stages and the fact that it is a tubular pump. The letter indicates the basic construction style and the final number indicates the size of the stator-rotor elements. This designation is used for tubular constructed pumps (Sections 23, 24 & 25).

"L" - Improved tubular horizontal cradle mounted B. B. construction. The drive head corresponds to minimum size used with stator-rotor elements.

e. g. Frame 2L3. The first number 2 designates two (2) stages of stator-rotor elements and the fact that it is a tubular pump. The letter L designates the basic construction design and the final number 3 refers to the basic size of the stator-rotor elements. (See Section 25).

M - Improved tubular horizontal cradle mounted B. B. construction. The drive head is one size larger than normally used with stator-rotor elements.

e. g. 6M4. The first number 6 designates six (6) stages of stator-rotor elements and the fact that it is a tubular pump. The letter M designates the drive head as being one size larger than normally used with the stator-rotor elements. The final number 4 designates the basic size of the stator-rotor elements. (See Section 25).

F - Semi-sanitary food type construction. Inasmuch as only one stage construction is available in the F pumps, we do not use a number preceding the letter although they are tubular pumps.

e. g. Frame F4. The letter F designates the food type B. B. construction. The number 4 designates the basic size of the stator-rotor elements. (See Section 24).

INSTALLATION AND OPERATION OF MOYNO PUMPS

OPERATING PRINCIPLE of the Moyno Pump is based on two pumping elements consisting of a helical rotor turning within a double thread helical stator. The meshing helical surfaces push the liquid ahead with uniform movement and low turbulence similar to a slow moving piston in a cylinder of infinite length. The screw-like rotor rolls within the nut-like stator with an eccentric rolling movement.

1. The rotor provides an effective seal of liquid flow from port to port at all positions of rotation.

2. Displacement is positive and proportional to pump speed.

3. Pressure is independent of the pump speed.

4. There are no valves in the pump.

DRY FRICTION is harmful to this pump. Do not run the pump under power until it is filled with the liquid to be pumped. This liquid serves as a lubricant rather than a prime, since a flow of 10% of the pump displacement will satisfy cooling and lubricating requirements.

BASE & FOUNDATION

1. A concrete pier of liberal dimensions and having a level top surface makes an excellent foundation.

2. A fabricated structural steel base carefully planed true makes a very satisfactory base.

3. Lag screws or imbedded hold-down bolts for mounting base to foundation should be used and may be located in accordance with our certified dimension prints.

4. Do not warp structural steel base by pulling down to uneven foundation surface—shim instead.

ALIGNMENT OF DIRECT DRIVEN PUMP & DRIVE should be carefully checked after the base has been fastened down to the foundation. A 1/16" gap should be uniform. Drives should be re-aligned after reaching destination by loosening drive mounting bolts and aligning drive to best running tone.

BELT DRIVEN PUMPS should be checked after base has been fastened down to the foundation to make sure belts and pulleys are still in alignment and that the belts have the proper amount of tension.

ROTATION OF PUMP with the exception of a few larger models can be arranged to operate in either direction. A rotation plate is mounted on each pump, plainly designating the recommended direction for correct operation. This information is furnished by the pump manufacturer and is in accordance with the information received concerning the service and duty of each pump. Both inlet and outlet port designations are related to this rotation inasmuch as the Moyno Pump is fully reversible. Pump rotation is always determined when viewing the pump from the shaft extension or pulley end. If in doubt check with the factory.

PIPING TO PUMP should generally be equal in size to the pump port opening. Pipe systems handling viscous, volatile, or high temperature materials are often exceptions to this rule.

1. All screwed joints should be carefully "doped" before tightening (especially suction line connections).

2. Connected piping should mate pump port fittings free of strain.

3. Make all lines as direct and free of fittings as possible and minimize suction line length by locating pump near source of liquid.

VALVES of stop-cock type are superior for most special purpose duties. Gate valves are satisfactory for thin, clear liquids, and globe valves are least satisfactory of all. Avoid use of globe valves in suction lines and when used otherwise make sure that they are in circuit correctly. Strainers and foot valves must be in good working order to be beneficial, otherwise it is often better to omit them.

PUMP BEARINGS are ball bearings on all sizes except the #12 and #14. These two drive sizes have roller bearings. All bearings are grease lubricated.

1. Do not give these bearings routine lubrication because far more bearings are ruined due to over-attention and improper attention than otherwise.

2. Do Not lubricate with any grease except an approved bearings grease such as Mobil Oil Company's Mobil-Plex EP-1.

3. It is recommended, under normal use, that no lubrication be added for the first twelve months of operation.

4. At the end of this time the bearing-shaft assembly should be removed and washed with clean benzine.

5. All old grease should be removed from the bearing housing and only enough new grease applied to bearing races so as to fill them flush.

6. Add a few drops of oil to bearing seals before re-mounting assembly.

It takes several days of running for grease lubricated ball bearings in a new pump or re-lubricated pump to level off to final running temperature. Prior to reaching this condition the bearings might run hot to the extent that it is not comfortable to hold the hand on the housing.

PACKING MAINTENANCE PROCEDURES (GENERAL)

1. Adjustment of packing gland should be kept sufficiently snug so as to prevent leakage but not so tight that the stuffing box feels hot to the touch. Gland bolts must be kept evenly adjusted.

2. Nearly all Moyno Pumps are supplied with a lantern ring in the mid-section of the packing and a grease fitting communicating with it. Careful lubrication of the packing with a grease insoluble in the liquid pumped will pay dividends. Greasing often but with limited quantities is best practice.

3. Scored shafts are packing destroyers. If shaft is scored as much as 1/64" deep it should be removed and polished before renewing packing. Shafts can be sent back to factory for grinding and re-surfacing at a nominal charge. Shafting grooved 1/32" or deeper cannot always be reclaimed.

4. Packing replacements can best be made with formed rings and these should be inserted with their joints staggered. Do not use a one piece spiral wrap of packing. Care must be exercised in slipping rings over the shaft—part them as below to avoid deforming.

5. Forming of new packing in the stuffing box should be done by pulling gland bolts down evenly and firmly. Bolts should then be backed off gradually as stuffing box warms up. Several "touch-up" adjustments with the new packing can be expected before final running condition is attained.

NOTE: When ordering parts ALWAYS specify pump SERIAL NUMBER

SUBJECT: Dis-Assembly and Assembly Instructions
GENERAL HEADING: Improved Cradle Mounted Tubular Pumps

INSTRUCTIONS FOR DIS-ASSEMBLY AND ASSEMBLY
OF IMPROVED CRADLE MOUNTED TUBULAR PUMPS
(See Repair Parts List-Index 25B, Page 5)
FRAMES 1L2, 2L2, 3L2, 6M2, 1L3, 2L3, 3L3, 6M3, 1L4,
2L4, 3L4, 6M4, 1L6, 2L6, 3L6, 1L8, 2L8, 3L8

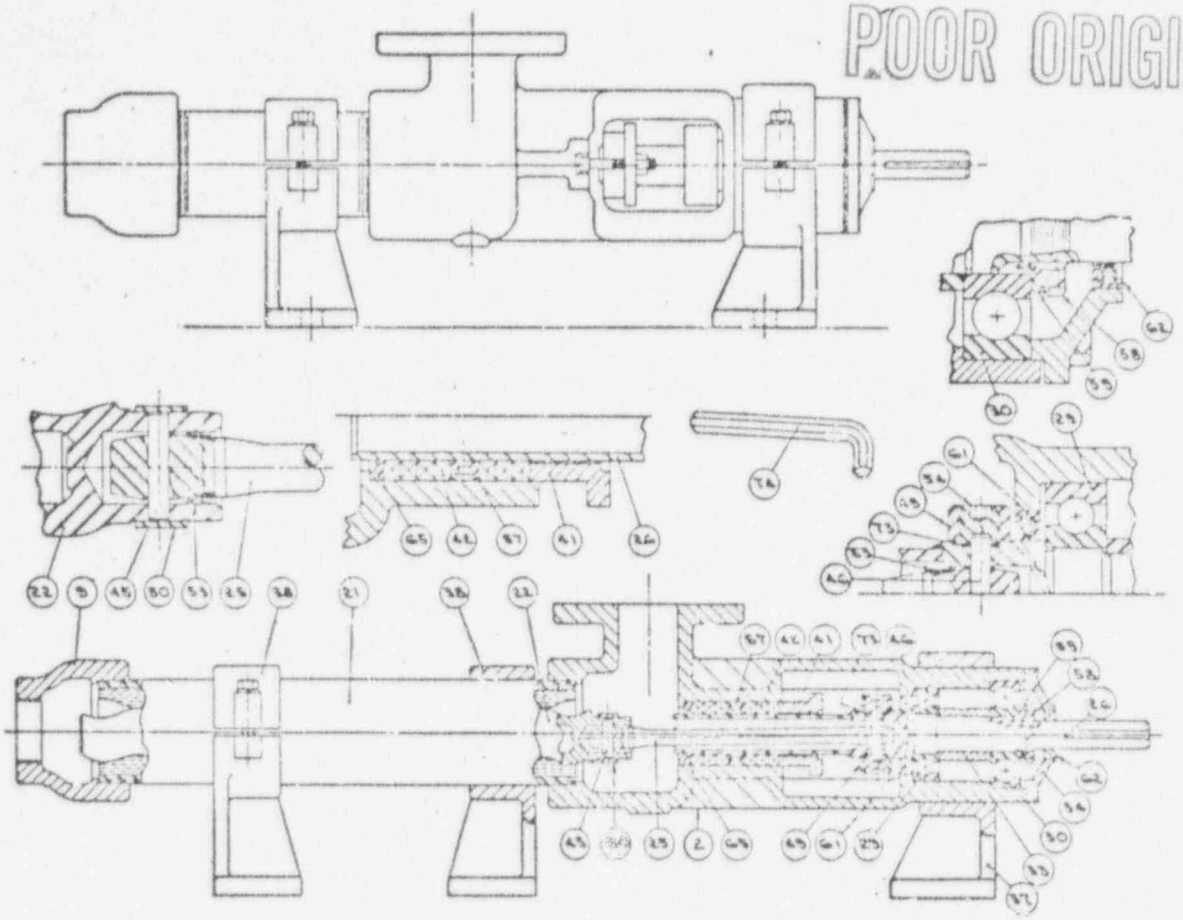
1. Remove clamp bolts from stator housing support #38, pull top half of stator support #38 from stator #21.
2. By using pipe wrench remove stator #21 from main body casting #1. Pull stator #21 off rotor #22.
3. Remove two drive pin screws #54 with Allen Wrench #74 and drive shaft pin #46 by pushing pin through collar #19.
4. Slide collar #49 back to packing gland #41.
5. Remove two drive pin washers #73. (It is usually best to use new drive pin washers when re-assembling).
6. Pull rotor #22 out of drive shaft #26.
7. To dis-assemble rotor and connecting rod, press rotor band #50 off rotor #22, push rotor pin #45 out of rotor #22, then pull connecting rod #25 out of rotor #22. To re-assemble rotor and connecting rod, use new connecting rod washers #53 and pack ball joint with water-proof grease.
8. Remove four cap screws from bearing cover plate #34.
9. Insert a small rod into drive shaft #26 through main body casting #1 and drive ball bearings and shaft assembly out of main body casting #1.
10. To dis-assemble drive shaft #26 and ball bearings, remove lock nut #58 and washer #59, then press bearing #29 and #30, also bearing spacer #33 off drive shaft #26. When assembling, bearing should be packed with a good bearing grease to about one third capacity of bearing housing.
11. Remove packing gland bolts and packing gland #41.
12. Remove packing #47 and note how the packing rings are staggered. When re-packing, stagger ends of packing. Remove lantern ring #57 and packing gland insert #65.
13. Press bearing housing grease seal #61 and bearing cover plate grease seal #62 out of main body casting #1 and bearing cover plate #34 respectively.
14. To re-assemble, reverse the above procedure.

NOTE: When ordering parts, ALWAYS specify pump SERIAL NUMBER.

90001228

REPAIR PARTS LIST

FRAMES 2M1, 3M1, 6M1, 1L2, 2L2, 3L2, 3M2, 6M2, 1L3, 2L3, 3L3, 3M3, 6M3, 1L4, 2L4, 3L4, 6P2, 9P2



Top Drawing 2M1, 3M1, 1L2, 2L2, 1L3, 2L3, 1L4, 2L4
Bottom Drawing 6M1, 3L2, 3M2, 6M2, 3L3, 3M3, 6M3, 3L4

Cat. No.	Part Name	Cat. No.	Part Name	Cat. No.	Part Name
2	Suction Body Cast.	34	Bearing Cover Plate	* 54	Dr. Pin Ret. Screws
5	Bearing Housing	37	Pump Support	57	Lantern Ring
9	Disch. End-Reducer	38	Stator Support	58	Bearing Lock Nut
* 21	Stator Assembly	41	Packing Gland	59	Bearing Lockwasher
* 22	Rotor	* 42	Packing Rings	61	Grease Seal-Radial
* 25	Connecting Rod	* 45	Rotor Drive Pin	62	Grease Seal-Thrust
26	Drive Shaft	* 46	Shaft Drive Pin	65	Packing Gland Insert
29	Radial Ball Bearing	49	Drive Shaft Collar	* 73	Drive Pin Washers
30	Thrust Ball Bearing	50	Rotor Band	74	Set Screw Wrench
33	Bearing Spacer	* 53	Conn. Rod Washer		

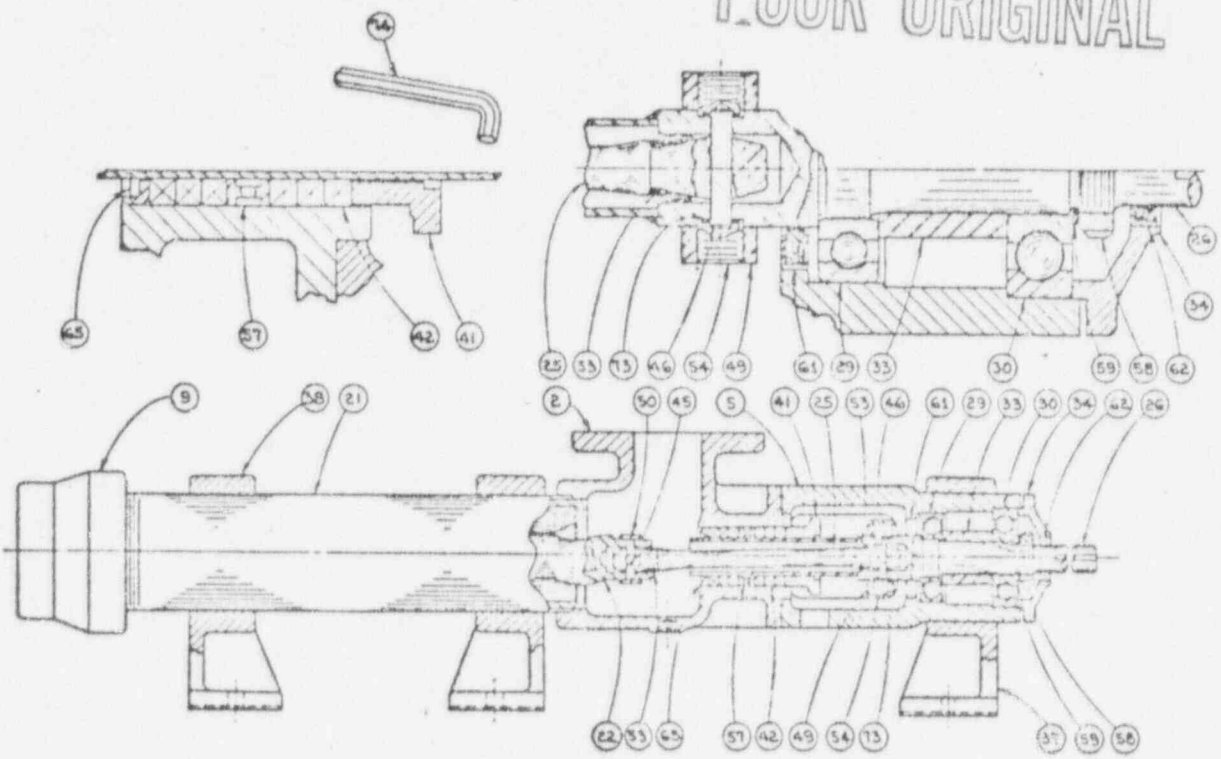
*Recommended spare parts

Miscellaneous hardware list (cap screws etc.) furnished on request.
NOTE: When ordering parts ALWAYS specify pump SERIAL NUMBER.

90001229

REPAIR PARTS LIST

FRAMES 3M4, 6M4, 1L6, 2L6, 3L6, 3M6, 1L8, 2L8, 3L8, 6P3, 9P3, 6P4, 9P4

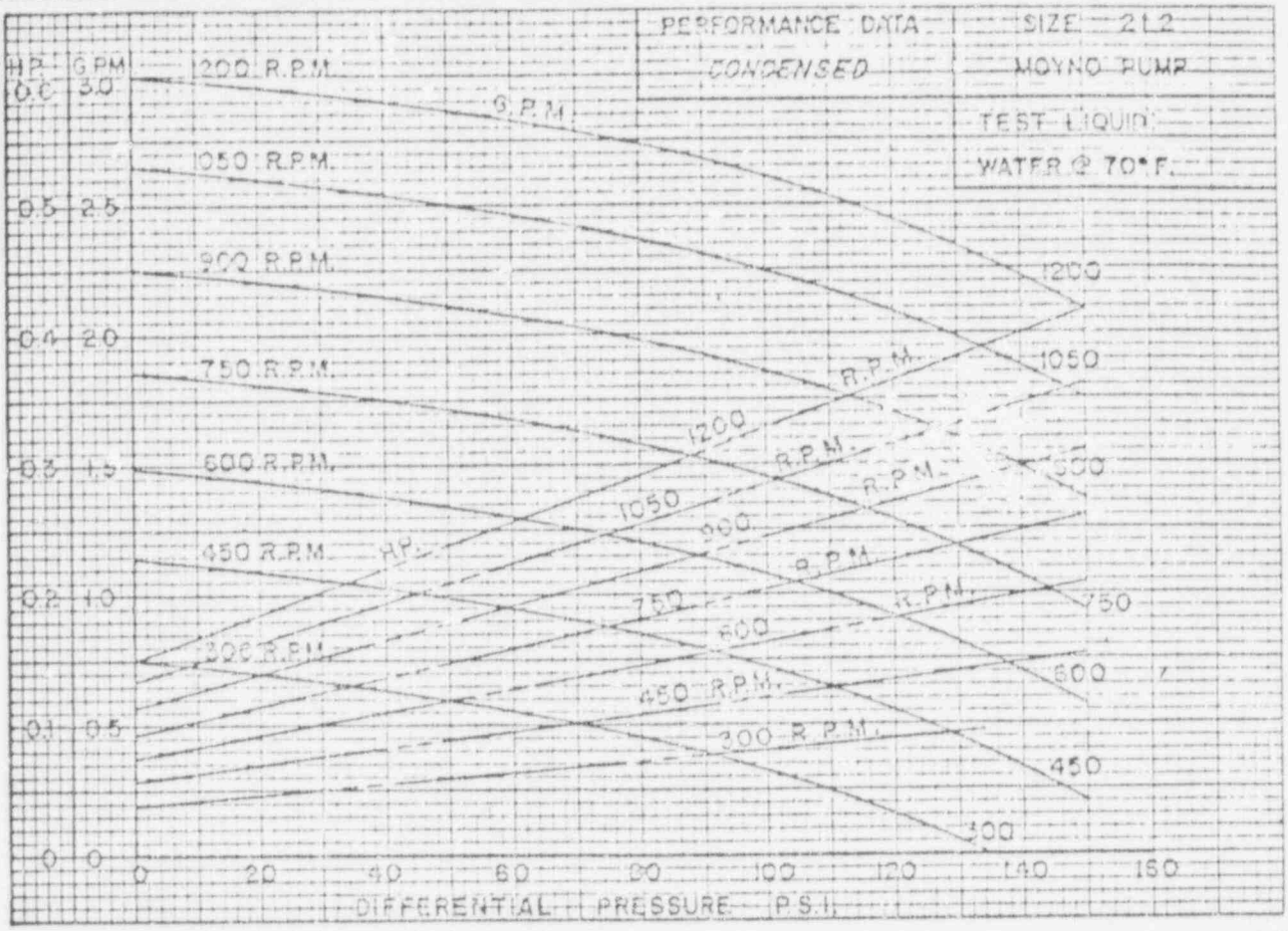


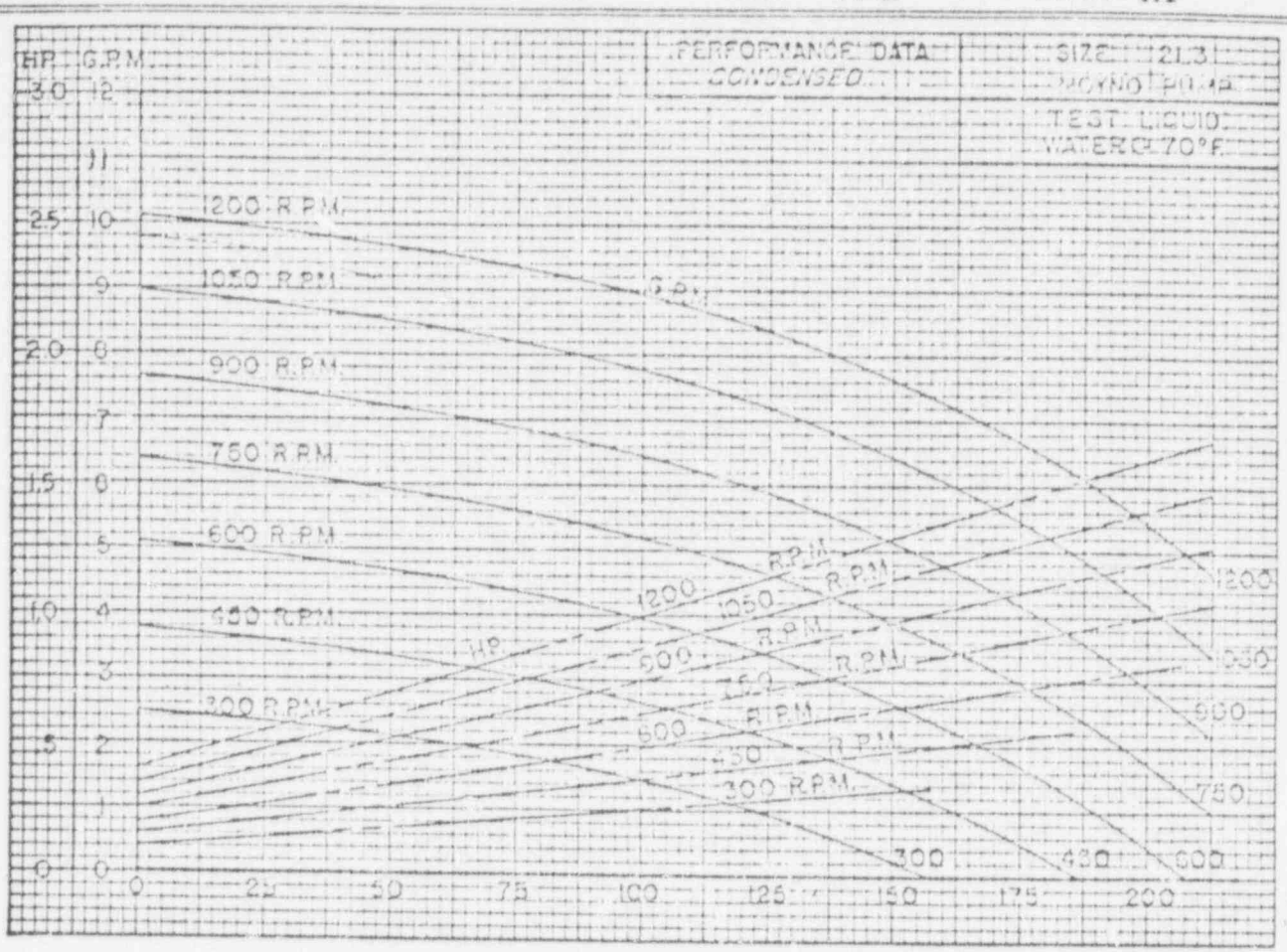
Cat. No.	Part Name	Cat. No.	Part Name	Cat. No.	Part Name
2	Suction Body Casting	34	Bearing Cover Plate	* 54	Dr. Pin Ret. Screws
5	Bearing Housing	37	Pump Support	57	Lantern Ring
9	Disch. End-Reducer	38	Stator Support	58	Bearing Lock Nut
* 21	Stator Assembly	41	Packing Gland	59	Bearing Lockwasher
* 22	Rotor	* 42	Packing Rings	61	Grease Seal-Radial
* 25	Connecting Rod	* 45	Rotor Drive Pin	62	Grease Seal-Thrust
26	Drive Shaft	* 46	Shaft Drive Pin	65	Packing Gland Insert
29	Radial Ball Bearing	49	Dr. Shaft Collar	* 73	Drive Pin Washer
30	Thrust Ball Bearing	50	Rotor Band	74	Set Screw Wrench
33	Bearing Spacer	* 53	Conn. Rod Washers		

*Recommended spare parts

Miscellaneous hardware list (cap screws etc.) furnished on request.
NOTE: When ordering parts ALWAYS specify pump SERIAL NUMBER.

90001230





ROPER PUMP COMPANY
COMMERCE, GEORGIA

DATE: November 1, 1972 SUBJECT: C

SUBJECT: OPERATION AND INSTALLATION OF 70000 SERIES PUMPS PAGE: 1

OPERATING PRINCIPLE of the 70000 Series pumps is based on two pumping elements consisting of a helical rotor turning within a double thread helical stator. The meshing helical surfaces push the liquid ahead with uniform movement and low turbulence. The rotor provides an effective seal of liquid flow from port to port at all positions of rotation. Pressure is independent of the pump speed. Displacement is positive and proportional to pump speed.

DRY FRICTION is harmful to this pump. Do not run the pump under power until it is filled with the liquid to be pumped. This liquid serves as a lubricant rather than a prime since a flow of 10% of the pump displacement will satisfy cooling and lubricating requirements.

FOUNDATION & BASE. A concrete pier having a level top surface makes a good foundation. A fabricated steel base is used on mounted units. Hold down bolts for mounting the base to the foundation should be used and may be located from available dimension prints. Do not warp the steel base by pulling down to an uneven foundation surface. Use shims as necessary.

BELT DRIVEN PUMPS should be checked after base has been fastened down to the foundation to make sure belts and pulleys are still in alignment and that the belts have the proper amount of tension.

ALIGNMENT of direct driven pump and drive should be carefully checked after the base has been fastened down to the foundation. A 1/16" coupling gap should be uniform. Drives should be re-aligned after reaching destination by loosening drive mounting bolts and aligning drive to best running tone.

ROTATION OF PUMP. The 70000 pump can be operated in either direction. A rotation plate is mounted on each pump designating the recommended direction of operation. This information is in accordance with the information received concerning the service and duty of each pump. Both inlet and outlet port designations are related to this rotation inasmuch as the 70000 pump is fully reversible. Pump rotation is always determined when viewing the pump from the shaft extension or pulley end.

PIPING TO PUMP should generally be equal in size to the pump port opening. Pipe systems handling viscous or high temperature materials are often exceptions to this rule. All screwed joints should be carefully doped before tightening. Connected piping should mate pump port fittings free of strain. Minimize suction line length by locating pump near source of liquid and make all lines as direct and free of fittings as possible.

VALVES of the ball or stop-cock type are superior for most applications. Gate valves are satisfactory for thin, clear liquids, and globe valves are least satisfactory of all. Avoid use of globe valves, strainers, and foot valves in the suction line whenever possible.

PUMP BEARINGS are ball bearings on all sizes. All bearings are grease lubricated.

1. Do not give bearings routine lubrication because more bearings are ruined due to over-attention than lack of attention.

2. Do not lubricate with any grease except an approved bearing grease such as Mobil Oil Company Mobile-Plex EP-1.

3. It is recommended that no lubrication be added for the first 12 months under normal operation.

4. Approximately every 12 months the bearing-shaft assembly should be removed and washed with clean benzine.

5. All old grease should be removed from the bearing housing and only enough new grease applied to bearing races so as to fill them flush.

6. Add a few drops of oil to bearing seals before re-mounting assembly.

It takes several days of operation for grease lubricated ball bearings in a new pump or re-lubricated pump to level off to final running temperature. Prior to reaching this condition the bearings may run hot.

PACKING MAINTENANCE PROCEDURES

1. Adjustment of packing gland should be kept sufficiently snug so as to prevent leakage but not so tight that the stuffing box feels hot to the touch. Gland bolts must be kept evenly adjusted.

2. 70000 Series pumps are supplied with a lantern ring in the midsection of the packing. A grease fitting may be installed communicating to it. Careful lubrication of the packing with a grease insoluble in the liquid pumped will pay dividends. Greasing often with small quantities is the best practice. As an alternate a continuous liquid flush may be used.

3. Scored shafts are packing destroyers. If the shaft is scored as much as 1/64 inch deep, it should be removed and polished before renewing packing. Shafts can be ground and re-surfaced. Shafting grooved more than 1/64 inch deep cannot always be reclaimed.

4. Packing replacements can best be made with standard formed rings and these should be inserted with their joints staggered. Do not use a one piece spiral wrap of packing. Care must be exercised in slipping rings over the shaft.

5. Forming of new packing in the stuffing box should be done by pulling gland bolts down evenly and firmly. Bolts should then be backed off gradually as stuffing box warms up. Several touch-up adjustments with the new packing can be expected before final running condition is attained.

ROPER PUMP COMPANY
COMMERCE, GEORGIA

DATE: November 1, 1972 SECTION: C

SUBJECT: APPLICATION DATA PAGE: 3

Application data is needed in selecting the best available type of construction and the proper size pump to give the most satisfactory service on any specific application.

1. MATERIAL TO BE PUMPED. Complete data is needed to select type of construction. When a trade name is used, secure the chemical analysis of the material to be handled.

2. WORKING TEMPERATURE RANGE. Helps in selecting stator construction and in determining maximum suction lift.

3. VISCOSITY. Obtain the viscosity at the working temperature range to help determine the pump operating speed and the frame size. Reference to a liquid similar in viscosity is helpful when a viscosity reading is unobtainable. See bulletin 72-45 table 2 for recommended speeds.

4. SPECIFIC GRAVITY. Should be obtained for calculating suction lift, discharge head and determining pipe friction.

5. CORROSIVE CHEMICAL CONTENT. A pH reading is needed in determining type of materials to be used in pump construction. Cast iron castings with standard steel internal parts can be used on liquids with a pH range of 5 to 9. On caustic liquids with pH reading above 9, use cast iron or 316 stainless castings w th 316 stainless internals. Liquids with pH reading of 2.5 to 5 can generally be handled with all 316 stainless pumps.

6. ABRASIVE CONTENT. Helps to determine pump operating speed. As the abrasive content increases, pump speed should be lowered in order to secure longer life from the internal working parts of the pump. See bulletin 72-45 table 3 for recommended speeds on abrasive materials.

7. PARTICLE SIZE. Helps in determining maximum operating speed of pump and selecting proper model and port sizes. The 70000 pump will pass solids without injury to the pump or without changing the form of the solids as follows:

PUMP SIZE	PARTICLE SIZE
01	.2"
02	.3"
05	.4"
12	.6"
19 and 28	.8"

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SUBJECT: APPLICATION DATA PAGE: 4

8. CAPACITY REQUIRED. To select model, secure the widest capacity range required for the application.

9. SERVICE CYCLE. As the service cycle increases, pump size should increase accordingly. Higher momentary surge pressures can be secured on intermittent service than on continuous operation.

REMARKS: Suction lift requires consideration as to the distance of lift, the specific gravity and the viscosity of the liquid to be handled. Suction pipe sizes should equal or be larger than the port size of the pump selected. Valves, elbows, strainers and other obstacles in the suction line increases pipe friction loss and should be avoided where possible.

Discharge pressures determine the number of stages to be used. Discharge pipe size should equal the port size. For pressure ratings see bulletin 72-45 table 4 or the pump curves.

Electrical characteristics are required when Roper is to furnish motors. When mounted units are supplied without motor, specify the motor frame number.

Any other information pertaining to the application which will assist in selecting the proper pump should be supplied.

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COMMERCE, GEORGIA

DATE: November 1, 1972 SECTION: C

SUBJECT: STATOR TYPE AND LIMITATIONS PAGE: 5

At present there are four types of standard stator materials available. The two most common are soft natural rubber and synthetic Buna N.

Type M is a soft 50 durometer hardness natural rubber. This type is used for all abrasive applications where no solvents or oils are present. Temperature limitation, 185°F.

Type L is Buna N synthetic rubber. It is comparable in hardness to tire tread at 70 durometer. This stator is used in handling water, oils, soaps, petroleum products, etc. Temperature limitation, 185°F.

Butyl and Viton are available. Butyle carries the same price as the other rubbers. Viton carries a special price and is not a stock item.

Listed below are the general classifications of liquids which usually cannot be handled with either type M or L.

Ketones and Aldehydes

1. Methyl Ethyl Ketone (MEK)
2. Methyl acetone
3. Acetone
4. Formaldehyde

Acetates

1. Ethyl acetate
2. Isopropyl acetate
3. Amyl acetate
4. Butyl acetate

Aromatic Hydrocarbons

1. Benzene
2. Toluol (toluene)
3. Zylene (xyol)
4. Benzol
5. Hexane
6. Cyclohexane
7. Napthalene

Chlorinated Hydrocarbons

1. Carbon tetrachloride
2. Trichlorethylene
3. Ethylene dichloride
4. Methyl chloride
5. Proply chloride
6. Chloroform
7. Dichlorethylene

Unclassified Liquids

1. Carbon disulphide
2. Furfurol (furoc)
3. Oleic acid
4. Liquid ammonia
5. Ethyl ether
6. Sulphuric acid (above 50% concentration, below 150°F.)
7. Nitric acid (above 35% concentration, below 150°F.

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SUBJECT: PACKING, LUBRICANTS AND BEARINGS PAGE: 6

RECOMMENDED PACKING

General purpose- Water, oils, petroleum, paint, solvents -- Durametallic graphite impregnated number 710B77.

Food applications - Durametallic mica impregnated number D110D-222.

STUFFING BOX DATA

Size	No. of Rings	O.D. X I.D.
01	6	1-9/16 X 1-1/8 (7/32 sq.)
02	6	2-1/16 X 1-5/16 (3/8 sq.)
05	8	2-3/8 X 1-5/8 (3/8 sq.)
12	7	3-1/8 X 2-1/8 (1/2 sq.)
19 & 28	7	3-1/2 X 2-1/2 (1/2 sq.)

INTERCHANGEABLE BEARINGS

Size	MRC		SKF		FAFNIR	
	Thrust	Radial	Thrust	Radial	Thrust	Radial
01	405S	306S	6405	6306	405K	306W
02	406S	307S	6406	6307	406K	307W
05	407S	308S	6407	6308	407K	308W
12	5410	310S	5410	6310	-	-
19 & 28	5314	214S	5314	6214	5314	214W

RECOMMENDED LUBRICANTS

Packing ——— Mobil Hytemp #1
Bearings ——— Mobil Grease EP-1
Pipe Joints ——— Lubriplate #630A

REPAIRING OF ROTORS & DRIVE SHAFTS

In some cases rotors and drive shafts may be repaired to permit additional hours of service. There are certain limitations in the repairing of these parts which must be considered.

ROTORS-Rotors can be built up by means of hard chrome plate provided:

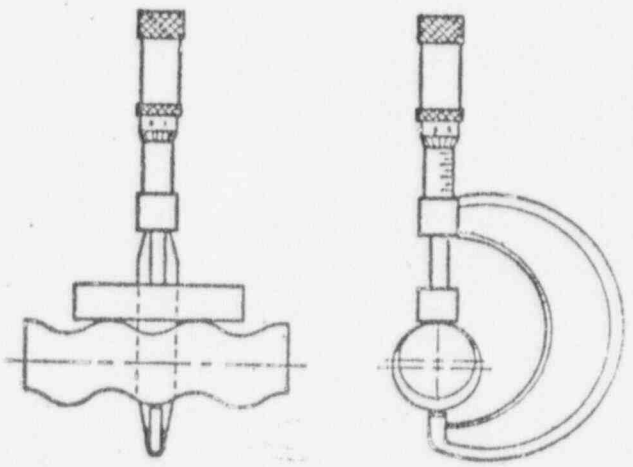
A. Rotor diameters (crest to crest) are not more than .050 under standard

B. Rotor drive pin holes are not worn.
C. Rotors are not pitted from corrosive liquids.
D. Rotors are not deeply grooved.

DRIVE SHAFTS - Drive shafts can be reground and built up with hard chrome plate provided:

A. Shaft threads are not damaged.
B. Shaft drive pin holes are not worn.
C. Packing end is not grooved to depths in excess of 1/64 inch.
D. Shafts are not corroded.

Pump Size	Crest to Crest Diameter
7X201	1.417
7X202	1.890
7X205	2.281
7X212	3.139
7X219	3.745
7X228	3.745



To mike any rotor, place a precision ground bar across the crest on one side of rotor and mike from bar to crest on opposite side of rotor. The micrometer reading minus the bar thickness equals the rotor size.

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SUBJECT: DIS-ASSEMBLY AND ASSEMBLY INSTRUCTIONS PAGE: 8

These Instructions apply to pump model 71201, 72201, 73201, 71202, 72202, 73202, 71205, 72205, 73205, 71212, 72212, 73212.

1. Remove clamp bolts from stator housing support 35, pull top half of stator support from stator 11.

2. By using pipe wrench remove stator from main body casting 40. Pull stator off rotor 12.

3. Remove two drive pin screws 21 with allen wrench and drive shaft pin 16 by pushing pin through collar 25.

4. Slide collar back to packing gland 24.

5. Remove two drive pin washers 20. (It is usually best to use new drive pin washers when re-assembling.)

6. Pull rotor out of drive shaft 14.

7. To dis-assemble rotor and connecting rod, heat rotor band 18 and slide off quickly before heat transfers to rotor. Push rotor pin 15 out of rotor and remove connecting rod 13. To re-assemble rotor and connecting rod, use new connecting rod washers 17 and pack ball joint with grease that is not soluable in the liquid pumped.

8. Remove four cap screws from bearing cover plate 33.

9. Insert a rod into drive shaft through main body casting and drive ball bearings and shaft assembly out of main body casting.

10. To dis-assemble drive shaft and ball bearings, remove lock nut 29 and washer 28, then press bearing 30 and 31 with bearing spacer 32 off drive shaft. When assembling, bearing should be packed with a good bearing grease to about one-fourth capacity of bearing housing.

11. Remove packing gland bolts and packing gland 24.

12. Remove packing 19 and note how the packing rings are staggered. When re-packing, stagger ends of packing. Remove lantern rings 23 and packing gland insert 22.

13. Press bearing housing grease seal 27 and bearing cover plate grease seal 26 out of main body casting and bearing cover plate 33.

14. To re-assemble, reverse the above procedure.

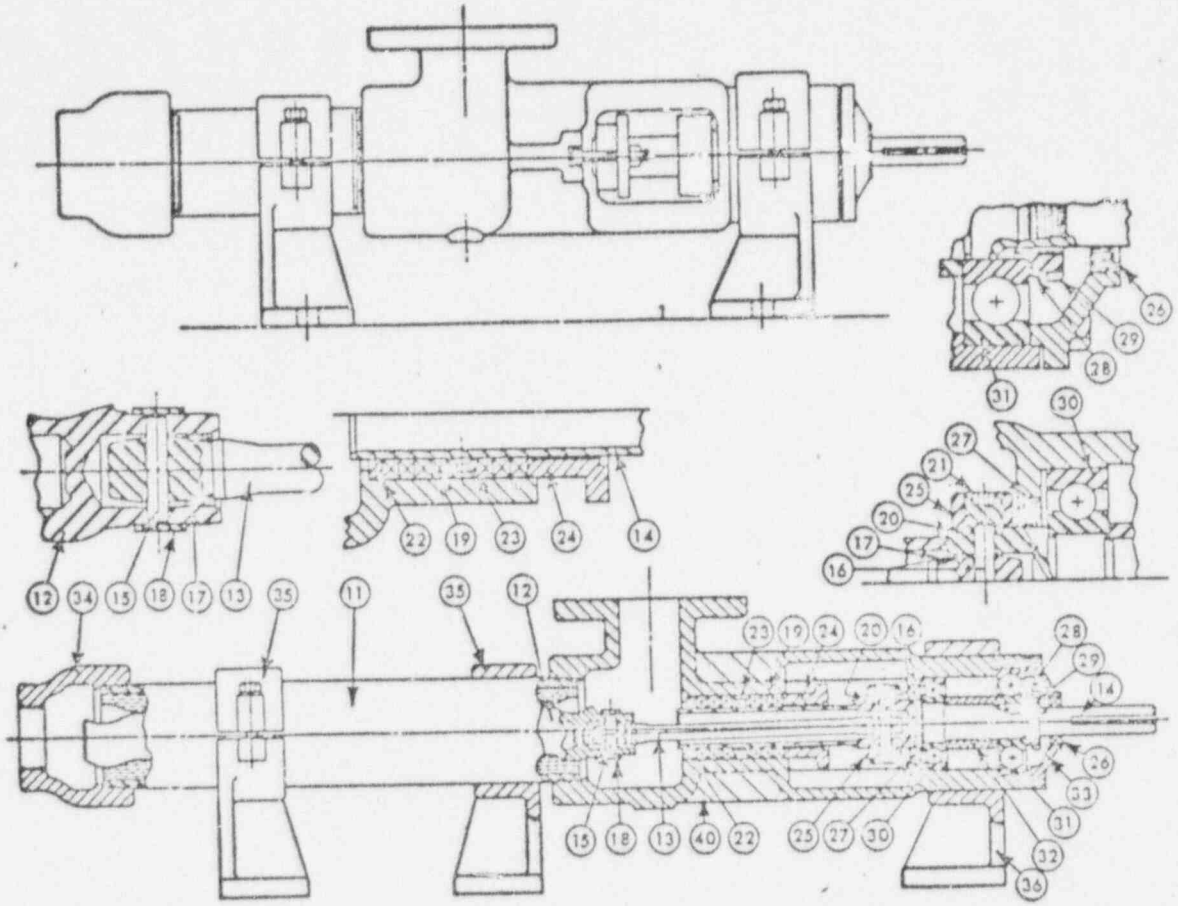
ROPER PUMP COMPANY
COMMERCE, GEORGIA

DATE: November 1,1972

SECTION: C

SUBJECT: REPAIR PARTS LIST
MODELS 71201,72201,73201,71202,72202,73202

PAGE: 9



SYMBOL NO.	DESCRIPTION
11	Stator
12	Rotor
13	Connecting Rod
14	Drive Shaft
15	Rotor Drive Pin
16	Shaft Drive Pin
17	Conn.Rod Washer (2 req.)
18	Rotor Band
19	Packing Rings (set)
20	Drive Pin Washer (2 req.)
21	Dr.Pin Ret.Screws (2 req.)
22	Packing Gland Insert
23	Lantern Ring
24	Packing Gland Casting

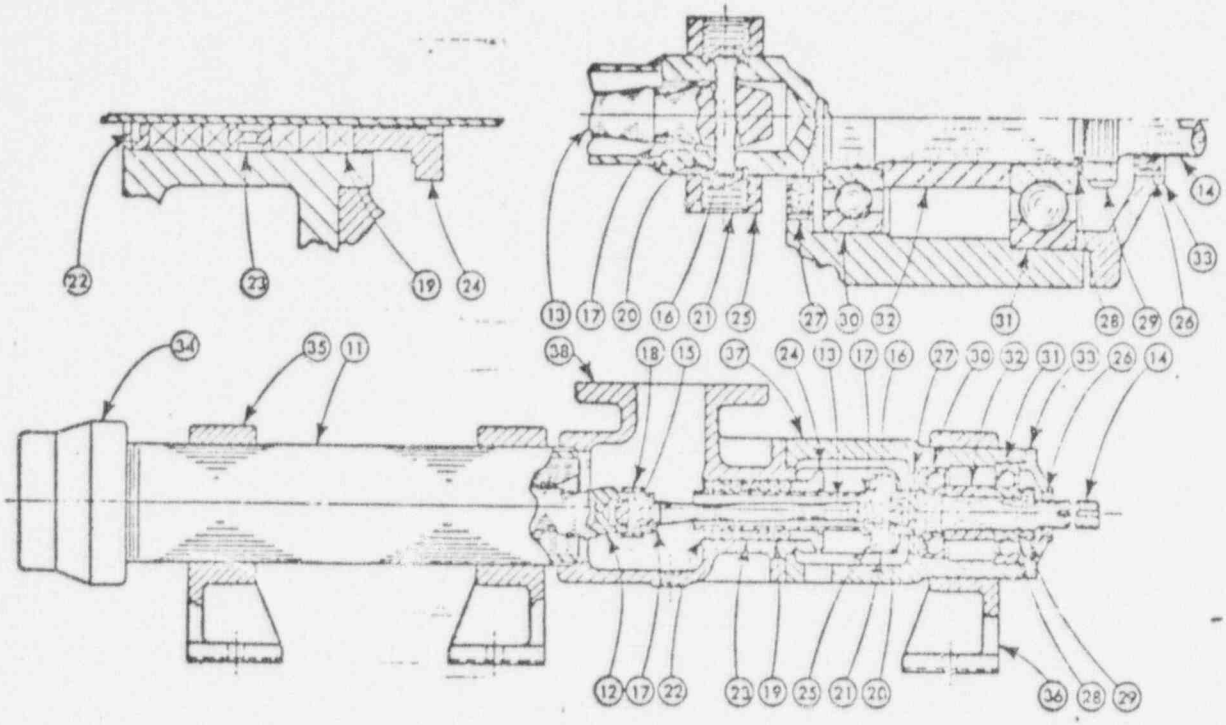
SYMBOL NO.	DESCRIPTION
25	Drive Shaft Collar
26	Cover Plate Gr.Seal (Thru
27	Bear.Housing Gr.Seal (Rad
28	Bearing Lockwasher
29	Bearing Locknut
30	Radial Ball Bearing
31	Thrust Ball Bearing
32	Bearing Spacer
33	Bearing Cover Plate
34	Reducing Coupling
35	Stator Support
36	Pump Support
40	Main Body Casting

90001241

ROPER PUMP COMPANY
COMMERCE, GEORGIA

DATE: November 1, 1972 SECTION: C

SUBJECT: REPAIR PARTS LIST PAGE: 10
MODELS 71205,72205,73205,71212,72212,73212



SYMBOL NO.	DESCRIPTION
11	Stator
12	Rotor
13	Connecting Rod
14	Drive Shaft
15	Rotor Drive Pin
16	Shaft Drive Pin
17	Conn.Rod Washer (2 req.)
18	Rotor Band
19	Packing Rings (set)
20	Drive Pin Washer (2 req.)
[illegible]	Dr.Pin Ret.Screws (2 req.)
[illegible]	Packing Gland Insert
23	Lantern Ring
24	Packing Gland Casting

SYMBOL NO.	DESCRIPTION
25	Drive Shaft Collar
26	Cover Plate Gr.Seal (Thrust)
27	Bear.Housing Gr.Seal (Radial)
28	Bearing Lockwasher
29	Bearing Locknut
30	Radial Ball Bearing
31	Thrust Ball Bearing
32	Bearing Spacer
33	Bearing Cover Plate
34	Reducing Coupling
35	Stator Support
36	Pump Support
37	Bearing Housing
38	Suction Body Casting

ROPER PUMP COMPANY
COMMERCE, GEORGIA

DATE: November 1,1972 SECTION: A

SUBJECT: GENERAL PUMP EXPLANATION PAGE: 1

70000 Pump constructions are identified and described by model and type.

PUMP FRAME EXPLANATION

The pump model is primarily an indication of size. It consists of five numbers.

(a) The first number of the pump model indicates the Roper Series. The second number indicates the number of pumping stages. The third number designates the assembly style. The fourth and fifth numbers indicate the size of the rotor-stator elements and the approximate delivery in gallons per 100 Rev.

(b) The number 2 assembly indicates the drive head corresponds to the standard size used with rotor-stator elements.

(c) The number 3 assembly indicates the drive head is one size larger than normally used with rotor-stator elements.

PUMP TYPE EXPLANATION

Pump type is designated by a group of three letters. They describe the grades of material used in construction of the pumps basic parts.

(a) BODY CASTING OR INLET HOUSING. The first letter always indicates the kind and grade of material used in the main body construction.

(b) ROTOR AND INTERNAL PARTS. The second letter indicates the kind and grade of material used in constructing the rotor and usually the other internal parts such as connecting rod, drive pins, drive shafts, etc.

(c) STATOR. The third letter refers to the grade and kind of material used in the stator construction.

TYPICAL EXAMPLES OF PUMP DESIGNATION

Roper model 73212 Type GHL pump. Standard cradel mounted pump with three stages of rotor-stator elements, standard construction, basic size 12 rotor-stator elements, cast iron body, hardened tool steel rotor with tool steel internal parts and Buna N stator of 70 Durometers.

If the same 73212 pump above had a #316 stainless steel body, #316 stainless steel rotor and internal parts and a natural rubber, 50 Durometer stator, the final three letters would be NNM.

MATERIAL CLASSIFICATION

STATOR. Stators are grouped in two classes, carbon steel sleeve and stainless steel sleeve. Three types of liner are available as standards, Buna N, Butyle, and Natural. Viton is available. Other materials on special order.

ROTOR. Rotors are grouped in two classes, tool steel and stainless steel. Both have chrome thickness of .010 as standard. Stainless steel rotors are available without chrome.

INTERNAL MACHINED PARTS. The basic pump uses carbon steel material as standard. Type 316 stainless steel material is classified under Stainless.

CASTINGS. Cast parts are of cast iron on standard pumps. Type 316 stainless steel castings are classified under Stainless.

ROPER PUMP COMPANY
COMMERCE, GEORGIA

Date: November 1,1972 Section: A

Subject: Cross Reference Page: 3

MODEL DESIGNATION

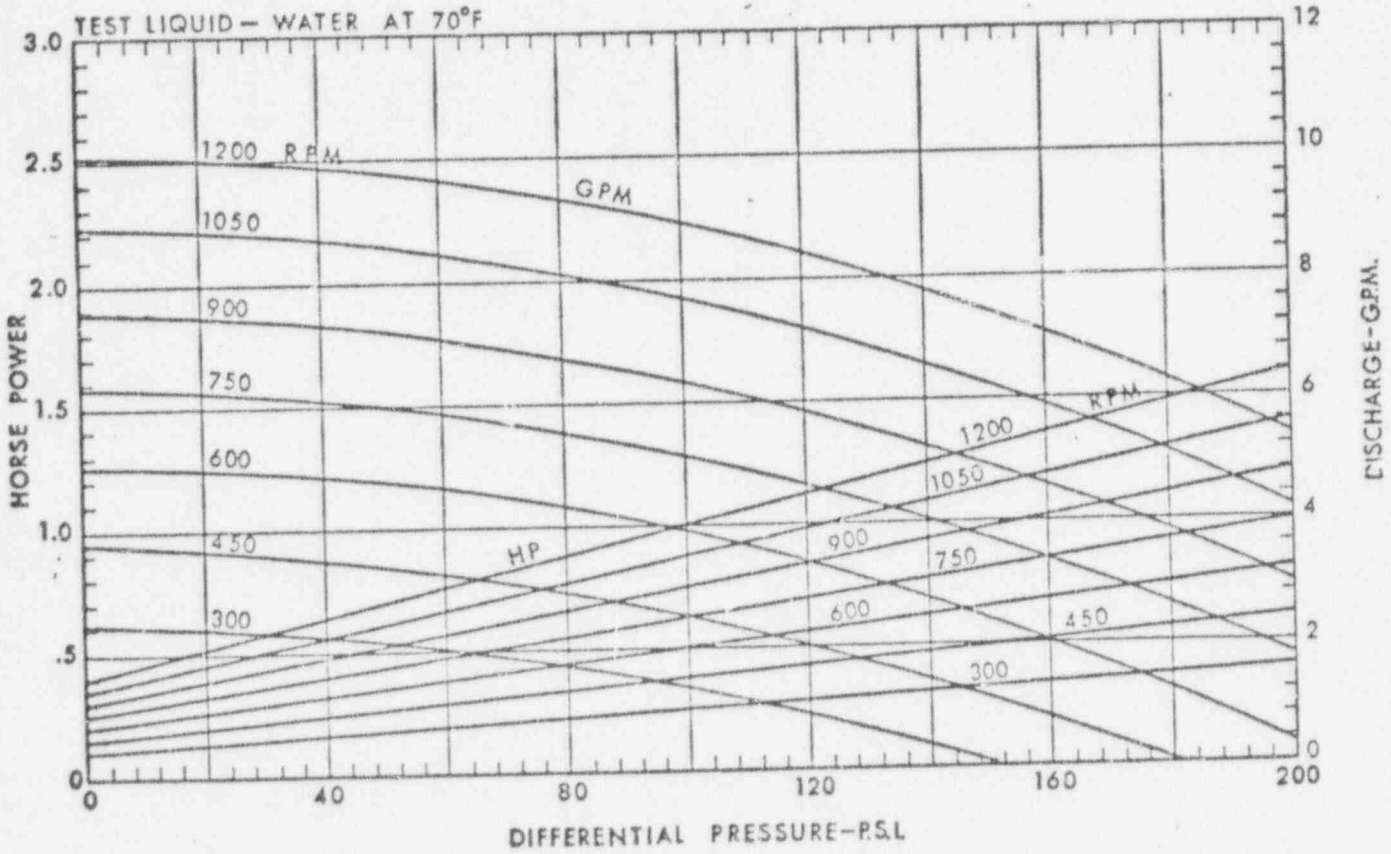
ROPER	MOYNO	HELIFERN
71201	1L3	12R
72201	2L3	22R
73201	3L3	32R
71202	1L4	12N
72202	2L4	22N
73202	3L4	32N
71205	1L6	120
72205	2L6	220
73205	3L6	320
71212	1L8	12T
72212	2L8	22T
73212	3L8	32T
71219	1L10	12FA
72219	2L10	22FA
73219	3L10	32FA
71228	1L10H	12FAI
72228	2L10H	22FAI

MATERIALS OF CONSTRUCTION

	ROPER/HELIFERN	MOYNO
Cast Iron	G	C
Alloy Steel	H	D
316 Stainless Steel	N	S
Buna N (70 Duro)	L	Q
Natural Rubber (50 Duro)	M	R
Butyl	C	B
Viton	V	-

ROPER PUMP COMPANY
COMMERCE, GEORGIA

PERFORMANCE DATA
70000 SERIES PUMP
MODEL 72201



90001246

II. GENERAL ELECTRIC MOTORS

GEI-56122A
Supersedes GEI-24640

TRI/CLAD® SINGLE AND POLYPHASE BALL BEARING MOTORS

Frames 143 - 184 and 143T - 184T

All Enclosures

SAFE MOTOR OPERATION

WARNING:

High voltage and rotating parts of electrical machinery can cause serious or fatal injury. Its installation, operation and maintenance should be performed by qualified personnel only. Familiarization with NEMA MG2 Safety Standard for Construction and Guide for Selection, Installation and Use of Fractional and Integral HP Motors and Generators, the National Electrical Code and sound local practices is recommended.

For equipment covered by these Instructions, it is important to observe safety precautions to protect personnel from possible injury. Personnel should be instructed to:

Avoid contact with energized circuits. Disconnect all power sources before attempting maintenance or repair.

Avoid contact with rotating parts and be sure that shaft key is fully captive before motor is energized.

Avoid contact with the start or run capacitors in single-phase motors until a safe discharge procedure has been followed.

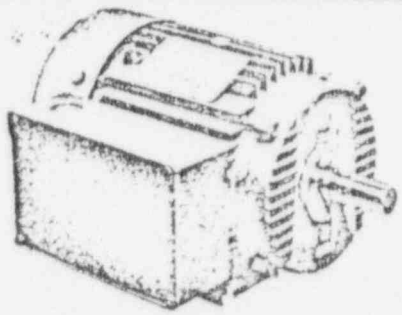
Act with care and in accordance with prescribed procedures in handling, lifting, installing, operating and maintaining the equipment. Do not lift motor and driven equipment with motor lifting means. If eyebolts are used for lifting motors, they must be securely tightened, and the direction of the lift must not exceed a 15-degree angle with the shank of the eyebolt.

Do not use motors with automatic-reset thermal protection where unexpected starting of equipment might be hazardous to personnel.

Provide proper safeguards for personnel against possible failure of motor-mounted brake, particularly on applications involving over-hauling loads.

Safe maintenance practices and qualified personnel are imperative. Before initiating maintenance procedures, be sure that all power sources are disconnected from the machine and accessories to avoid electric shock and personal injury from rotating parts. If a high-potential insulation test is required, procedures and precautions out-lined in NEMA Standards MG1 should be followed.

FAILURE TO PROPERLY GROUND MOTOR MAY CAUSE SERIOUS INJURY TO PERSONNEL. GROUNDING SHOULD BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND CONSISTENT WITH SOUND LOCAL PRACTICE.



Typical 180-frame motor

INSTALLATION

1. LOCATION

a. Dripproof Motors are designed for installation in a well ventilated place where the atmosphere is reasonably free of dirt and moisture.

b. Standard Enclosed Motors are designed for installation where motor may be exposed to dirt, moisture and most outdoor conditions.

c. Severe-duty Enclosed Motors are designed for installation in highly corrosive or excessively moist atmospheres.

d. Explosion-Proof Motors have a U/L label which indicates manufacture to Underwriters' Laboratories standards for hazardous locations shown on the label.

2. MOUNTING

a. Mount motor securely on a firm, flat base. All ball-bearing motors, except vertical high-thrust, may be mounted in any position.

Remove drain plugs from the frame of enclosed motors used outdoors or in other high moisture areas.

b. Align motor accurately, using a flexible coupling if possible. For drive recommendations consult drive or equipment manufacturer, or General Electric Company.

c. V-belt Sheave Pitch Diameters should not be less than the following values:

Horsepower				V-belt Sheave, Min Dia.	
Synchronous Speed, Rpm				Conventional* A and B Pitch Dia.	Super** 3V Outside Dia.
3600	1800	1200	900		
1-1/2	1	3/4	1/2	2.2	2.2
2-3	1-1/2-2	1	3/4	2.4	2.4
–	3	1-1/2	1	2.4	2.4
–	–	2	1-1/2	2.4	2.4
5	–	–	–	2.6	2.4
7-1/2	5	–	–	3.0	3.0

* Max sheave width 2 (N-W) – 1/4".
** Max sheave width N-W.

Sheave ratios greater than 5:1 and center-to-center distances less than the diameter of the large sheave should be referred to the Company.

d. Tighten belts only enough to prevent slippage. Belt speed should not exceed 5000 ft. per min.

3. POWER SUPPLY & CONNECTIONS

a. Nameplate voltage and frequency should agree with power supply. Motor will operate satisfactorily on line voltage within 10% of nameplate value; or frequency within 5%; combined variation not to exceed 10%.

b. Dual voltage motors can be connected for the desired voltage by following instructions on nameplate or connection diagram.

c. Wiring of motor and control, overload protection and grounding should be in accordance with National Electrical Code and local building codes.

Individual Branch Circuit for Single-Phase Motor						
Motor HP	Volts	Max* Fuse Amps	Minimum wire gage no. for branch circuit lengths indicated			
			0-50 ft *	100 ft	200 ft	500 ft
1	230 115	25 30	14 12	14 8	12 6	8
1-1/2	230 115	30 60	14 10	12 6	10 4	6
2	230 115	40 60	14 10	12 6	8	4
3	230 115	60 110	10 6	10 4	8	4
5	230	90	3	8	6	2

*Values based on National Electrical Code

If wire size is selected from the preceding table, single-phase motor performance will not be adversely affected by voltage drop in the branch circuit.

4. THERMAL PROTECTORS

a. the words "Thermally Protecied" on the nameplate identify motors having built-in protection against dangerous overheating.

1. Manual reset protectors are reset after motor cools by pressing external reset button.

2. Automatic reset protectors (no external button) reset automatically after motor cools.

CAUTION: Where unexpected starting would be dangerous, do not use automatic reset protection.

OPERATION

1. Dry, the motor windings if stored in a damp location. In drying, do not exceed 85 C (185 F).
2. Check rotation under no-load conditions. To reverse rotation: 3 Phase – interchange any two line leads; 2 Phase – interchange line leads 1 & 3; 1 Phase – follow connection nameplate or label on motor.
3. Operate under load for at least one hour. Then observe whether any unusual noise or heating has developed.
4. Check operating current against nameplate.

MAINTENANCE

1. INSPECTION

a. Inspect motor at regular intervals. Keep motor clean and ventilating openings clear.

2. LUBRICATION

a. Ballbearing motors are adequately lubricated at the factory. Relubrication at intervals consistent with the type of service (see table for motors with standard grease) will provide maximum bearing life. Excessive or too frequent lubrication may damage the motor.

b. Relubricate with General Electric D6A2C5 grease unless special grease is specified on nameplate.

c. Motors having pipe plugs or grease fittings in bearing housings should be relubricated while warm and at stand-still. Replace one pipe plug on each end shield with 1/8" pipe thread lubrication fitting. Remove the other plug for grease relief. Be sure fittings are clean and free from dirt. Using a low-pressure grease gun, pump in the recommended grease until new grease appears at grease relief hole. After relubricating, allow motor to run for 10 minutes before replacing relief plugs.

d. Motors not having pipe plugs or grease fittings in bearing housings can be relubricated by removing end shields from motor, cleaning grease cavity and refilling the cavity with recommended grease.

CAUTION: Bearings and grease must be kept free of dirt.

Type of Service	Typical Examples	Hp Range	Relubrication Interval
Easy	Valves; door openers; portable floor sanders; motors operating infrequently (1 hour per day).	1/2-7-1/2	10 years
Standard	Machine tools; air-conditioning apparatus; conveyors, 1 or 2 shifts; garage compressors; refrigeration machinery; laundry machinery; textile machinery; oilwell pumps; woodworking machinery.	1-1/2-7-1/2	7 years
Severe	Motors for fans, M-G sets, etc., that run 24 hours per day, 365 days per year; coal and mining machinery; motors subject to severe vibration; steel-mill service.	1-1/2-7-1/2	4 years
Very Severe	Dirty, vibrating applications; where end of shaft is hot (pumps and fans); high ambient.	1-1/2-7-1/2	9 months

3. EXPLOSION-PROOF MOTORS

a. Explosion-proof motors contain special features and are manufactured in accordance with U/L and carries their label. Therefore, it is recommended that repairs be made at a General Electric Apparatus Service Shop which has been authorized to make such repairs.

4. MOTOR WINDINGS

a. To clean, use a soft brush and, if necessary, a slow-acting solvent in a well-ventilated room.

SERVICE

Your GE motor should be serviced only by qualified persons who have the proper tools and equipment. Fast, dependable in-warranty or out-of-warranty service for your motor can be obtained from any of General Electric's nationwide network of authorized Electric Motor Servicenters. Consult the Yellow Pages of your telephone directory for the Servicenter nearest you.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

General Electric Company
General Purpose Motor Department | Fort Wayne, Decatur • Ind.
Paterson • N.J.

GENERAL ELECTRIC

KINAMATIC®

INDUSTRIAL DIRECT-CURRENT MOTORS AND GENERATORS

TYPE CD, FRAMES 182AT-L186AT

1/2-5 HP, 3/4-4 1/2 KW

POWER SUPPLIES

Motors in these frame sizes are suitable for operation from m-g set power supplies and from full-wave rectified power supplies where the a-c voltage applied to the conversion unit does not exceed 150% of the d-c motor nameplate voltage. Unless specified on the nameplate, motors are not suitable for operation from one-half wave, single-phase, rectified power supplies, or from full-wave rectified power supplies where the a-c voltage exceeds the above. Refer to the Company for unusual rectifier applications.

RECEIVING

Each shipment should be carefully examined upon arrival. Any damage should be reported promptly to the carrier and to the nearest office of the General Electric Company.

STORAGE

If a machine, or any part of a machine, is not to be installed immediately, it should be stored in a clean, dry place and protected from variations in temperature, high humidity, and dust. If possible, sudden changes in temperature and humidity should be avoided. If the temperature of the storage room varies to such an extent that the windings and coils are exposed to sweating or freezing conditions, the machine should be protected by a safe, reliable heating system which will keep the temperature of the machine slightly above that of the storage room. Brushes should not be allowed to remain in contact with the commutator during prolonged storage, otherwise corrosion may occur and later result in flat spots on the commutator, with corresponding poor and destructive commutation.

If the machine has been exposed to low temperature for an extended period of time, it should not be unpacked until it has reached room temperature, otherwise it will sweat. This condensation of moisture on the windings can cause short insulation life and premature armature failure.

All exposed machined-steel parts are coated with a rust preventive before shipment. These surfaces should be examined carefully for signs of rust and moisture, and recoated if necessary. Once started, rust will continue if the surface is recoated without first removing all rust and moisture. Rust may be removed by careful use of fine abrasive paper. Slushing compound can be removed by use of a solvent such as toluene, xylene or any hydrocarbon.

WARNING: TOLUENE AND XYLENE ARE FLAMMABLE AND MODERATELY TOXIC. THE USUAL PRECAUTIONS FOR HANDLING CHEMICALS OF THIS TYPE SHOULD BE OBSERVED.

THESE INCLUDE:

A. AVOID EXCESSIVE CONTACT WITH SKIN.

B. USE IN WELL VENTILATED AREAS.

C. TAKE NECESSARY PRECAUTIONS TO PREVENT FIRE OR EXPLOSION HAZARDS.

Care must be taken when cleaning to avoid damaging machined surfaces. Extreme care must be exercised to prevent these parts from rusting since it is difficult, and sometimes impossible, to remove rust from these surfaces without damaging or deforming the surface. If burrs or bumps result from careless handling, carefully remove them, using a fine file or scraper. Machines in storage should be inspected, have the insulation resistance checked at frequent and regular intervals with an instrument such as a hand-operated megger, and a log should be kept of pertinent data. If the log indicates a decreasing insulation resistance, the motor should be moved to a drier location.

HANDLING

Complete motors or generators can be lifted by using hooks or slings in the lifting lugs on the frame. These lugs are designed to carry safely the weight of the whole machine and can be removed or turned down if not needed.

GENERAL ELECTRIC

90001250

LOCATION

Locate motors so that cool, clean air is available and intake and outlet air openings are not blocked.

MOUNTING

Standard machines will operate successfully when mounted at any angle horizontal to vertical, shaft up or down, on floor, wall or ceiling, without changing position of bearing brackets (end shields). Commutator end bearing bracket can be rotated 180° provided the brush stud connections are reversed. The drive end bearing bracket can be rotated 90°.

On ceiling-mounted machines, the dripproof covers on the commutator end and the drive end bracket should be reversed so that the louvers and the air exhaust face downward. Special covers are required to maintain dripproof enclosure on wall or vertical mounting.

CAUTION:

Do not change position of brushholders with respect to the frame.

CONDUIT CONNECTION

On standard floor-mounted machines, the conduit connection will be made to the top of the commutator end bracket. If 3" or more of clearance below the commutator end bracket is available, the bracket may be rotated 180 degrees to allow conduit connection from the bottom. For simplified connection, flexible conduit is generally used to connect solid conduit to the machine. All standard units are provided with a ¾" NPT hole for conduit connections.

CONNECTIONS

Connection diagram is included on the inside of the conduit connection cover.

"V"-BELT DRIVE

Align the sheaves carefully to avoid thrust on the bearings. Adjust the belt tension in accordance with the manufacturer's directions (also see paragraph on Thrust). If possible, make the lower side the driving side. The belt speed should not exceed 5000 feet per minute, unless otherwise recommended by the belt manufacturer.

Since belt drives impose a bending moment on the motor shaft, it is always desirable to have the motor sheave located as close to the motor bearing as possible. This will result in increased bearing life and decreased shaft stress regardless of the load.

The standard shaft extension is designed for belted loads.

The following table can be used to select the MINIMUM allowable sheave diameter from the standpoint of bearing life and shaft stress. A larger sheave will further reduce the shaft stress and bearing loading. This table is based upon the belts being tightened to a maximum total pull of 1.5 times that required to transmit the load used in the sheave diameter calculation.

Minimum Sheave Diameter (Inches)

HP	2500 RPM	1750 RPM	1150 RPM	850 RPM
1	1⅓*	1⅓*	1⅓*	1⅓*
1½	1⅓*	1⅓*	1⅓*	2
2	1⅓*	1⅓*	2½	3
3	1⅓*	2½	3	—
5	2½	3½	—	—

*Limited by shaft diameter.

CHAIN DRIVE

Align the sprockets and adjust the chain just enough to permit a slight sag on the slack side. The distance between shaft centers should not be less than the diameter of the larger sprocket plus the radius of the smaller. If possible, make the lower side the driving side. Consult the chain manufacturer for the maximum ratio, speed, and lubrication of the chain.

For applications where a chain and sprocket drive is selected, the minimum motor sheave diameter can be selected from "V-belt Drives" and multiplied by 0.667. This factor is based on no tension in the slack side of the chain.

PINION DRIVES

Pinion drives frequently result in torsional vibrations and/or abnormal bearing load. These motors are not intended for pinion drives and must not be so applied without referring to the factory.

THRUST LOADS

Owing to the mounting position or type of drive arrangement, a thrust load may be imposed on the motor bearing. Kinamatic motors in these frame sizes permit a limited amount of thrust load in its standard configurtion. The amount of permissible thrust varies by mounting position and direction of the load.

	Horizontal Mounting	Vertical Mounting (Upward Thrust)	Vertical Mounting (Downward Thrust)
Axial Load Capacity in Pounds	90	105	75

DIRECTION OF ROTATION

The standard shunt wound motor is capable of rotation in either direction by reversing either the armature or shunt field polarity without changing brushes. For compound wound motors, refer to the connection diagram.

90001251

MAINTENANCE

Inspect motors at regular intervals, depending on service conditions. Periodically check all brushes for ample remaining wear length. Be certain that ventilating openings are not obstructed. Correct the cause of abnormal vibration. Keep motor clean. Replace covers.

LUBRICATION

Since the oil in the grease will ultimately become depleted, it is necessary to relubricate ball-bearing motors periodically depending on size and type of service. For service in normal ambient on machine tools, fans, pumps, etc., where motor does not operate more than 8 hours per day, original lubrication is adequate for approximately 5 years. Under severe temperature, dirt, or vibration conditions or continuous operation, more frequent lubrication may be required. This relubrication period will depend on service conditions and may vary from 5 years to 6 months.

Instructions for Lubricating

For best lubrication results, regrease with GE grease No. D6A2C5 (lithium base, ball-bearing grease). Avoid mixing different kinds of grease.

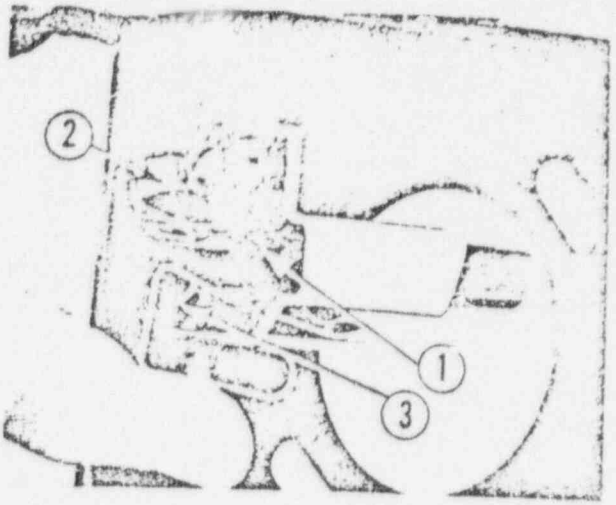
To regrease bearings, the end brackets should be removed. Make certain, however, that the commutator end bracket is marked so that when replacing the bracket the location of the brushes is maintained. Both the bearings and the bearing housing should be cleaned with a hot oil or a suitable solvent. The housing and the bearings should be repacked with grease and the end brackets replaced.

BRUSHES

Brushes should be inspected for wear at regular intervals. Brush pigtails are provided with wear indicator markers (1). When marker reaches the top of the brushholder box, the brush should be discarded. Continued use of worn-out brushes will result in damage to the commutator.

NOTE: Direct-current motors and generators operated for long periods of time at light loads or in contaminated atmospheres may be subject to abnormal brush and commutator wear. This can result in the need for excessive maintenance. If the application requires operation under these conditions, the General Electric Company will be pleased to suggest a change in brush grade or other measures to minimize the problem.

Brush Removal



With machine stopped and power off.

1. Unfasten pigtail (2).
2. Push spring in and toward opposite side of brushholder to disengage lock tab (3).
3. Lift spring out. Spring can either be completely removed from brushholder or left attached with outside bottom loop engaged in lock tab slot. Remove brush.

Brush Installation

1. Place brush in holder with bevel towards spring. Brushes should move freely in holder.
2. Push spring into position until lock tab engages slot and locks.
3. Connect pigtail.

Fit brush to commutator contour using strip of coarse sandpaper. *Do not use emery cloth.* Keep the sand side turned to the brush face. After fitting brushes, clean the dust from the commutator, brushholder and adjacent parts with a vacuum cleaner or other suitable means.

COMMUTATOR

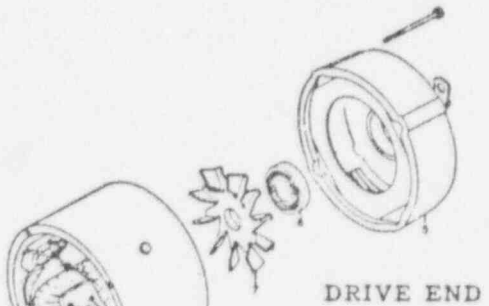
Keep the commutator clean. Ordinarily, the commutator will require only occasional wiping with a piece of canvas or other nonlinting cloth. Do not use lubricant or solvent on the commutator.

TYPE CD, FRAMES 182AT TO L186AT KINAMATIC DIRECT CURRENT MOTORS AND GENERATORS

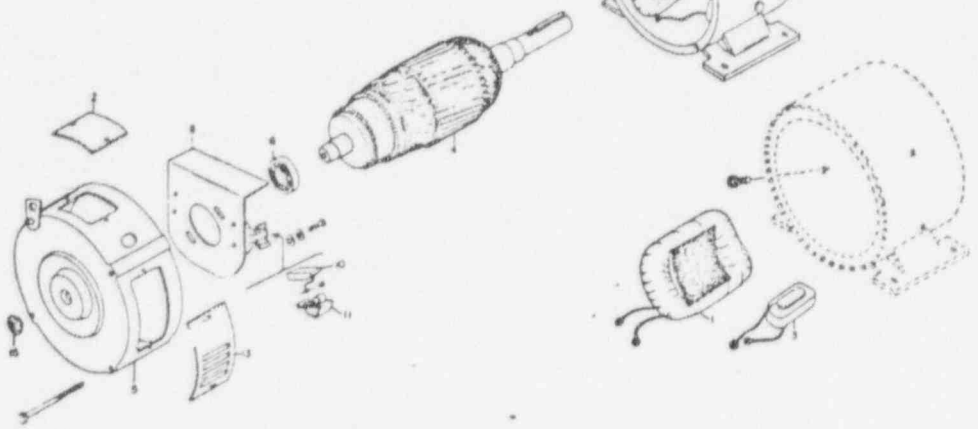
Use only genuine GE renewal parts. When ordering, specify model number and serial number of motor. (Complete nameplate data is desirable.) Specify quantity and describe part.

RENEWAL PARTS

1	Coil, Main and Pole
2	Conduit Box Cover
3	Coil, Comm and Pole
4	Armature
*5	Bracket, Bearing
*6	Bearing Ball, Antifriction
7	Fan, Armature
8	Yoke and Brushholder Assembly
10	Brush, Carbon
11	Spring, Brushholder
13	Cover, Hand Hole
15	Monogram
*	Specify whether Drive End or Front End



DRIVE END



FRONT END

SPARE PARTS ARE A GOOD INVESTMENT

Realize important dividends in better maintenance and less down time through a stock of the most frequently required parts.

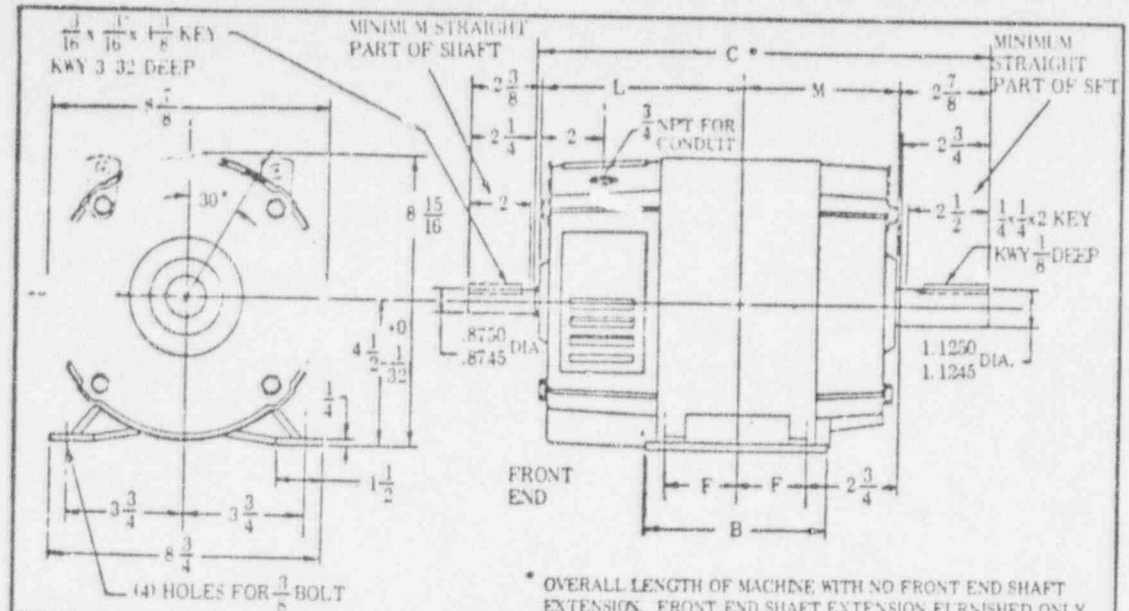
Recommended Quantities

Description	Number of Duplicate Motors in Service				
	1	2-4	5-10	10-20	More than 20
Complete Machine	—	—	—	1	2
Drive End Ball Bearing	1	1	1	2	3
Front End Ball Bearing	1	1	1	2	3
Brushes (Sets)	2	4	6	8	10
Brushholder Assembly	—	½	½	1	1
Brushholder Springs (Sets)	½	1	1	2	2
Main Field Coil and Pole	—	1	1	2	3
Commutating Field Coil and Pole	—	1	1	2	3
Armature Complete	—	1	1	2	2

Extreme operating conditions may alter the above recommendations. Refer major repairs to your General Electric Service Shop, which is equipped to repair, overhaul, or rebuild your G.E. motors and generators economically and quickly. Factory specifications are followed, genuine G.E. parts are used, and all units are completely tested.

In addition to renewal parts the following accessories are available:

- Splash Cover Kit—To convert motors of standard dripproof enclosure to splashproof enclosure.
- Sliding Base—Used as a convenient means of adjusting belt tension, where required.
- Tachometer Generator—for speed-regulating and/or speed-indicating duty.
- Blower, and Blower with Filters.
- Speed Limit Device.
- Shaft Extension Covers.



* OVERALL LENGTH OF MACHINE WITH NO FRONT END SHAFT EXTENSION. FRONT END SHAFT EXTENSION FURNISHED ONLY WHEN SPECIFICALLY ORDERED.

SPLASHPROOF COVERS INCREASE THE OVERALL WIDTH TO 10 7/8 AT THE FRONT END COVER OPENINGS.

LIFTING LUGS ARE REMOVABLE OR CAN BE ROTATED OUT OF POSITION.

MOTORS CAN BE USED FOR WALL, CEILING OR VERTICAL MOUNTING. TO MAINTAIN DRIPPROOF ENCLOSURE ON CEILING MOUNTING, REVERSE FRONT END COVERS. SPECIAL COVERS ARE REQUIRED TO MAINTAIN DRIPPROOF ENCLOSURE ON WALL OR VERTICAL MOUNTING.

TOTALLY ENCLOSED NON-VENTILATED MOTORS HAVE THE SAME DIMENSIONS AS SHOWN ABOVE, BUT HAVE SOLID COVERS ON ALL OPENINGS.

FRAME	APPROX NET WT LB	APPROX SHIPPING WT LB	B	C	F	L	M
182AT	70	119	3 3/4	14 1/8	2 1/4	6 1/4	4 7/8
L182AT	84	128	3 3/4	15 1/8	2 1/4	7 1/4	4 7/8
186AT	108	145	3 1/4	16 5/8	3 1/2	7 1/2	6 1/8
L186AT	140	167	3 1/4	18 5/8	3 1/2	9 1/2	8 1/8

WHEN YOU NEED SERVICE

IF YOU NEED TO REPAIR, recondition, or rebuild any electric apparatus,a G-E service shop near you is available day and night, seven days a week, for work in the shops or on your premises. Latest factory methods and genuine G-E renewal parts are used to maintain the original performance of your G-E equipment. For full information about these services, contact the nearest service shop listed below:

Albany, N.Y. - - - - - - - - 1097 Central Ave.
Allentown, Pa. - - - - - - - 668 E. Highland St.
Appleton, Wisc. - - - - - - - - P.O. Box 83
Manasha, Wisc. - - - - - - - - 568 Valley Rd.
Atlanta-Chamblee, Ga. - - 5035 Peachtree, Indus. Blvd.
Baltimore 30, Md. - - - - - - 920 E. Fort Ave.
Birmingham, Ala. - - P.O. Box 3687 - 1500 Mims Ave.
Boston-Medford 55, Mass. - 3960 Mystic, Valley Pkwy.
Buffalo 11, N.Y. - - - - - - - - 318 Urban St.
Charleston 28, W.Va. - - - 306 MacCorkle Ave., S.E.
Charlotte, N.C. - - - - - - - 2328 Thrift Road
Chicago 32, Ill. - - - - - - - 4360 W. 47th St.
Cincinnati 2, Ohio - - - - - - 444 W. Third St.
Cleveland 4, Ohio - - - - - - 4477 East 49th St.
Columbus 23, Ohio - - - - - - 2128 Eakin Rd.
Corpus Christi, Texas - - - - - 115 Waco St.
Dallas 19, Texas - - - - - - - 3202 Manor Way
Davenport-Bettendorf, Ia. - - - - - 1025 State St.
Denver 5, Colo. - - - - - - - - 3353 Larimer St.
Detroit 2, Mich. - - - - - - - 5950 Third Ave.
Ft. Wayne, Ind. - - - - - - - 1731 Edsall Ave.
Houston 20, Texas - - - - 5534 Harvey Wilson Drive
Indianapolis 22, Ind. - - - - 1740 W. Vermont St.
Jacksonville, Fla. - - P.O. Box 2932, 2020 W. Beaver St.
Johnstown, Pa. - - - - - - - - 841 Oak St.
Kansas City 20, Mo. - - - - - 3525 Gardner Ave.
Los Angeles 1, Calif. - - - - 6900 Stanford Ave.
Louisville, Ky. - - - - - - 3900 Crittendon Drive
Miami, Fla. (Hialeah) - - - - - 1062 East 28th St.
Midland, Texas - - - - - - - 704 So. Johnson St.
Milwaukee 3, Wisc. - - - - - 940 W. St. Paul Ave.
Minneapolis 12, Minn. - - - - 2025 49th Ave., N.
New Orleans, La. - - - - - - - 1115 De Armas St.
New York - N. Bergen, N.J. - - - 6001 Tonnelle Ave.
Oakland, Calif. - - - - - - - - 3400 Wood St.
Philadelphia 24, Pa. - - - - - 1040 E. Erie Ave.
Phoenix; Glendale, Ariz. - - - - 4911 W. Colter St.
Pittsburgh, Pa. (West Mifflin)
4930 Buttermilk Hollow Road
Portland 10, Oregon - - - - 2727 N.W. 29th Ave.
Richmond 24, Va. - - - - - - 1403 Ingram Ave.
Roanoke, Va. - - - - - - - - 115 Albermarle St.
Sacramento, Calif. - - - - - - - 99 N. 17th St.
St. Louis 10, Mo. - - - - - - - 1115 East Road
Salt Lake City 4, Utah - - - 301 S. Seventh West St.
San Francisco 3, Calif. - - - - 1098 Harrison St.
Seattle 4, Wash. - - - - - - - 3422 First Ave., S.
Southington (Plantsville), Conn. - 370 Atwater St.
Spokane 3, Wash. - - - - - - E. 4323 Mission St.
Tampa 1, Fla. - - - - - - - - P.O. Box 1245
Toledo 4, Ohio - - - - - - - 405 Dearborn Ave.
York, Pa. - - - - - - - - - 54 N. Harrison St.
Youngstown 7, Ohio - - - - 272 E. Indianola Ave.

III. VALVES - 3-WAY

DIMENSIONS – Fig. No. 4B300 – Sizes: 1½" to 8"

DIM.	DESCRIPTION	1½	2	3	4	6	8
A	END TO END	9	9	13 ½	14	18	21
AA	CENTER TO FACE	4½	4½	6⅛	7	9	10½
B	FLANGE, I.D.	1½	2	3	4	6	8
C	FLANGE, O.D.	5	6	7½	9	11	13½
D	FLANGE, DIAMETER OF R.F.	2⅞	3¾	5	6 5/16	8½	10⅛
E	FLANGE, THICKNESS (Min.)	9/16	⅝	¾	13/16	1	1⅛
F	FLANGE, DIAMETER OF BOLT CIRCLE	3⅛	4¾	6	7½	9½	11¾
K	CENTER TO TOP	6 7/16	6¾	9⅛	12½	14 7/8	15 7/16
M	HANDLE LENGTH	10	10	21	33½	33½	45
V	PORT DIAMETER	1 5/16	1½	2¾	3½	5⅛	6

FIG. NO.

150 lb. Flanged

SIZES: 1½"-8"

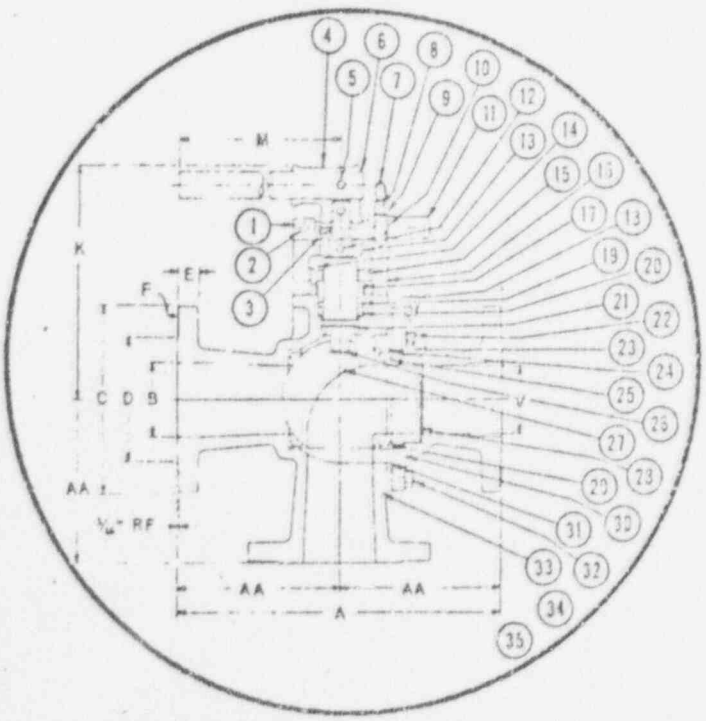


Illustration depicts port arrangement Number 1.

LIST OF PARTS & MATERIALS		
FIG. NO. 4B300–CARBON STEEL–PS SEALS		
No.	Name of Part	Material
1	Lock Nut (Position Stop)	Carbon Steel+
2	Set Screw (Position Stop)	Carbon Steel+
3	Set Screw (Indicator)	Carbon Steel+
4	Ell Handle	Carbon Steel
5	Set Screw (Handle)	Carbon Steel+
6	Handle (Std. Pipe)	Carbon Steel*
7	Lift Ring (Indicator)	Carbon Steel+
8	Pin (Indicator)	Carbon Steel+
9	Snap Ring (Indicator)	Carbon Steel+
10	Spring (Indicator)	Carbon Steel
11	Position Stop & Indicator	Carbon Steel
12	Set Screw (Yoke Stem Bearing)	Carbon Steel*
13	Bushing (Yoke Stem)	Bronze
14	Cap Screw (Yoke)	Alloy Steel*
15	Gland Flange	Ductile Iron
16	Yoke	Carbon Steel
17	Gland	Bronze
18	Pipe Plug	Carbon Steel*
19	Packing	Teflon
20	Retainer (Packing)	Carbon Steel*
21	Bearing (Stem)	Type 416 Stainless Steel
22	Set Screw (Compression Ring)	Carbon Steel*
23	Thread Lock	Kel-F
24	Retainer (Ball Seal)	Carbon Steel
25	Ball Seal	Teflon
26	Stem	Carbon Steel♦++
27	Ball	Carbon Steel♦**
28	Compression Ring	Carbon Steel*
29	Gasket (Compression Ring)	Teflon
30	Adapter	ASTM A216 Grade WCB
31	Gasket (Adapter)	Teflon
32	Cap Screw (Body)	Alloy Steel*
33	Body	ASTM A216 Grade WCB
34	Stud (Gland Flange)	Alloy Steel*
35	Nut (Gland Flange)	Alloy Steel*

* Coated + Plated ♦Hard Plated

++ For 1½" and 2" material is Type 416 Stainless Steel.

** Ni-CH Plated 2" & Smaller

90001256

ENGINEERING AND TECHNICAL DATA

W.O.G. at ambient temp. (-20 F to +100 F) Non-Shock
(For All Seal Codes)

Test	BODY MATERIALS Pacific Alloy Code	
	BR	CS,G,S,A
Maximum Working Pressure	225	275
Hydrostatic Shell Test	350	425
Hydrostatic Seat Test	225	275
Seat Test, air under water	50 to 100	

MAXIMUM WORKING & TEST PRESSURE 150# VALVES
FIG. 4B300

W.O.G. at ambient temp. (from -20 F to +100 F)
(For P5 Seal Code)

Test	BODY MATERIALS Pacific Alloy Code	
	CS,S,A	G
Maximum Working Pressure	720	615
Hydrostatic Shell Test	1100	925
Hydrostatic Seat Test	720	615
Seat Test, air under water	50 to 100	

MAXIMUM WORKING & TEST PRESSURE 300# VALVES
FIG. 3B300

W.O.G. at ambient temp. (from -20 F to +100 F)

Test	Body Materials Pacific Alloy Code
	BR,CS,G,S,A
½" to 1"	1000
Hydrostatic Shell Test	1500
Hydrostatic Seat Test	1000
Seat Test, air under water	50 to 100

MAXIMUM WORKING & TEST PRESSURE 1000# VALVES
VALVE SIZES ½" to 1"
FIG. -2B325

W.O.G. at ambient temp. (from -20 F to +100 F)

Test	Body Materials Pacific Alloy Code
	BR,CS,G,S,A
1½" & 2"	600
Hydrostatic Shell Test	900
Seat Test, air under water	600
Seat Test, air under water	50 to 100

MAXIMUM WORKING & TEST PRESSURE 600# VALVES
VALVE SIZES 1½" to 2"
FIG. -2B325

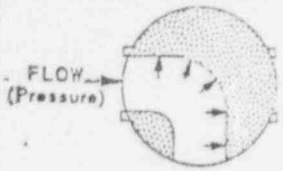
For Steam Service. Max. Steam Press. 125 PSIA at 353 F.

90001257

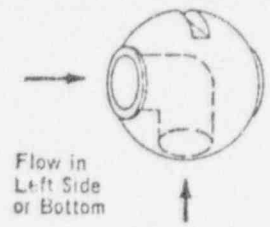
STEAM SERVICE
All Sizes

Pacific 3-way ball valves are constructed to the same quality and strength criteria as their equivalent straightway ball valve. Their parts are similar and often completely interchangeable, and they can be expected to provide the same tight shut-offs but only when the flow direction is positive, i.e. when the line pressure or pressure differential acts to hold the ball against the seat or port that is to be sealed off. When the flow is "negative" or "neutral" in relation to a given port or ports, Pacific does not warrant absolutely tight shut-offs at these ports.

"Positive Flow" In Relation to R. H. Port

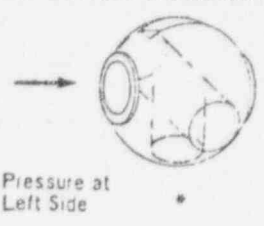


"Positive Flow" In Relation to R. H. Port



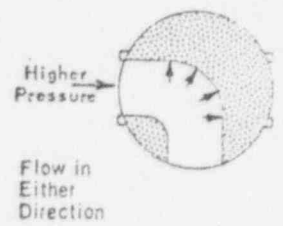
ARRGT. NO. 1

"Positive Pres." In Relation to R. H. Port

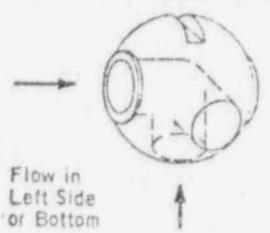


ARRGT. NO. 3

"Positive Flow" In Relation to R. H. Port

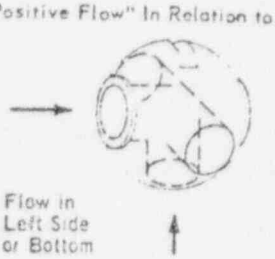


"Positive Flow" In Relation to R. H. Port



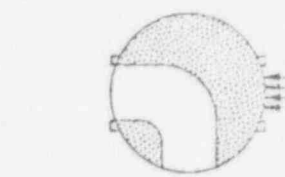
ARRGT. NO. 2

"Positive Flow" In Relation to R. H. Port

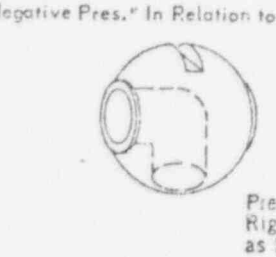


ARRGT. NO. 4

"Negative Flow" In Relation to R. H. Port

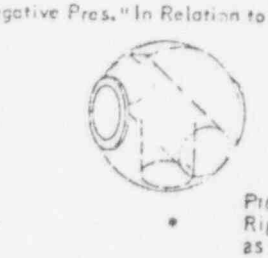


"Negative Pres." In Relation to R. H. Port



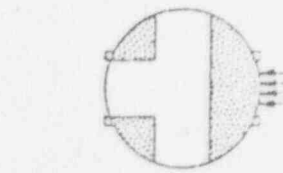
ARRGT. NO. 1

"Negative Pres." In Relation to R. H. Port

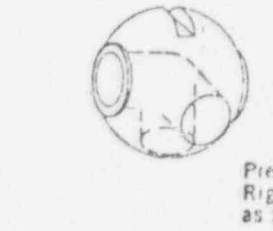


ARRGT. NO. 3

"Negative Flow" In Relation to R. H. Port

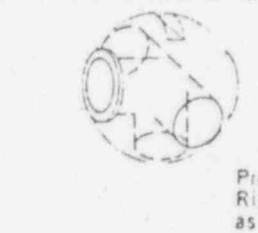


"Negative Pres." In Relation to R. H. Port



ARRGT. NO. 2

"Negative Pres." In Relation to R. H. Port



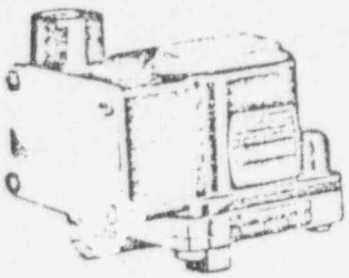
ARRGT. NO. 4

* With pressure at bottom port, the pressure is "neutral". The pressure is "negative" at the upstream port.

IV. PRESSURE SWITCHES

OPERATING CHARACTERISTICS • ORDERING DATA

Diaphragm Models with
Water Tight Housing (NEMA 4)
Covered Terminal Strip.
Tamperproof External Adjustment



PRESSURE SWITCHES — All values given in P.S.I. (Gauge)

Pr of (Test) Pressure	Adjustable Range Decreasing Min.	Adjustable Range Decreasing Max.	Adjustable Range Increasing Min.	Adjustable Range Increasing Max.	Approx. Actuation Value (Differential)	Wetted Material*	D1T Catalog Number
3	.018	1.654	.064	1.7	.018 to .046	B 25	D1T-H2
3	.018	1.65	.068	1.7	.02 to .05	17-7PH	D1T-H2SS
10	.03	2.89	.14	3.	.05 to .11	B 25	D1T-A3
10	.03	2.85	.18	3.	.07 to .15	17-7PH	D1T-A3SS
60	.4	17.80	.60	18.	.1 to .20	B 25	D1T-H18
60	.4	17.74	.66	18.	.12 to .26	17-7PH	D1T-H18SS
[illegible]	.5	77.2	3.3	80.	1.4 to 2.8	B 25	D1T-A80
160	.5	76.6	3.9	80.	1.6 to 3.4	17-7PH	D1T-A80SS
300	1.5	144.8	6.7	150.	2.2 to 5.2	B 25	D1T-A150
300	1.5	144.	7.5	150.	2.3 to 6.0	17-7PH	D1T-A150SS

D1T SINGLE SETTING

D2T DUAL CONTROL

VACUUM SWITCHES — All values given in inches of mercury (Gauge)

Proof (Test) Vacuum	Proof (Test) Pressure	Adjustable Range Dec. Vacuum Min.	Adjustable Range Dec. Vacuum Max.	Adjustable Range Incr. Vacuum Min.	Adjustable Range Incr. Vacuum Max.	Approx. Actuation Value (Differential)	Wetted Material*	D1T Catalog Number
6	10 P.S.I.	.06	5.8	.26	6.	.09 to .20	B 25	D1T-A3
6	10 P.S.I.	.06	5.72	.34	6.	.14 to .28	17-7PH	D1T-A3SS
30	60 P.S.I.	.8	29.34	1.46	30.	.4 to .66	B 25	D1T-H18
30	60 P.S.I.	.8	29.2	1.6	30.	.4 to .8	17-7PH	D1T-H18SS

*B 25 Beryllium Copper, 17-7PH Stainless Steel

Approx. Shipping Weight 2 lbs.

DETAIL DATA

ELECTRICAL CHARACTERISTICS: All models incorporate Underwriters' Laboratories, Inc. listed single pole double throw snap-action switching elements. Electrical rating (continuous inductive) 10 amps 125 or 250 volts AC, 3 amps 480 volts AC, .5 amps 24 volts DC. Automatically reset by snap-action of switch. For more details and other switch classes, see pages 2 and 3.

ELECTRICAL CONNECTION: To screw terminals on covered terminal strip through ½" nps conduit connector.

PRESSURE (VACUUM) CONNECTION: ¼" npt internal thread, ½" npt available add —P2 to catalog number when ordering.

ADJUSTMENT INSTRUCTIONS

Positive Pressure: Turn adjustment screw clockwise to lower actuation point (switch setting).

Vacuum: Turn adjustment screw counterclockwise to approach atmospheric pressure.

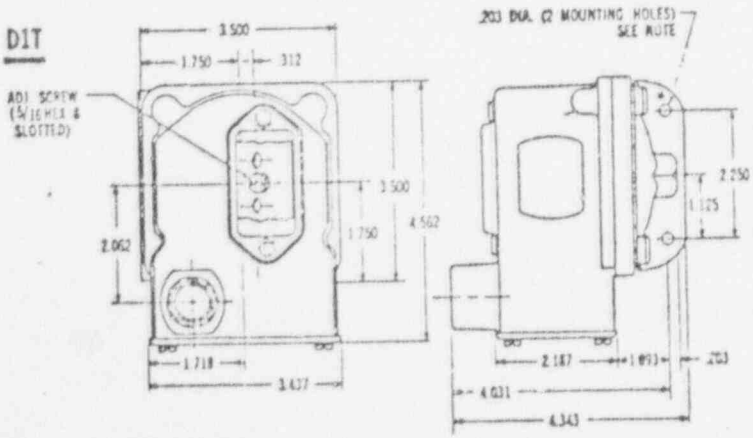
WIRE CODING — PRESSURE
Circuit #1: Common — Purple
Normally Closed — Blue
Normally Open — Red
Circuit #2: Common — Brown
Normally Closed — Orange
Normally Open — Yellow

WIRE CODING — VACUUM
Circuit #1: Common — Purple
Normally Closed — Red
Normally Open — Blue
Circuit #2: Common — Brown
Normally Closed — Yellow
Normally Open — Orange

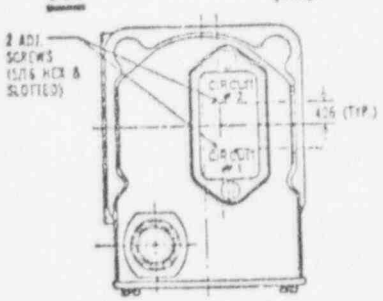
Switches Underwriters Laboratories and Factory Mutual listed for Fire Protection service request bulletin 690627.

Note: All other dimensions for D2T are the same as D1T (left).

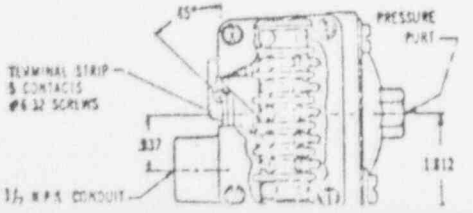
D1T



D2T

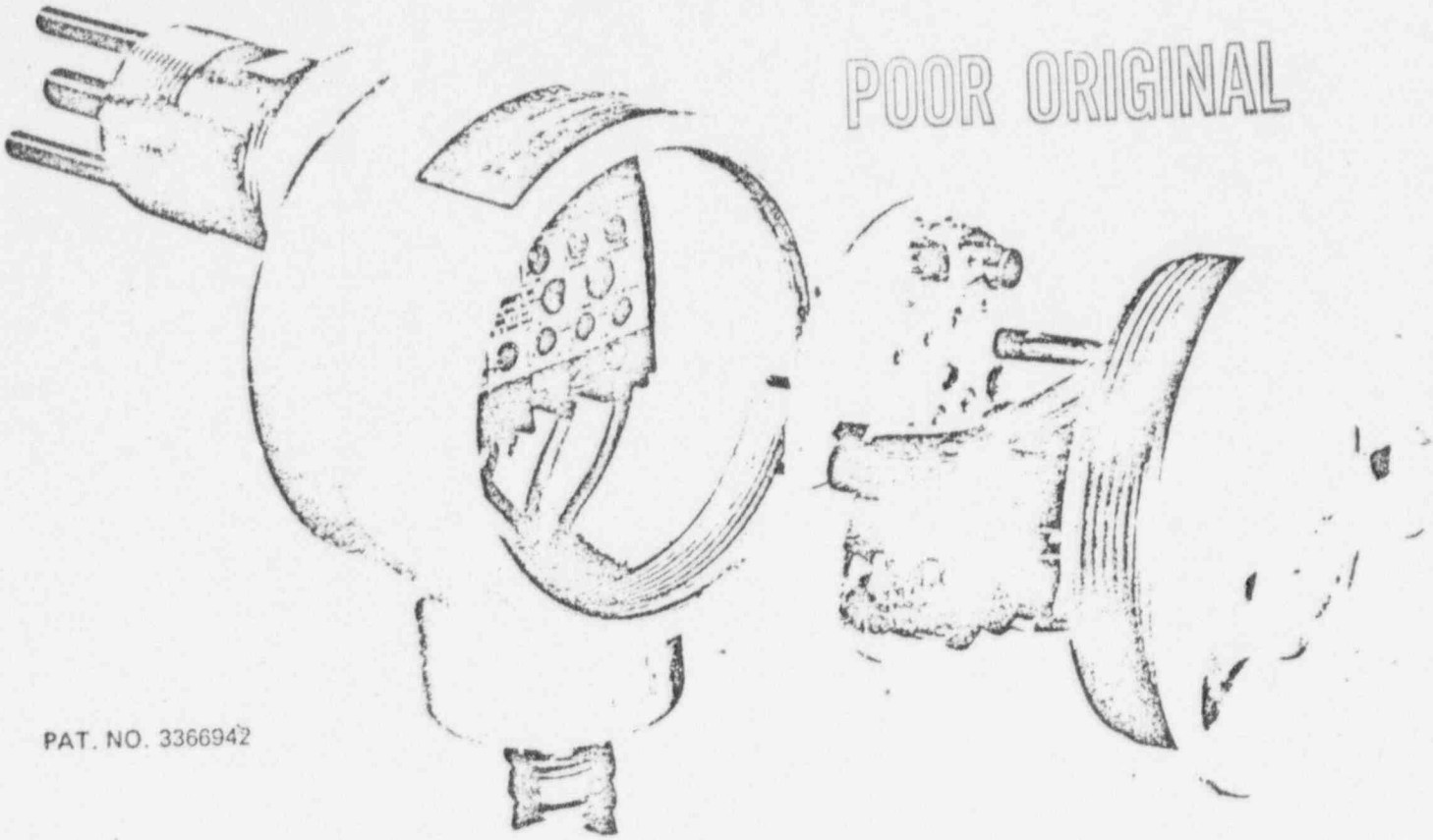


NOTE: MOUNTING BRACKET MAY BE ROTATED 90° OR 180° FROM POSITION SHOWN



V. FLOW

- NO MOVING PARTS
- FIELD ADJUSTABLE SWITCH POINT
- SWITCH POINT UNAFFECTED BY CHANGE IN PRODUCT:
  TEMPERATURE VISCOSITY DENSITY
  PRESSURE PHASE (oil to water)
- STAINLESS STEEL CONSTRUCTION
- RELIABLE – ECONOMICAL INSTALLATION – MAINTENANCE FREE



PAT. NO. 3366942

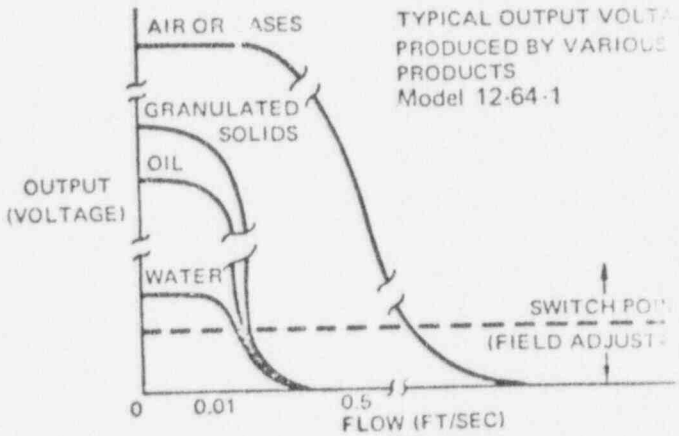
PRINCIPLE OF OPERATION

All heat actuated flow switches sense the movement or stoppage of a product by detecting a temperature change in a heated temperature probe.

The Model 12-64 Flow Switch is different from conventional heat actuated flow switches in that it has a separate low powered heater probe and two separate temperature sensor probes. These probes contain two matched temperature sensors which are wired into a Wheatstone bridge circuit. The heater warms the product and, in the absence of flow, preferentially heats one sensor which causes an imbalance in the bridge circuit, de-energizing the relay to indicate no-flow.

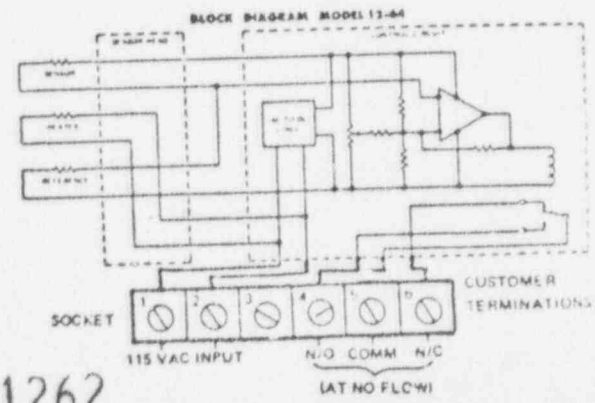
During flow the heat is swept downstream by the product allowing the temperature probes to be thermally balanced, also balancing the bridge circuit, energizing the relay to indicate flow.

Small movements of any product will interrupt the heat transfer path to positively indicate flow regardless of product composition. The switch point, which is field adjustable, is relatively unaffected by extreme changes in product temperature viscosity, density and pressure (Fig. 1).

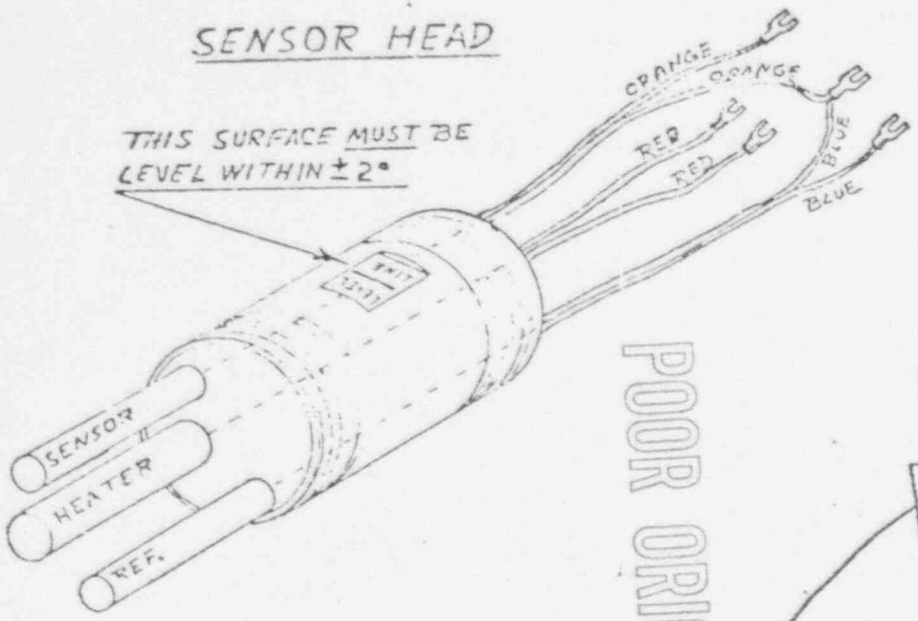


TYPICAL OUTPUT VOLT
PRODUCED BY VARIOU
PRODUCTS
Model 12-64-1

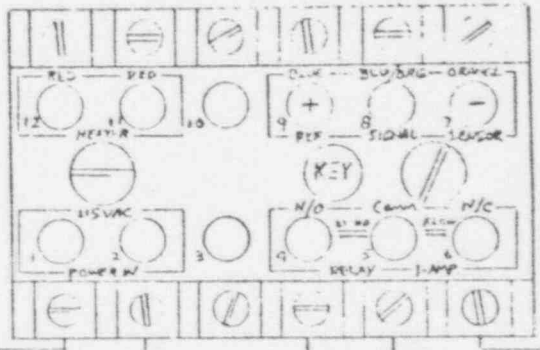
FIG. 1

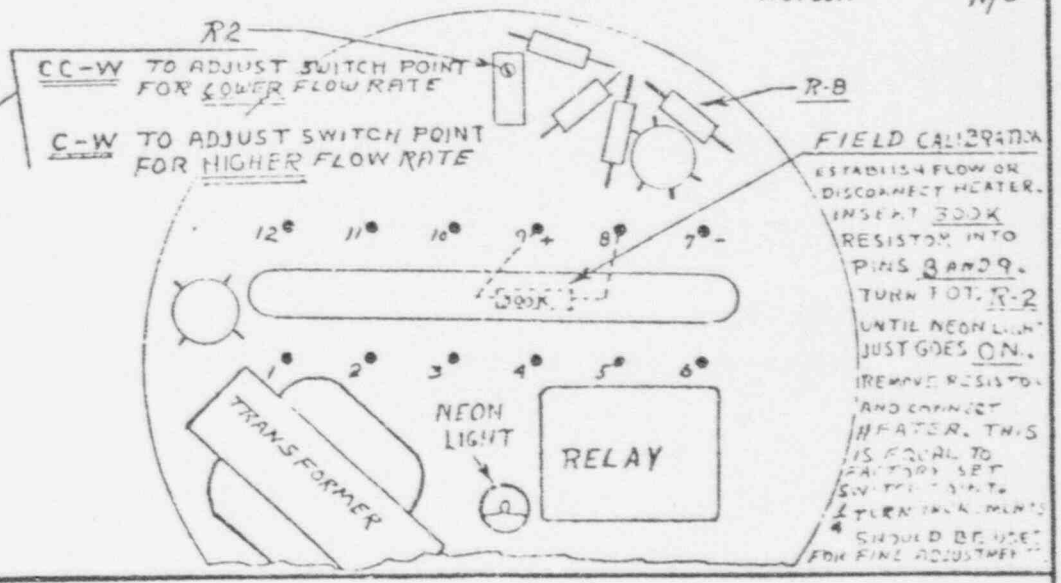


SENSOR HEAD



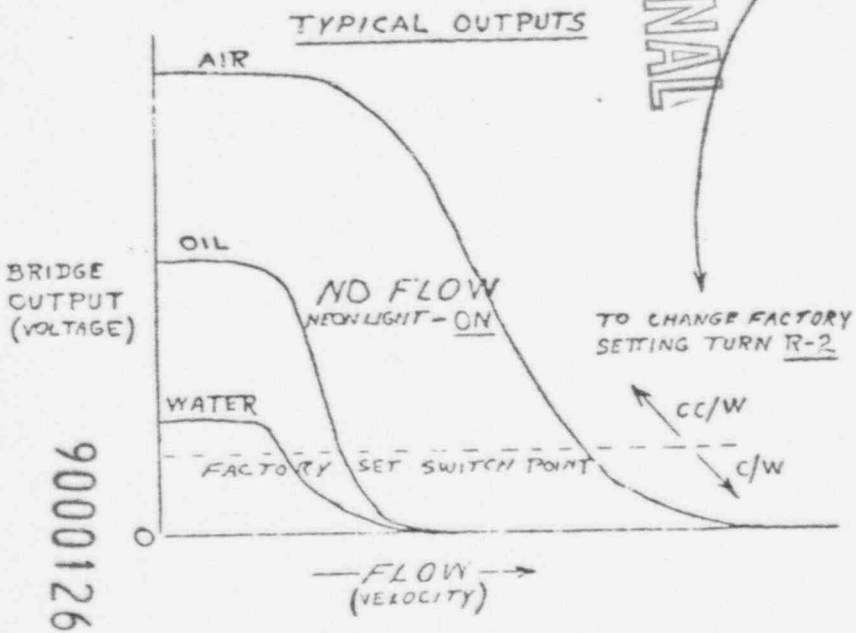
SOCKET





POOR ORIGINAL

TYPICAL OUTPUTS



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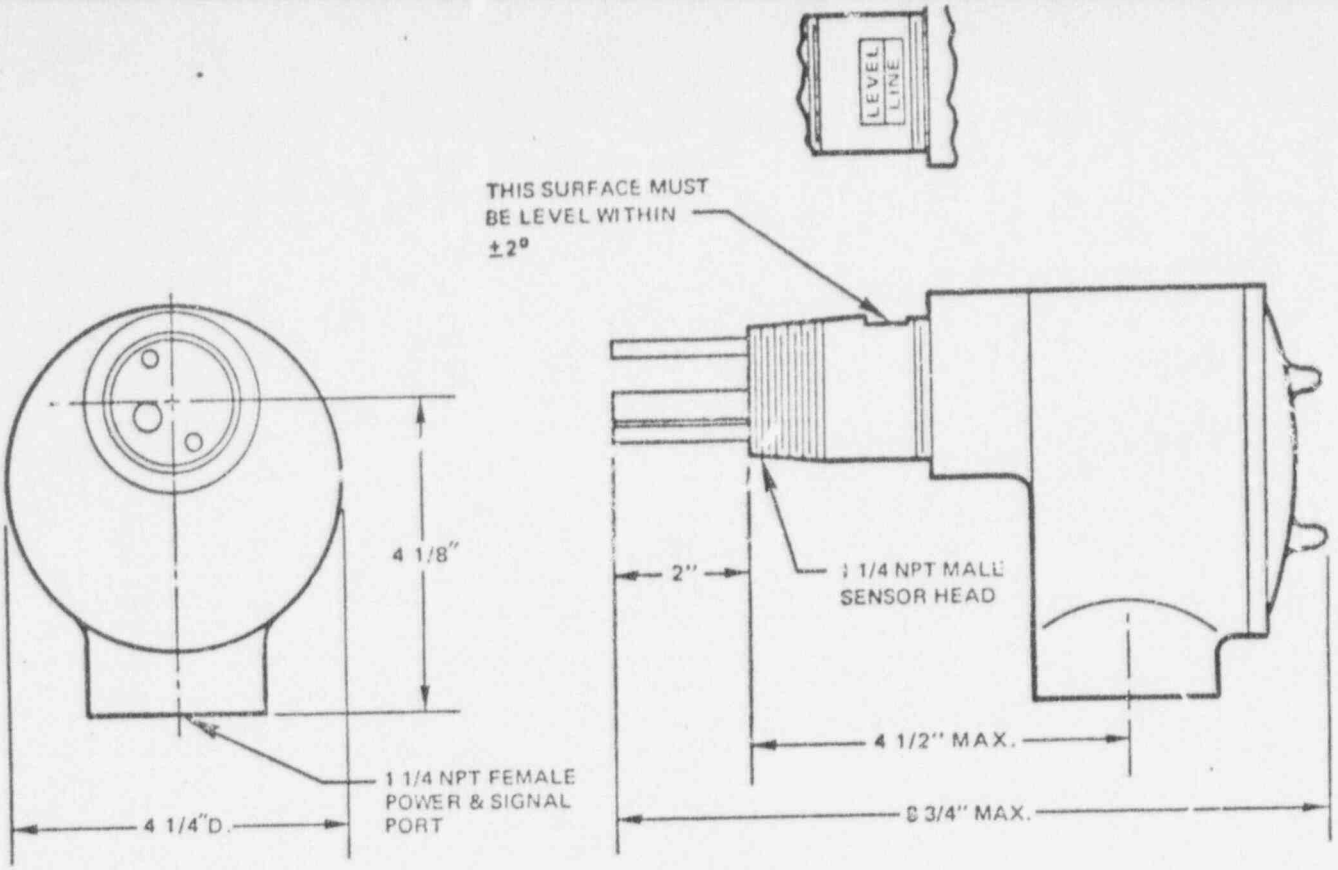
FIELD ADJUSTMENTS and WIRING HOOK UP

SCALE:	APPROVED BY	DRAWN BY AMD
DATE:		

MODEL 12-64 FLOW SWITCHES

FLUID COMPONENTS, INC.

DRAWING NUMBER



GENERAL SPECIFICATIONS

Approximate flow ranges (ft./sec.) for horizontal pipe

PRODUCT	MODEL 12-64			
	-1	-2	-3	-4
WATER	.01-.05	.05-.1	.1-.5	.5-2.0
OIL	.01-.05	.05-.1	.1-.5	.5-2.0
GASES	.5-2.0	2.0-5.	5.-10	10-50

Field adjustment: Any value within the indicated range. All units shipped with switch point set at mid-range (water) unless otherwise specified.

Repeatability: 10% of range.

Operating temperature: Sensor head -100 to +350 F (higher on application)
Electronic housing –65 to +150 °F

NOTE: For applications where product temperature exceeds 150 °F the electronic housing should be located remotely. See Model 12-64R on back page. Interconnecting cable quoted separately (specify length in feet).

Operating Pressure; To 3000 PSI (higher on application).

Material: Wetted surface 304 or 316 stainless steel. Other materials on application.

Sensor Mounting: 1 1/4 inch NPT female port. See back page for typical installations.

Electrical Connection: 1 1/4 inch NPT female port.

Power Input: 90 to 130 VAC, 50 or 60 Hz 10 watts. Models are available which will operate on voltages down to 24 VAC or VDC.

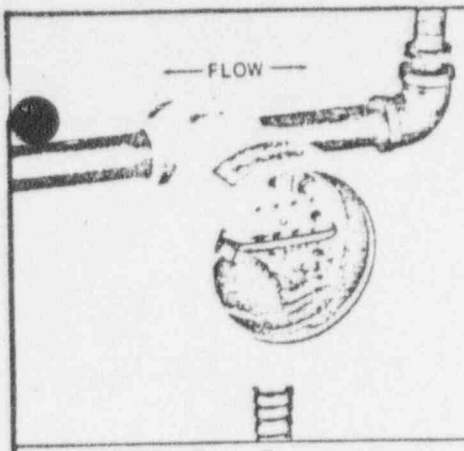
Relay Contact Rating: SPDT, 1 amp at 115 VAC or 24 VDC resistive. Hermetically sealed reed switches or solid state relays available on application.

Electrical Rating: The control circuit is mounted within junction box rated for hazardous areas which complies with;
NEC Class I, Groups C and D
Class II, Groups E, F, and G
UL Standard: 886

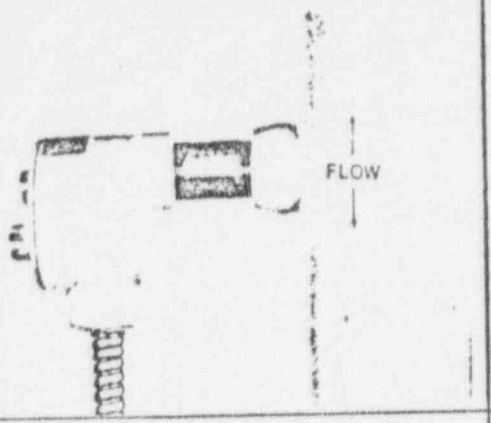
Shipping Weight; Approx. 7 lbs.

NOTE: For endothermic (heat absorbing) processes, consult the factory for mounting recommendations.

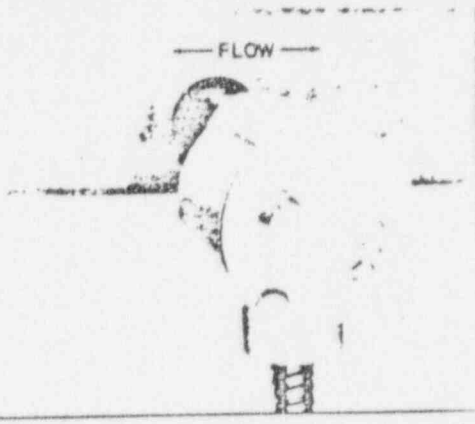
Typical Applications



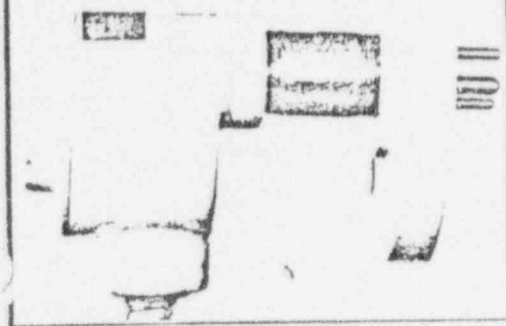
Model FR-70 2 to 5 second response time. Switch point as low as 0.01 GPM.



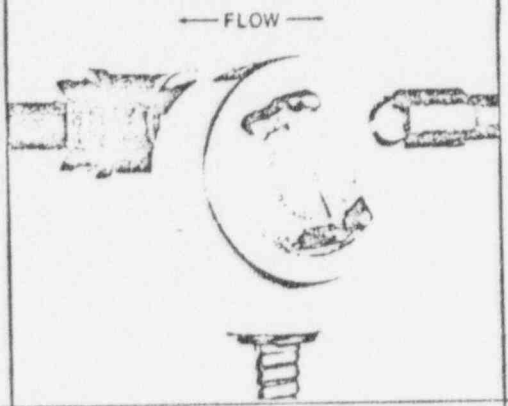
Model 12-64 Vertical pipe with 1¼" half-coupling for mounting boss.



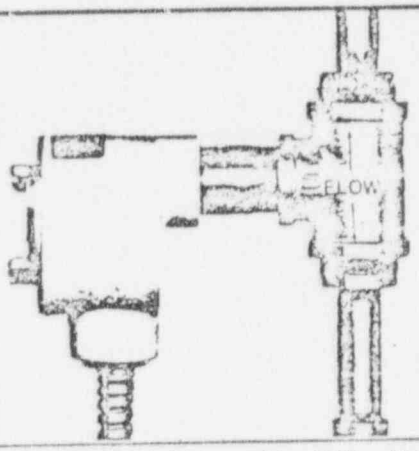
Model 12-64 Horizontal pipe with 1 ¼" half-coupling for mounting boss.



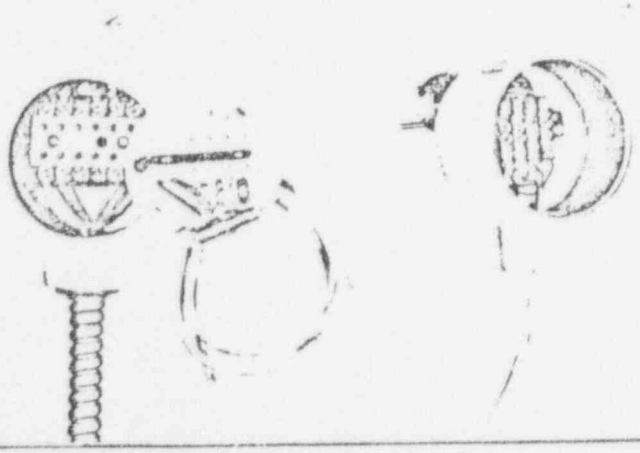
Model 12-64 Mounted in reducing or blind flange.



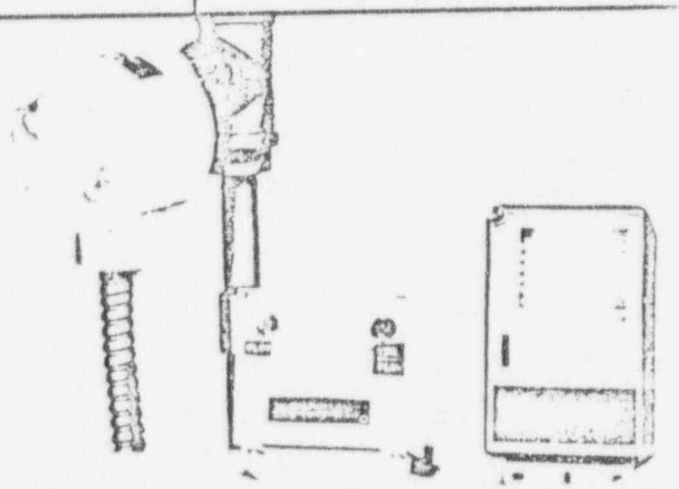
MODEL 12–64 Mounted in 1½" x 1½" x 1¼" tee. Horizontal installation.



Model 12-64 Mounted in 1½" x 1½" x 1¼" tee. Vertical installation.



MODEL 12–64R Remote electrical housing

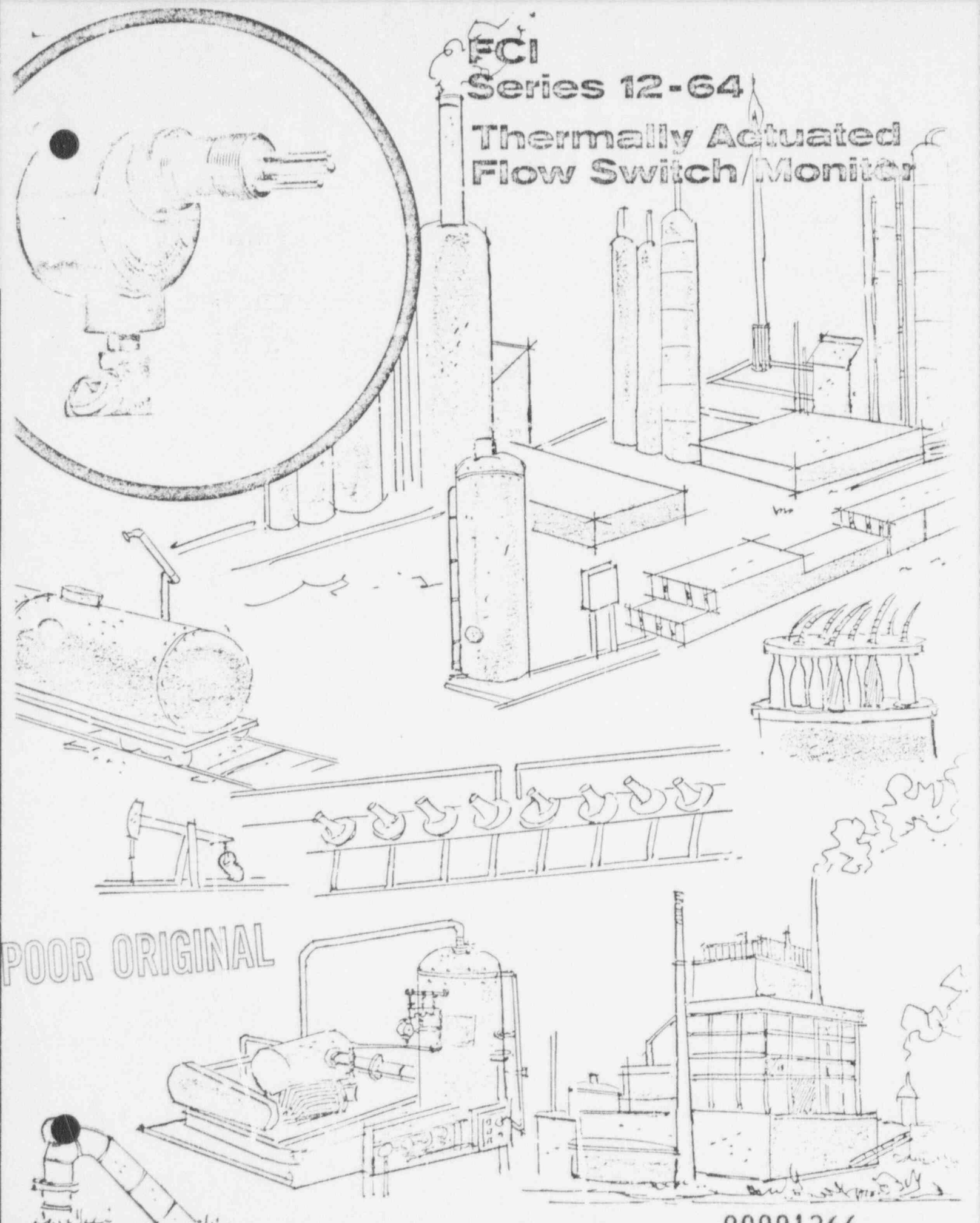


Optional readout and indicating devices.

REPRESENTED BY

FLUID COMPONENTS, INC.
22344 Mandell Street, Canoga Park, California 91304
P. O. Box 1165 Phone (213) 883-0806

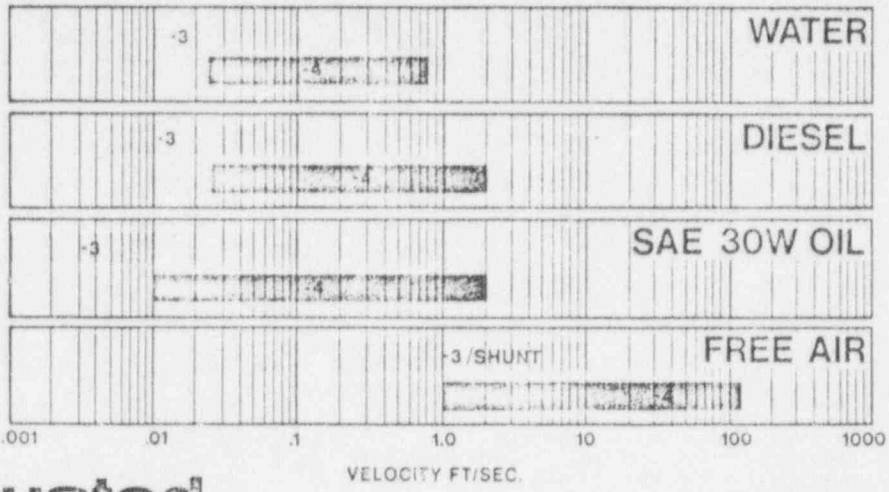
FCI
Series 12-64
Thermally Actuated Flow Switch/Monitor



90001266

FLUID COMPONENTS, INC. P.O. BOX 1165, CANOGA PARK, CA 91304 · Phone (213) 341-7722 · Toll Free (800) 423-5081

Field adjustable switch point range for typical media



FCI Series 12-64 Thermally Actuated Flow Switch/Monitor

The FCI 12-64 Series Flow Switch/Monitor is a thermally actuated, ruggedly designed flow sensor that will provide maintenance-free performance over long periods of time in a wide range of applications. It features:

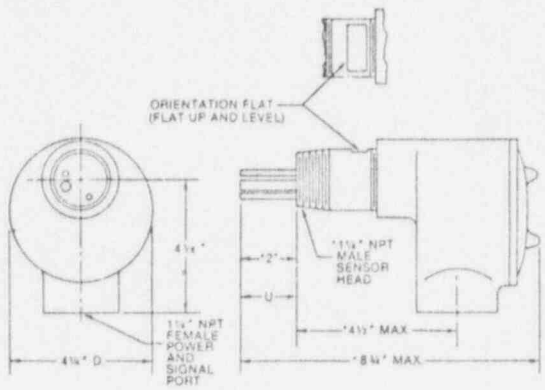
Versatility — The 12-64 will detect the flow of virtually any medium at virtually any pressure, temperature or viscosity. Design variations are available for all mounting requirements. Electrical options include SPDT, DPST and dual switch point contacts as well as millivolt and milliamp analog outputs.

Reliability — No moving parts assures years of reliable, maintenance-free operation. The Switch/Monitor is designed to withstand abnormally high flow velocities. All wetted parts are of stainless steel.

Sensitivity — Flow velocities as low as 0.01 ft/sec in liquids and 0.05 ft/sec in gases may be detected regardless of process line diameter.

Rangeability — Switch points may be field adjusted over a range of 100 to 1.

Repeatability — 0.5 to 1.0% of full signal (depending on medium) at constant conditions.

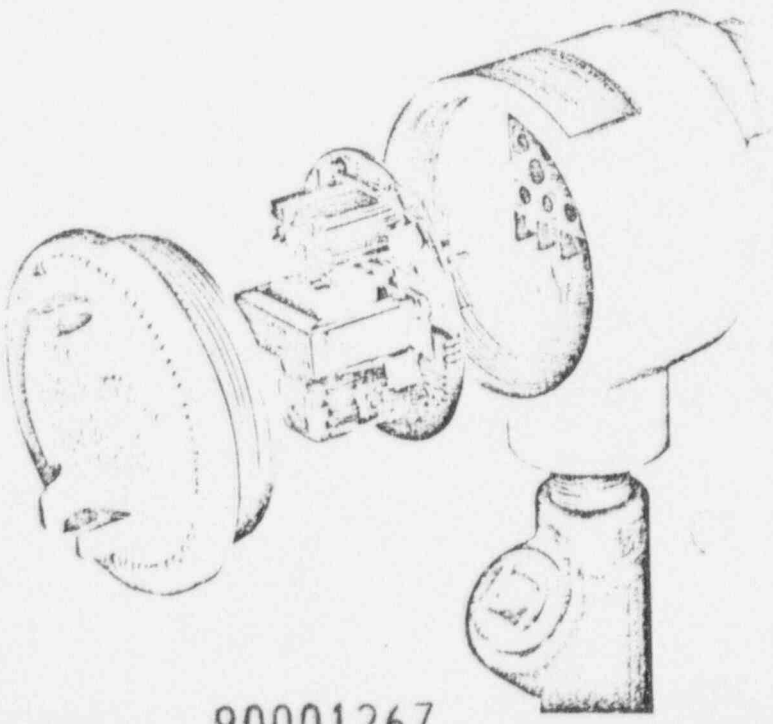


*FOR ILLUSTRATED CONFIGURATION. OTHER MOUNTINGS AND OPTIONAL "U" LENGTHS AVAILABLE.

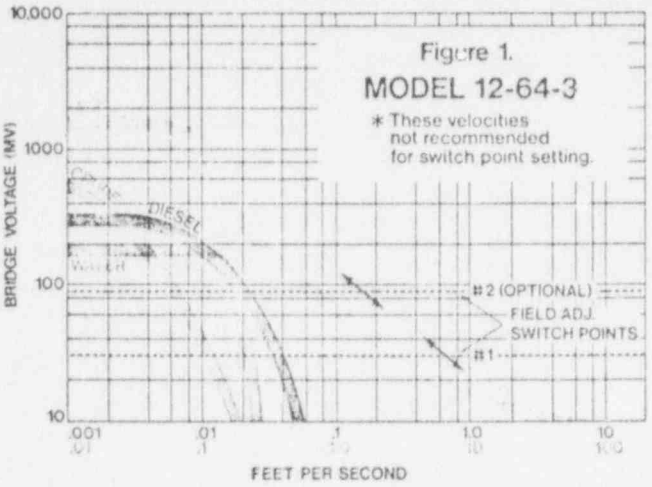
PRINCIPLE OF OPERATION

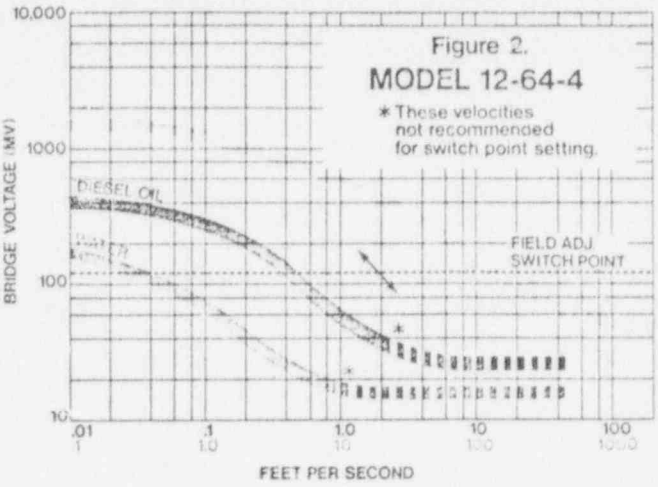
The Model 12-64 detects variations in flow velocity by sensing changes in the heat transfer properties of the flowing medium. The sensing head consists of three stainless steel thermowells in direct contact with the product. A matched pair of resistive temperature sensors, one active and one reference, is precisely located in respective wells. These sensors are self-compensating for fluctuations in product temperature. A low-powered heating element is installed in the third well and is located so that it will always preferentially heat the active temperature sensor. This creates a temperature differential between the active and reference temperature sensors. Minute changes in flow rate alter the heat transfer path between the heater and active temperature sensor causing a relative change in temperature differential.

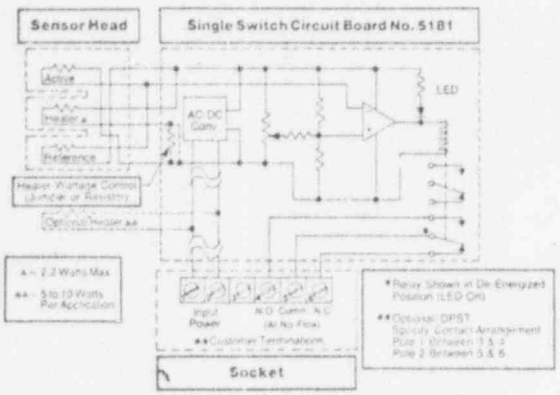
This temperature differential is electronically converted to a signal that is inversely related to actual flow rate. (See Figure 1 and [redacted]). At any predetermined level of this signal, a potentiometer can be field adjusted to actuate the relay. External voltage is switched across the normally open or normally closed contacts of the SPDT relay to indicate that flow rate is above or below the desired switch point. The standard circuitry is designed so that at low flow or no flow the signal is greatest and the relay is de-energized.

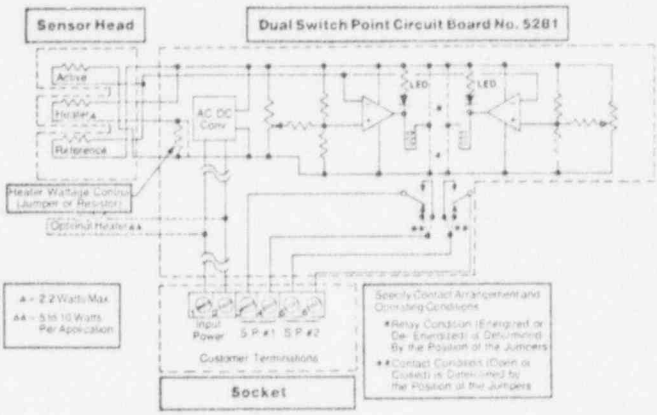


Approximate bridge voltage for typical media.









SPECIFICATIONS

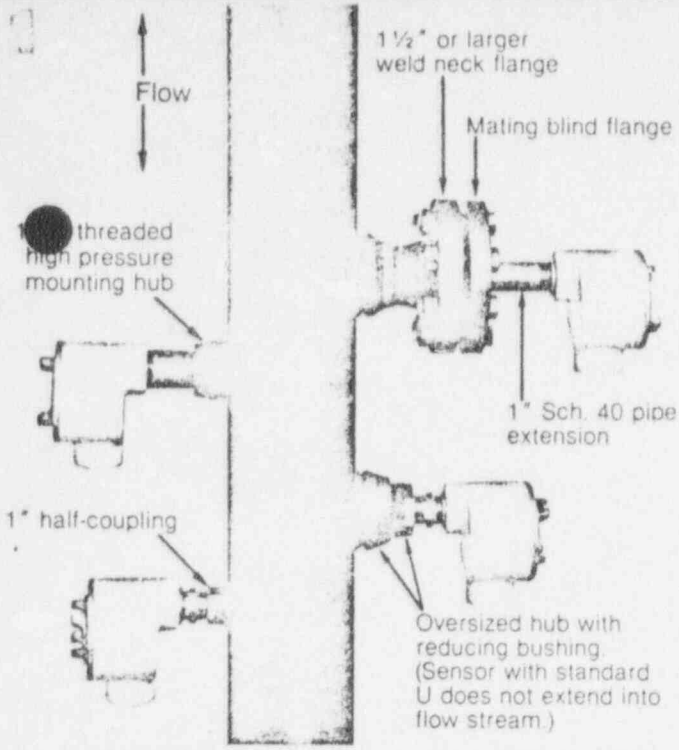
Process connections: 1" or 1¼" MNPT; flanged mountings available.
Insertion length: 2" tip of probe to process connection (U dimension); customer specified U length available.
Material: All wetted surfaces 316 stainless steel and nickel brazed per process specifications AMS 4777. Other materials, welding materials, brazing processes and coatings available.
Field adjustable switch point: Any value within the indicated flow range. 5 millivolt deadband. All units preset with switch point at mid-range in water. Factory certified switch points available.
Electrical connections: 1¼" FNPT.
Relay: SPDT contacts rated at 2 amps @ 115 VAC or 24 VDC resistive; relay coil de-energized at no flow. Other contacts and/or coil arrangements available.
Power input: 100-130 VAC, 50 or 60 Hz 6 watts maximum. 24 VAC or DC and other power inputs available.
Electrical rating: The control circuit is mounted in a junction box rated for hazardous areas and complies with NEC Class I, Groups C and D, Div. 1 and 2; Class II, Groups E, F and G, Div. 1 and 2; UL standard 886; Class I, Group B, Div. 1 and 2 junction box available.
Repeatability: 0.5 to 1.0% of full signal range (depending on medium) at constant conditions.
Operating temperatures: Sensor head -100° to +350°F; sensor heads to +750°F available.
Electrical controls: -50° to +150°F.
*Note: For applications where control housing temperature exceeds 150°F, the control electronics should be located remotely. See Model 12-64R on back page, photo 4.
Operating pressure: Sensor assembly hydrostatically pressure checked to 4000 PSIG. Units for higher pressure applications available.
Shipping weight: 7 lbs. standard, 14 lbs remote.
Options:
Sensor assembly: Retractable probe and packing gland assembly to fit through 1¼" full bore ball valve.
Sanitary construction with ferrule mounting flanges.
Shield assembly (S.A.) for higher switch point flow ranges.
Electronic circuitry:
Dual switch point circuit board.
Analog output, either millivolt or milliamp.

INSTALLATION RECOMMENDATIONS

MODEL	SERVICE	RECOMMENDED HEATER WATTAGE	PROCESS PIPING ARRANGEMENT	PROBE ORIENTATION
12-64-3/S	Gas	2.2	Any	Any (3)
12-64-3	Liquid	5	Any (1,2)	Side mounted orientation flat must be up and level ± 2°
12-64-4	Gas	2.2	Any	Any (3)
	Liquid	5	Any (1,2)	

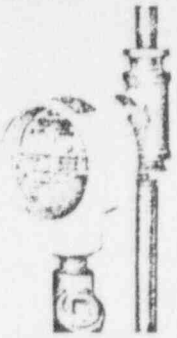
NOTES

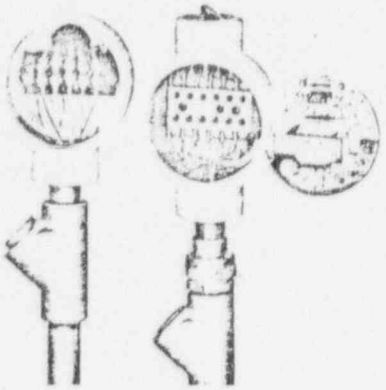
(1) The 12-64 specified for liquid service should be located in the process pipe so that it will remain wetted at all times during operation. If periodic draining or partially filled flowing lines normally occur, consult manufacturer or representatives for recommendations.
(2) The 12-64 mounted in a tee or section of pipe larger than the normal process pipe should be located in a vertical run of pipe with flow upward. This will prevent the trapping of air or gas bubbles at the sensor assembly.
(3) The 12-64-3/S and 12-64-4 will function in any orientation, but caution must be taken to prevent condensation build-up in a sensor assembly that is installed with the probe inserted downward.



TYPICAL MOUNTING IN A VERTICAL PIPE

Equipped with 1.2" sensor probes, the **1" MNPT 12-64** sensor assembly may be mounted in a 1" NPT tee. This mounting arrangement, with reducing bushings, will accommodate smaller than 1" NPT pipe or tubing.

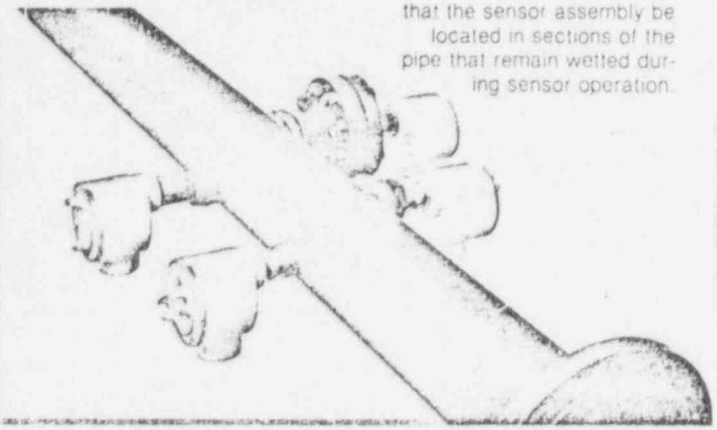


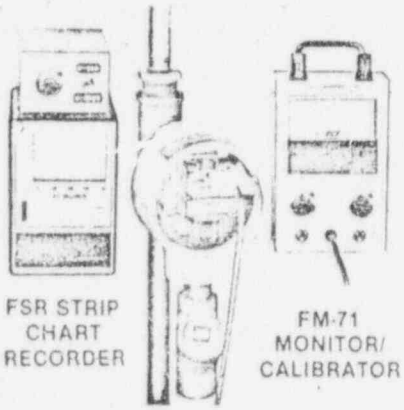


The 12-64R remote electrical enclosure must be used in areas of high temperature, excessive vibration and extreme radiation. It is also desirable for remote control panels, where the illustrated extra electrical housing may not be necessary, or inaccessible sensor assembly locations. The sensor and control circuitry may be separated up to 500 ft. with a shielded interconnecting cable.

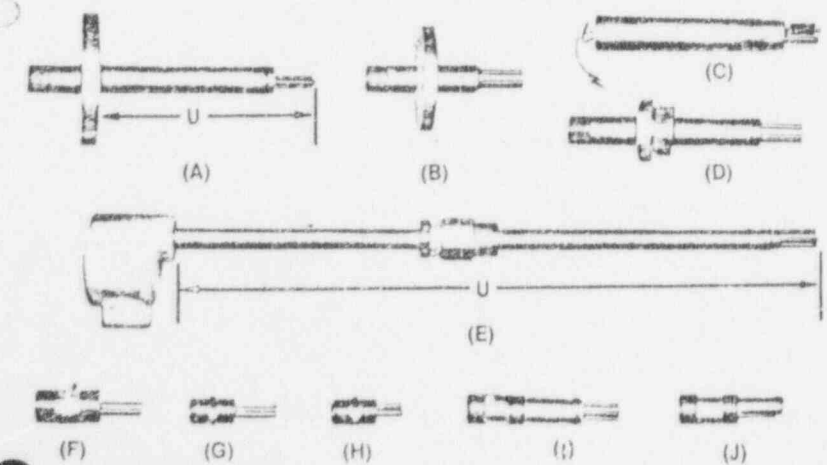
TYPICAL MOUNTING IN HORIZONTAL PIPE

For horizontal pipe, the preferred probe orientation is side mounted. In liquid service, it is recommended that the sensor assembly be located in sections of the pipe that remain wetted during sensor operation.





The FM 71 Monitor/ Calibrator and **FSR Strip Chart Recorder** are used to display and/or record flow changes at the sensor assembly. These accessories aid in establishing and verifying a switch point, and trouble shooting process and instrument problems. Either device may be plugged directly into the control circuitry of all FCI switch/ monitors.



EXAMPLES OF OPTIONAL 12-64 SENSOR ASSEMBLIES

(A) and (B). Flange mounted with customer specified insertion length (U).

(C). Special oil well production monitor.

(D). 2" MNPT mounting with customer specified U.

(E). Retractable probe including gland nut packing assembly for insertion through 1¼" full bore ball valve.

(F). 1¼" MNPT with standard 2" U.

(G). 1" MNPT with standard 2" U.

(H). 1" MNPT with 1.2" U to fit in a 1" NPT tee.

(I). 1¼" MNPT with customer specified U.

(J). 1¼" MNPT with shroud assembly (SA) option for high flow switch point.

Manufactured by

FCI FLUID COMPONENTS, INC.
P. O. Box 1165 Canoga Park, Calif. 91304
(213) 341-7722 Toll Free (800) 423-5081

Represented by

SWITCH POINT SETTING

FLOW SWITCH TO DETECT DECREASING FLOW RATE:

1. Install the Flow Switch in the pipeline. Fill pipeline so that sensor head is surrounded by liquid, if the sensor is to monitor liquid flow.

2. Power the Flow Switch and wait a few minutes for the sensor head to become active.

3. Flow the pipeline at the normal or expected rate. Remove the Crouse-Hinds cover on the electrical housing and locate the R2 potentiometer on the circuit board (its location is illustrated on the accompanying sheet titled "Field Adjustments & Wiring Hook-Up").

4. If the neon light or LED is off, turn potentiometer R2 clockwise until the light clicks on. With the light on, turn potentiometer R2 slowly counterclockwise one half turn past the point at which the light just turns off.
NOTE: The potentiometer may have up to 1 full turn of backlash. If mark is overshot, the procedure should be started over again.

FLOW SWITCH TO DETECT INCREASING FLOW RATE:

1. Install the Flow Switch in the pipeline. Fill pipeline so that sensor head is surrounded by liquid, if the sensor is to monitor liquid flow.

2. Power the Flow Switch and wait a few minutes for the sensor head to become active.

3. Flow the pipeline at the normal or expected rate. Remove the Crouse-Hinds cover on the electrical housing and locate the R2 potentiometer on the circuit board (its location is illustrated on the accompanying sheet titled "Field Adjustments & Wiring Hook-Up").

4. If the neon light or LED is on, turn potentiometer R2 counterclockwise until the light clicks off. With light oft, turn potentiometer R2 slowly clockwise one half turn past the point at which the light just turns on.
NOTE: The potentiometer may have up to one full turn of backlash. If mark is overshot, the procedure should be started over again.

(ONE TURN IS EQUAL TO APPROXIMATELY 100 mV)

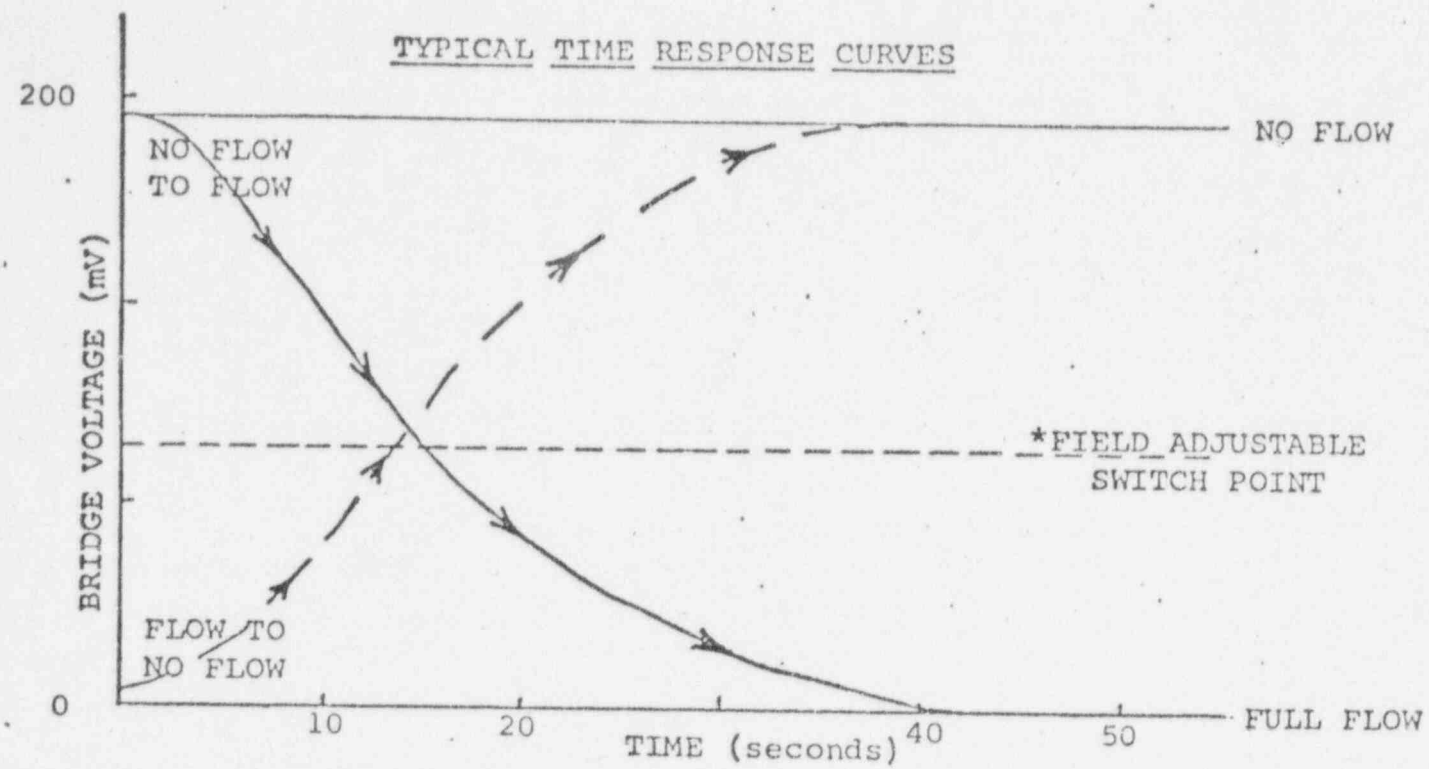
90001270

TIME RESPONSE AND VELOCITY GRAPHS FOR

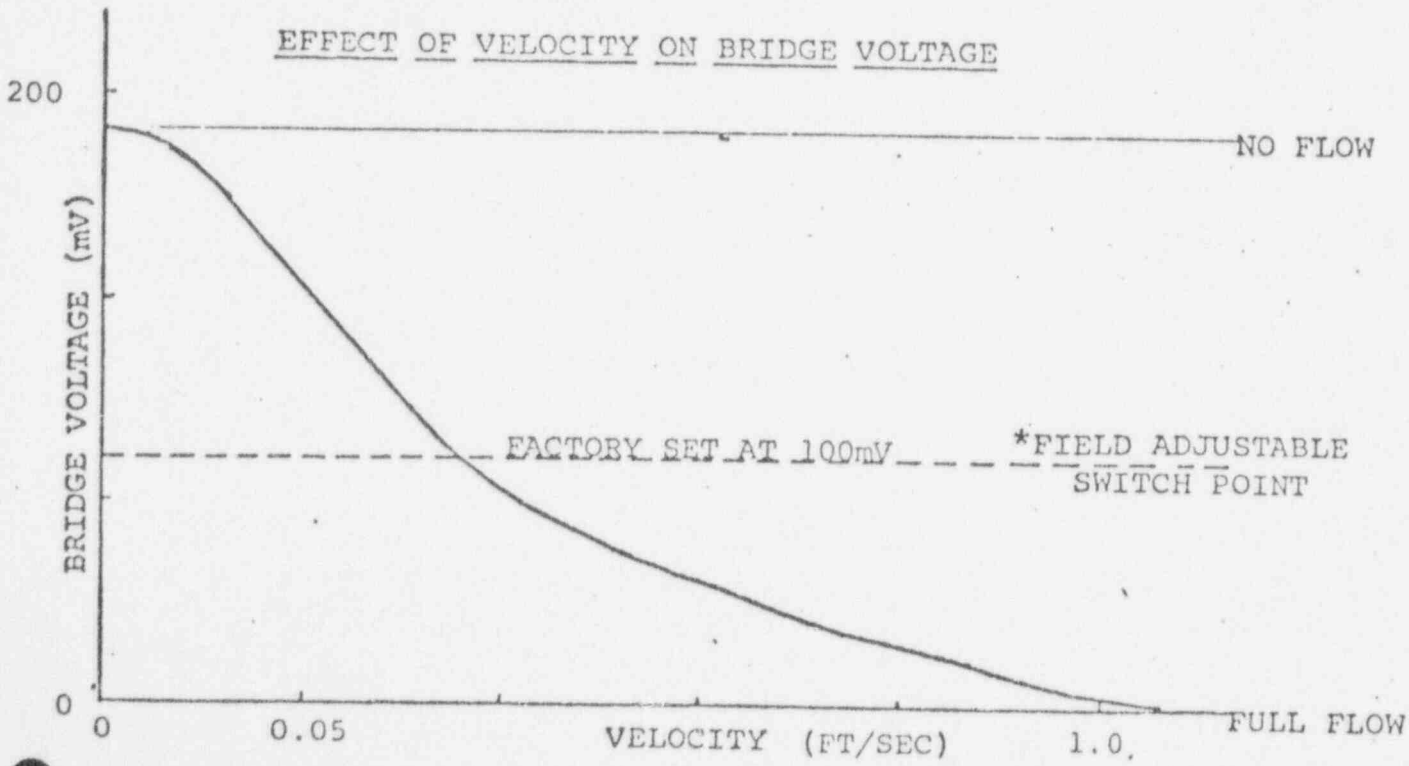
FLUID COMPONENTS MODEL 12-64-4FLOW SWITCH

IN WATER

TYPICAL TIME RESPONSE CURVES



EFFECT OF VELOCITY ON BRIDGE VOLTAGE

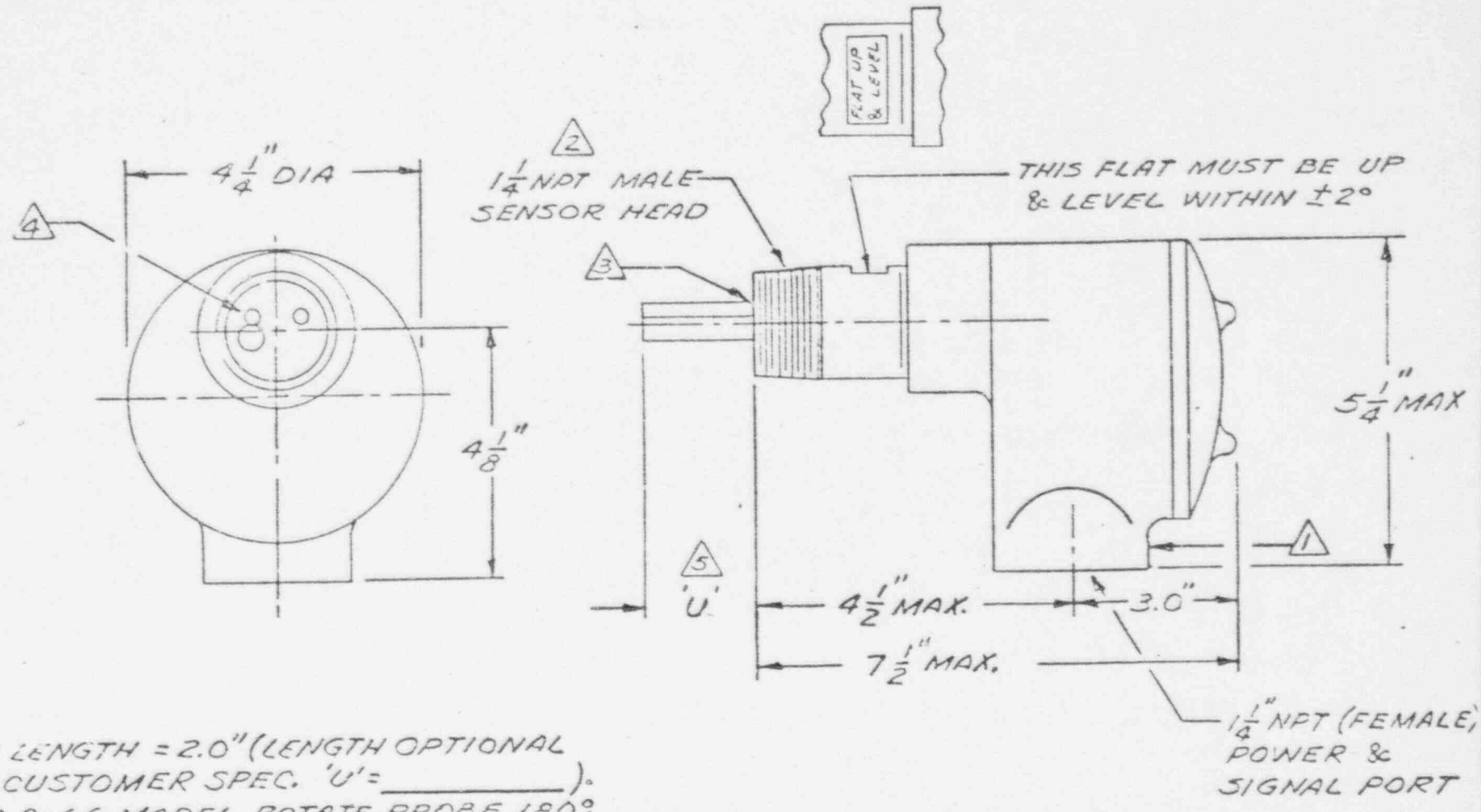


*TURN POTENTIOMETER CLOCKWISE TO MOVE SWITCH POINT DOWN.
TURN POTENTIOMETER COUNTERCLOCKWISE TO MOVE SWITCH POINT UP.

90001271

CUSTOMER:	P.O. NO.	QTY:	A	3501

POOR ORIGINAL



5 STD LENGTH = 2.0" (LENGTH OPTIONAL PER CUSTOMER SPEC. 'U' = _____).

4 FOR 8-66 MODEL ROTATE PROBE 180°

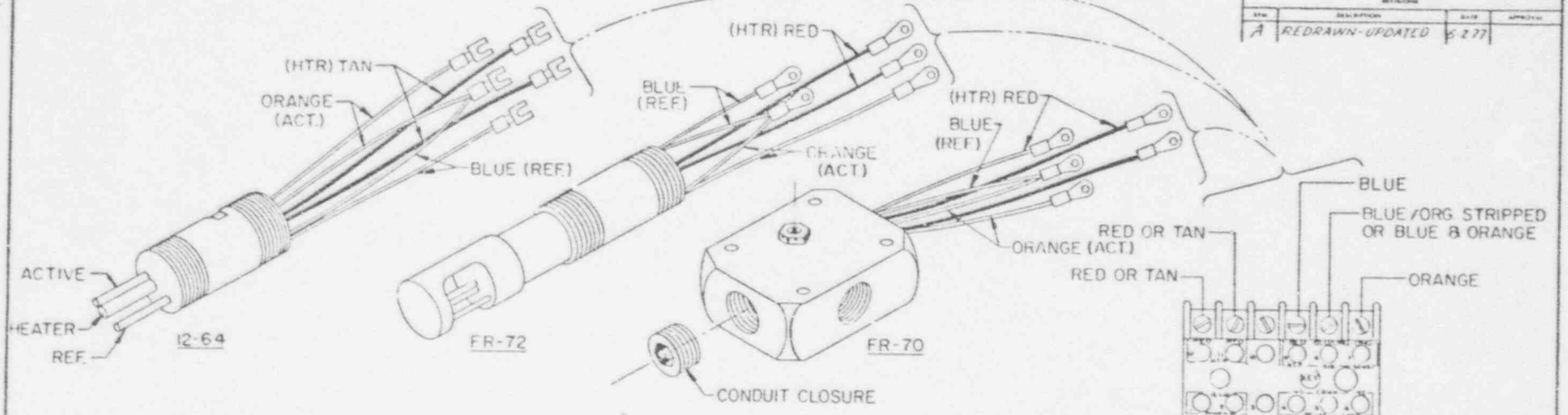
3 NICKEL FURNACE BRAZE PER AMS 4777.

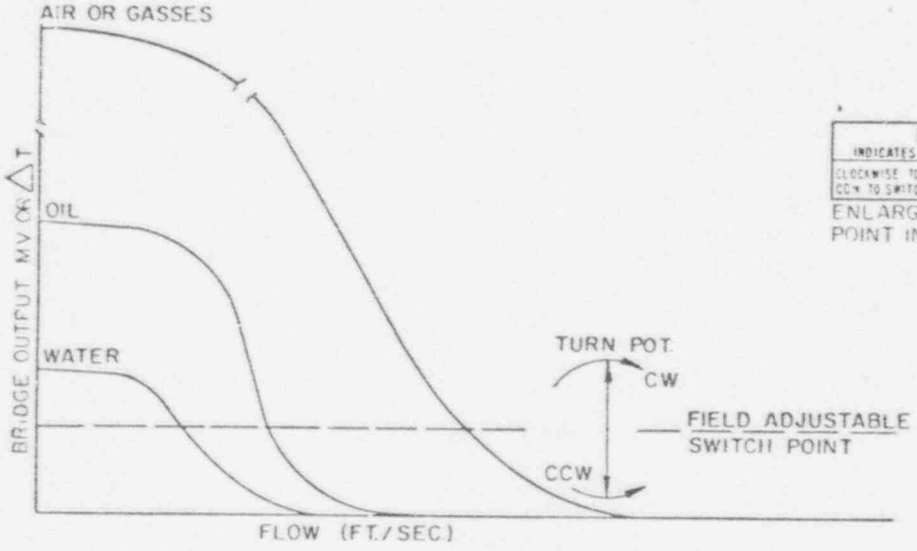
2 MATERIAL: PIPE NIPPLE 316 SS
SENSOR TUBES 316 SS

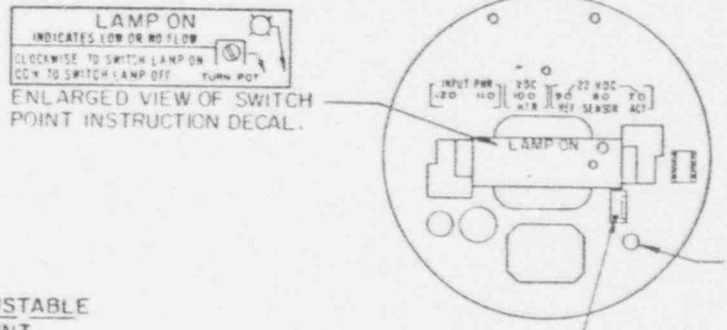
1 COMPLIES WITH N.E.C. CLASS I, GROUPS C & D, CLASS II, GROUPS E, F & G U.L. STD 886.

SCALE: ———	**FLUID COMPONENTS, INC.** Canoga Park, California 91304	
DWN ED 3-18-78	MODEL 12-64-4	
CK'D	MAT'L SEE NOTE 2	
APP'D	FINISH F.C.I. SHOP NO.	
TITLE 1 1/4" NPT MOUNTING, FLOW OR LIQUID LEVEL SWITCH (12-64/8-66 SERIES)		

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
A	REDRAWN-UPDATED	5 277	







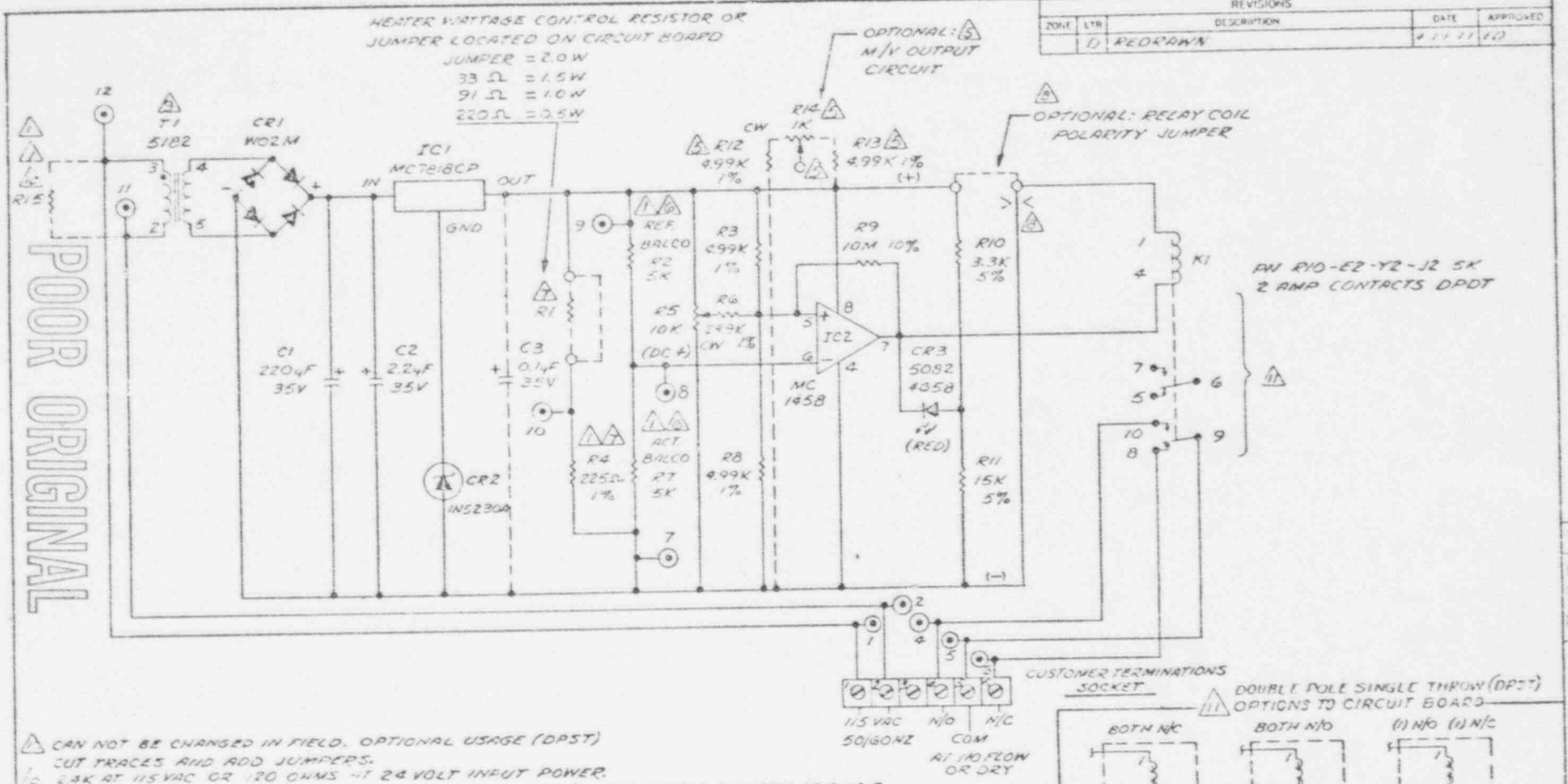
TURN CCW TO ADJUST SWITCH POINT FOR LOWER FLOW RATE

TURN CW TO ADJUST SWITCH POINT FOR HIGHER FLOW RATE

HEATER POWER 115 VAC

TOL. UNLESS NOTED: DEC .XXX, FRAC. & DEC. .XX, ANGLES ±1/2°. DIAMETERS WITH SAME ℄ SHALL BE CONCENTRIC WITHIN .005 TIR. SURFACES MUST BE "FLAT WITHIN .002 PER IN. MAX FILLET .015 UNLESS NOTED. DEBURR EDGES .005 MAX UNLESS NOTED. SURFACE FINISH 63 UNLESS NOTED.	SCALE	FLUID COMPONENTS, INC. Canoga Park, California 91304
	DWN. WC 5 277	MODEL 12-64, FR-72, FR-70
	CHD.	MATL.
	APPVD.	FINISH
	TITLE FIELD ADJUSTMENTS AND	

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	D	REDRAWN	4-11-11	LD



△ CAN NOT BE CHANGED IN FIELD. OPTIONAL USAGE (DPST) CUT TRACES AND ADD JUMPERS.

1. 24K AT 115 VAC OR 120 OHMS AT 24 VOLT INPUT POWER.

2. 24 VOLT INPUT POWER APPLICATION: REMOVE TRANSFORMER (T1) & ADD JUMPER BETWEEN 3 & 4; 2 & 5.

3. RELAY COIL NORMALLY DE-ENERGIZED AT NO-FLOW OR DRY; CUT TRACE AT (><) & ADD JUMPER TO ENERGIZE COIL AT NO-FLOW OR DRY.

4. R15 USED ONLY IN LIQUID SERVICE MODELS 12-66-3, -4. R1 & R4 ARE NOT USED IF R15 IS USED.

5. FP70, FP72 & FP73 SERIES = 4Ω RESISTANCE. 12-66 & P-66 SERIES = 5K RESISTANCE. } R2, R7

6. R12 R13 & R14 ARE OPTIONAL, USED WHEN BRIDGE MILLIVOLT OUT IS REQ'D. R14 IS ZERO ADJUSTING POT., WIPER JUMPERED TO AVAILABLE VACANT PLUG-IN CONTACT. BRIDGE 4/V OUTPUT PICKED UP AT PIN 8 (DC +) & R14 WIPER (DC −).

7. OPTIONAL: C3

3 CIRCUIT BOARD ASSEMBLY P/N 5181-177-1

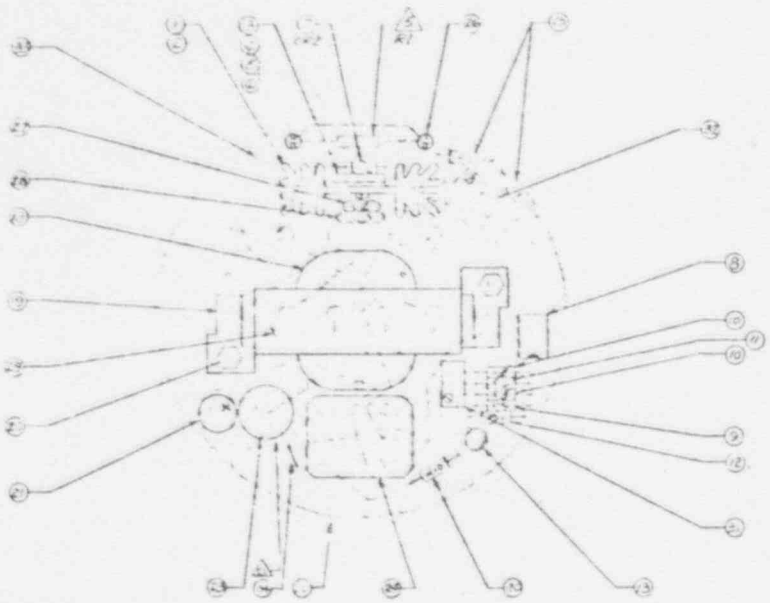
2 ⊙ INDICATES NUMBERED PLUG-IN CONTACTS ON CIRCUIT BD. CONTACTS FOR RECORDER PLUG 7, 8, 9, 11 & 12. CONTACTS FOR HAND HELD INDICATOR 7, 8 & 9. A 1000Ω RESISTANCE BETWEEN 8 & 9 OFFSETS BRIDGE, SIMULATES A NO-FLOW CONDITION FOR SETTING SWITCH POINT (HEATER OFF).

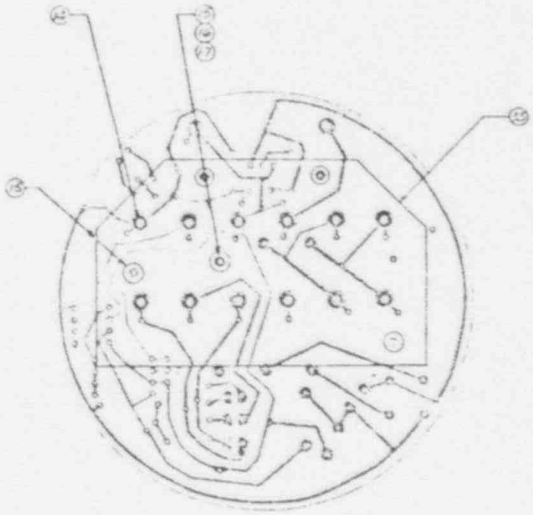
1 COMPONENTS INDICATED ARE MOUNTED OFF CIRCUIT BOARD IN SENSOR HEAD.

NOTES: UNLESS OTHERWISE SPECIFIED

FLUID COMPONENTS, INC.
ED #-777 MODEL ALL SERIES
CIRCUIT DIAGRAM (SPDT)
5180 D

5181-177-1





	1		M32M	DIODE BRIDGE		CR1
	4		6-32	NUT, HEX		
	1		5190	HANDLE KIT, TRANSFORMER		
	1		*TC2	TRANSFORMER	T1	
	1		NO. 6	LOCKWASHER, INT. TOOTH		
	1		5036	KIT, MOUNTING		
	2		#4-40 x 3/16	SCREW, TRUSS HEAD		
	12		#43-1	PIN, SOCKET - GAUGE		
	1		T1C-4563	DIODE, LED (RED)		
	1		1/8 W, 5%	RESISTOR	R11	
	1		2.49K, 1%	RESISTOR	R8	
	1		4.99K, 1%	RESISTOR	R3, R9	
	1		1K, 10%	RESISTOR	R7	
	1		MC1494	INTEGRATED CIRCUIT	IC2	
	1		IN4004	DIODE	CR2	
	1		4-40 x 1/4	SCREW, PAN HD. PHIL.		
	1		NO. 4	LOCKWASHER, INT. TOOTH		
	1		4-40	NUT, HEX		
	1		NE5534P	INTEGRATED CIRCUIT	IC1	
			*C4 x *115	CAPACITOR, TANTALUM		
	1		5031-410	HEAT SINK		

	1		E21C	INSULATOR, LOWER	35
A	1			JUMPER, 1¼ LONG	34
	1		5231	INSULATOR, HEAT - UPPER	33
A	1		3386P-1-102	POTENTIOMETER 1K	R14 32
	1		6637103	POTENTIOMETER 10K	R5 31
			0.05 Ω 5%	RESISTOR	R10 30
	1		4024	CIRCUIT, HEAT ADJUST	29
A			1 µF 35V	CAPACITOR	C3 28
	1		22 µF 25V	CAPACITOR	C2 27
	2		10-412-2	TERMINAL	26
B			4.99K 1%	RESISTOR	R2, R13 25
			10K, 1%	RESISTOR	R1 24
	1		2200 µF 35V	CAPACITOR	C1 23
	1		5181-177-2	CIRCUIT BD. SMALL SIZE	22
	QTY PER	UNIT OF MEAS	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	ITEM NO.

△ RELAY COIL DE-ENERGIZED AT NO-FLOW OR DRY. CUT TRACE AT (5) & ADD JUMPER TO ENERGIZE COIL AT NO-FLOW OR DRY.

△ HEATER WATTAGE CONTROL

DROPPING RES.	HEATER POWER
JUMPER	2.0 W
33Ω	1.5 W
91Ω	1.0 W
220Ω	0.5 W

△ OPTIONAL: C5, R12, R13, R14.

3. CAPACITOR VALUES ARE IN MICROFARADS.

2. RESISTOR VALUES ARE IN OHMS.

1. CIRCUIT DIAGRAM NO. 5180.

NOTES UNLESS OTHERWISE SPECIFIED

CIRCUIT BOARD ASSEMBLY, • STANDARD

D | 4N889 | 5181-177-1

SHT 1 OF 1

5181-177-1

VI. POWER MODULE

PPL MODIFICATIONS TO THE SCR DRIVES

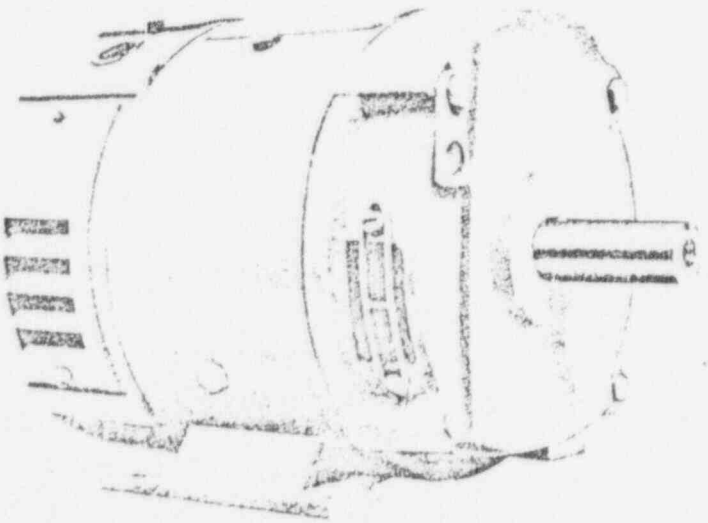
The operator's station on the adjustable speed drive supplied with the subject equipment is significantly different than described in the enclosed instructions from the manufacturer of the drive. The adjustable speed drives have been modified for remote control by the solid state logic and provision made for the selection of either of two speeds. The operator's station has on its face two speed potentioneters and a three position selector switch. When the selector switch is in the "AUTO" position, the start-stop and speed selection functions are controlled by the solid state logic in the Control Module. When the switch is in the "HIGH" position, the motor is in the manual control high speed mode. When the switch is in the "LOW" position, the motor is in the manual control low speed mode.

INSTRUCTIONS

GP-100*

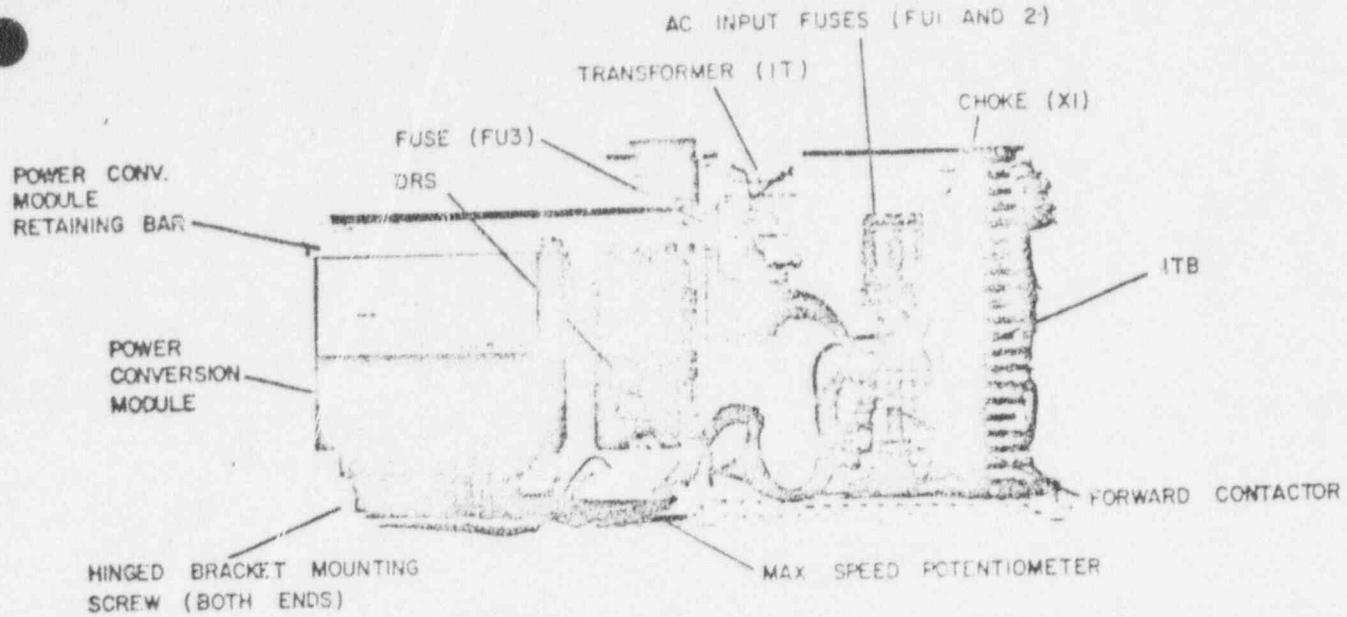
ADJUSTABLE SPEED DRIVE

1-5 HP, SINGLE PHASE

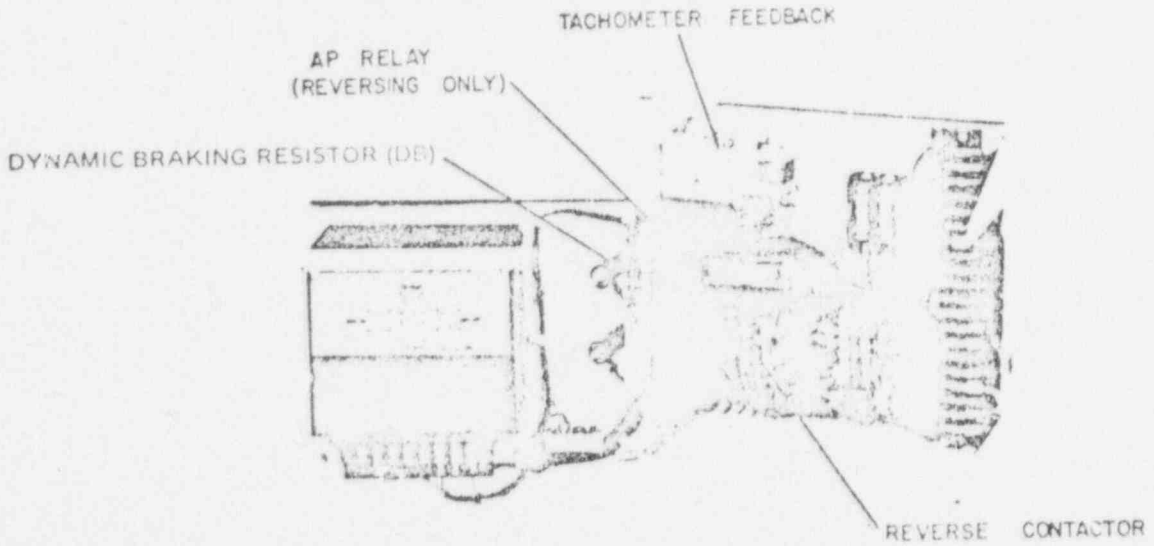


These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

GENERAL ELECTRIC

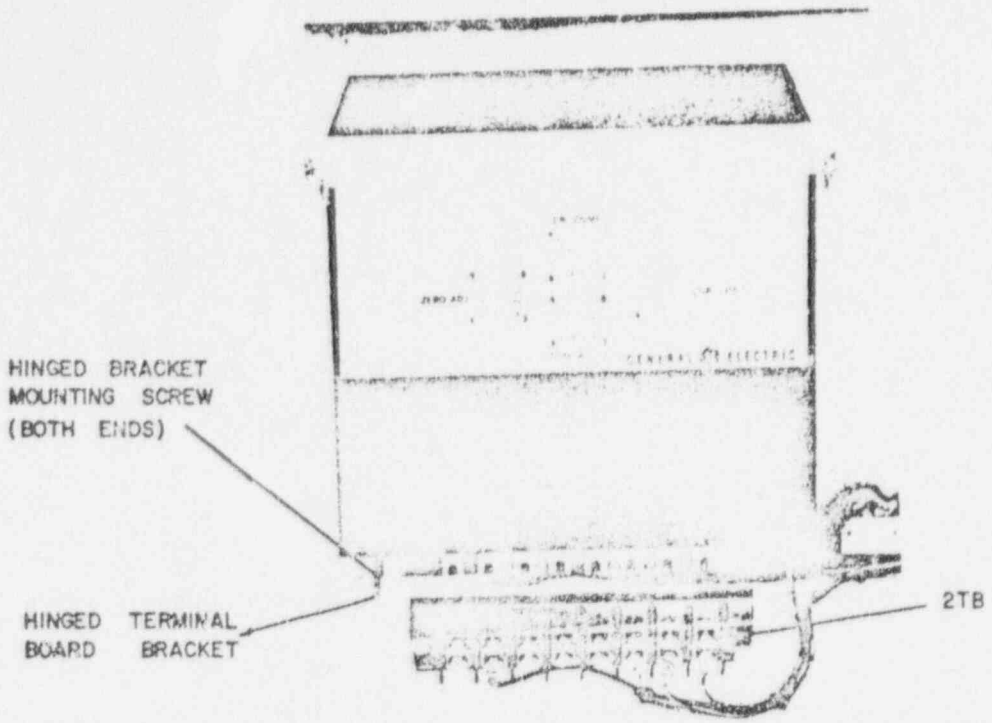


POWER UNIT—BASIC, NON-REVERSING, HINGED DOOR OPEN

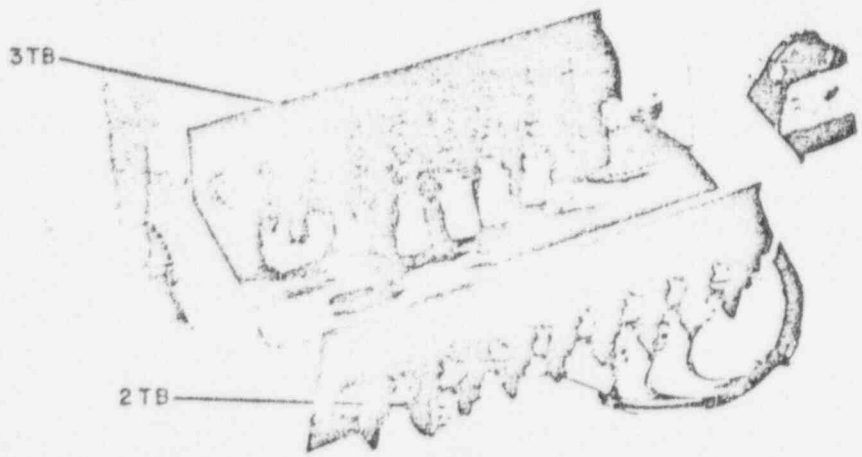


POWER UNIT—REVERSING, ONLY MODIFICATION OPTIONS IDENTIFIED

FIGURE 2



POWER CONVERSION MODULE – 2TB HINGED BRACKET LOWERED



POWER CONVERSION MODULE REMOVED – 2TB HINGED DOWN POSITION

FIGURE 4

PART I
INSTALLATION AND SETUP INSTRUCTIONS

INSTALLATION

GENERAL

When the equipment is installed, check all accessible factory-made connections for tightness, since connections may become loose during shipping or storage.

WARNING

EXCESSIVE SPEED CAN CAUSE DAMAGE TO MOTORS AND SERIOUS INJURY TO PERSONNEL. BEFORE ATTEMPTING TO OPERATE THE DRIVE,

1. THE FEEDBACK OF ARMATURE VOLTAGE SHOULD BE CHECKED TO MAKE SURE IT IS CONNECTED (JUMPER BETWEEN TERMINALS 1 AND 16 ON 3TB).
2. THE MOTOR FIELD SHOULD BE CHECKED TO MAKE SURE IT IS CONNECTED, AT THE MOTOR AND AT THE TERMINAL BOARD 1TB. (TERMINAL 19 TO MOTOR LEAD F4 AND TERMINAL 18 TO LEAD F1).

POWER UNIT

Installation requires removing the cover from the power unit to facilitate mounting and wiring. To remove the cover of the power-unit enclosure, release the two cover latches (one on each side of cover). Pull outward on the enclosure cover approximately three inches, then slide the entire cover upward approximately one inch to free it, and lift the cover off the enclosure.

NOTE

ALL MODIFICATION KITS ORDERED SHOULD BE INSTALLED PRIOR TO MOUNTING THE POWER UNIT.

OPERATOR'S STATION

The operator's station must be disassembled for mounting and wiring. First, remove the two screws securing the cover to the operator's station enclosure and then remove the cover (with the control devices mounted on the cover) from the enclosure. See Figure 5, page 10.

For convenience and ease of wiring, a pictorial wiring decal is provided on the back of the front cover plate that coincides with the group number ordered. All external wiring must be connected as the decal indicates.

DC MOTOR

A separate instruction book is provided giving information on location, conduit entrance and mounting of the d-c motor. The motor should be mounted on the driven machine (or as appropriate for the installation) before proceeding with wiring, setup and adjustment.

Do not couple the motor to the load until after preliminary setup instructions have been completed.

LOCATION

The DC 1021 SCR power unit and operator's station are suitable for use in most factory areas where other industrial equipment is installed. However, avoid locations subject to steam vapors, oil vapors, chemical fumes, excessive moisture, or excessive dirt, dust, or lint.

WARNING

NEVER INSTALL THE UNITS WHERE HAZARDOUS INFLAMMABLE OR COMBUSTIBLE VAPORS OR DUSTS ARE PRESENT.

The operator's station should be in a position which is convenient for the machine operator. The power unit should be located in a well-ventilated area which is not subject to ambient temperatures above 40 C (104 F).

The power unit enclosure is convection cooled. Air enters through the bottom of the enclosure and exits through the upper part of the front and sides. Make sure that there is clearance around the outside of the enclosure to allow a normal flow of cooling air.

INTERCONNECTION WIRING

GENERAL

All internal electrical connections between devices in the power unit have been made at the General Electric factory except connections for the modifications options, which may be shipped separately for installation by the purchaser.

PRECAUTIONS (VOLTAGE TRANSIENT)

The DC 1021 SCR Drive includes voltage transient protection which is adequate for most drive applications. However, since the exact nature of voltage transients present in any location cannot be anticipated, certain precautions should be followed to insure maximum reliability and life.

When silicon rectifiers (diodes) and silicon controlled rectifiers (SCR's) are subjected to voltage transients (spikes) in excess of their maximum rating, even for extremely short periods of time, they are apt to be permanently damaged. Destructive voltage transients (in excess of those for which the drive is protected) may be produced by interrupting relay coils, brake solenoid coils, transformer primaries and other inductive electrical devices.

To insure maximum protection of the SCR Drive, the following practices are suggested.

1. Always stop the SCR Drive by opening the d-c armature loop first (drive stop pushbutton) before disconnecting the drive from the a-c line.

2. Do not switch associated power or control transformer primaries when the SCR Drive is operating (see No. 1 above).

3. Avoid switching transformers and other heavy loads on the a-c line, while the SCR Drive is operating (see No. 1 above).

4. Do not run the SCR Drive interconnecting power wires in the same conduit runs or in close proximity to other control equipment wires.

5. Use a control transformer to supply a-c power to auxiliary relays and devices.

6. For a particular application some of the steps listed above may not be necessary. Also, where extensive relaying is proposed, additional problems may be encountered. It is suggested that a sketch or drawing of the proposed circuits be sent to the General Electric Company for recommendations.

7. All modification kits that were ordered should be installed in the drive system as listed in Table 3 under modifications prior to the interconnection of the major drive components.

INTERCONNECTION OF DRIVE COMPONENTS

Electrical interconnections are required between the power unit and motor and between the power unit and operator's station as shown on Fig. 6. Table III shows the number of wires and recommended wire size required for each conduit run as shown in Fig. 6. Wire sizes for interconnections have been selected in accordance with the ampere requirements shown in Table I and in accordance with National Electrical Code.

TABLE 1

POWER UNIT RATING DATA

HP	Rated AC Line Amps 230V	Rated DC Line Amps	Motor Shunt Field Amps
1	10.6	5.6	0.9
1 1/2	13.5	8.5	0.9
2	16.0	10.5	1.1
3	22.0	15.0	1.3
5	34.0	24.0	2.1

90001282

GROUNDING

No part of the a-c or d-c electrical circuit of the SCR drive may be grounded unless a line isolating transformer is used on the a-c input, and then only at one point. SCR drives are designed to operate on normal a-c power systems which are normally grounded. If a follower voltage signal is used and is not isolated from the a-c line, the SCR drive must be equipped with a line isolating transformer.

It is recommended that the power unit, operator's station and d-c motor enclosures be grounded in accordance with NEC or local code requirements.

AC POWER CONNECTION

1. Make certain that the input voltage and frequency of the available power supply agree with the rating on the power-unit nameplate located on the inside back of the power-unit enclosure. If an a-c line transformer is to be used, refer to step 4.

2. Electrical codes generally require the use of a fused disconnecting switch or circuit breaker in the a-c power line ahead of the SCR drive and transformer (if used). This disconnecting device also provides a convenient method of removing field excitation from the d-c motor when the drive is not in use, and allows complete removal of power for routine maintenance and inspection. The disconnecting switch and fuse (or circuit breaker) should be selected in accordance with the National Electrical Code and/or local code requirements based on the power input data on the SCR drive nameplate. This data is summarized in Table II to aid in the selection of disconnecting devices, fuses and wire sizes.

3. A-c power connection from the disconnecting device to the power unit may now be made in accordance with Table III.

4. If the available power supply is other than 230 volts a-c, 50/60 hz, it will be necessary to use a line transformer between the disconnecting device and the power unit. This transformer will be separately mounted by the purchaser. The appendix provides complete information on both auto and isolating transformers for use with SCR drives, including required kva, dimensions, connections and catalog numbers.

FINAL CHECK

After all electrical connections have been made, complete the installation as follows.

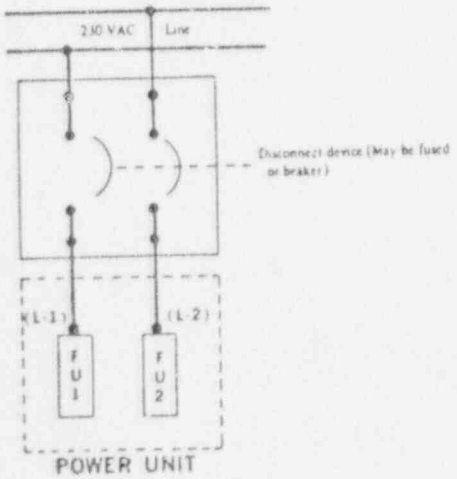
1. Recheck all connections using the check-off list provided in the Interconnection Chart, Table III. Recheck the transformer connections (if used) and connections to the disconnecting device (if used).

2. Reassemble the operator's station. Carefully dress the interconnecting wire into the back of the station so that the device assembly may be installed. Keep the wires away from sharp edges and do not force the device assembly into place. Replace the station cover and secure with cover retaining screws.

3. Recheck the motor connections, carefully tape and insert them in the conduit box. Replace the conduit-box cover.

4. Install protective fuses in the a-c disconnect (if used).

5. Replace the power-unit cover, unless setup and adjustment are to be done immediately.



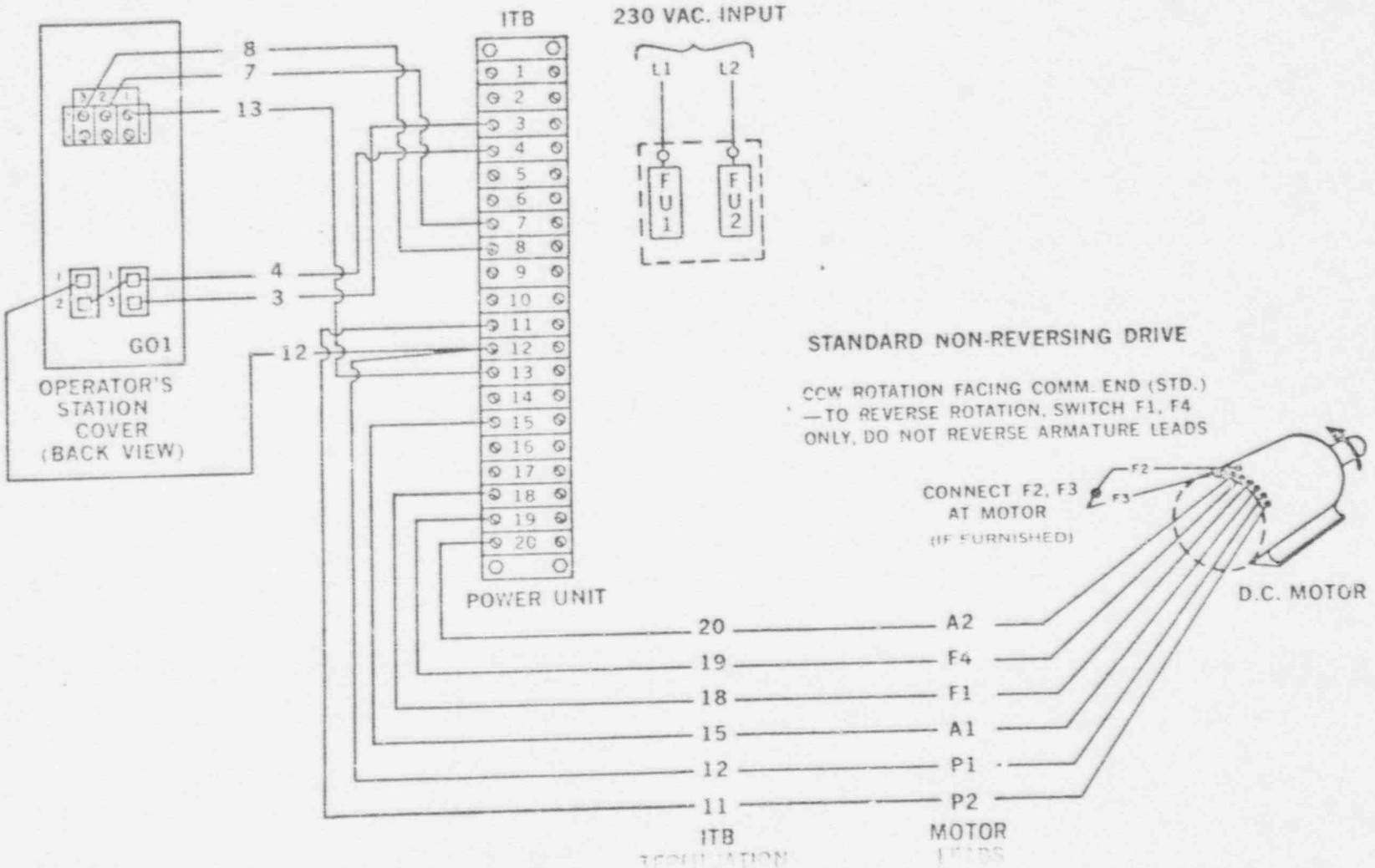
Recommended NEC Fuse Ratings for Line Disconnect	
Wire Size from Table III.	Fuse Amps
AWG 8	60
10	40
12	25

TABLE II

90001283

INTERCONNECTING THE DRIVE SYSTEM

FIG 6



SETUP AND ADJUSTMENT

SETUP INSTRUMENTS AND TOOLS

A 250-volt d-c voltmeter and a screwdriver will suffice to set up and adjust an SCR Drive. However, if optimum drive performance is required, it is recommended that a hand tachometer and a d-c ammeter of appropriate rating also be available. The required ammeter rating may be determined from the tabulation of d-c motor current in Table 1, Page 11.

PRELIMINARY

1. Remove the front cover of the power-unit enclosure. Check to see that motor is not coupled to the load and is free to rotate.

2. Connect the voltmeter across the d-c armature at TB points 15 and 20. Point 15 is positive in the "forward" mode.

3. Connect the ammeter (if used) by removing the wire from point 20 on the terminal board and connecting the ammeter in series with the d-c motor armature. Point 20 is negative.

4. Close the incoming line to the power unit.

WARNING

HIGH VOLTAGE. ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. THIS EQUIPMENT IS AT LINE VOLTAGE ANY TIME THE INCOMING LINE IS CLOSED WHETHER THE UNIT IS IN OPERATION OR NOT IN OPERATION. A-C POWER MUST BE DISCONNECTED (BOTH A-C LINES) FROM THE POWER UNIT BEFORE IT IS SAFE TO TOUCH ANY INTERNAL PARTS OF THIS EQUIPMENT.

SPEED RANGE (MOTOR NOT COUPLED TO MACHINE)

NOTE

IF THE TACHOMETER FEEDBACK MODIFICATION HAS BEEN ORDERED, OMIT THIS PROCEDURE AND SUBSTITUTE "TACHOMETER FEEDBACK" ON PAGE 24.

WARNING

EXCESSIVE SPEED CAN CAUSE DAMAGE TO MOTORS AND SERIOUS INJURY TO PERSONNEL.

BEFORE ATTEMPTING TO OPERATE THE DRIVE,

1. THE FEEDBACK OF ARMATURE VOLTAGE SHOULD BE CHECKED TO MAKE SURE IT IS CONNECTED (JUMPER BETWEEN TERMINALS 1 AND 16).
2. THE MOTOR FIELD SHOULD BE CHECKED TO MAKE SURE IT IS CONNECTED, AT THE MOTOR AND AT THE TERMINAL BOARD (TERMINAL 19 TO MOTOR LEAD F4 AND TERMINAL 18 TO LEAD F1).
3. ANY OVERSPEED OR FIELD LOSS PROTECTION, WHEN PROVIDED, SHOULD BE CONNECTED.

To adjust the speed range of the drive, complete the following steps:

1. Set the SPEED potentiometer on the operator's station to zero.

2. Depress and release the START push button.

3. Adjust the minimum speed (by means of the ZERO ADJ. potentiometer on the power unit) so that the motor just turns over.

4. Back off the ZERO ADJ. setting until the motor just stops.

5. Turn the SPEED potentiometer on the operator's station to 100 percent (full CW) and observe the d-c armature voltage on the voltmeter. This voltage should be approximately 175 to 180 volts d-c with no load on the motor.

6. If this voltage is not correct, adjust the MAX SPEED rheostat until the d-c armature voltage is within the required limits. Turning the rheostat shaft clockwise increases armature voltage and speed.

SETUP AND ADJUSTMENT (CON'D)

7. Depress and release the STOP push button.

8. If the direction of motor rotation is not correct remove a-c power, and then interchange motor field leads at the power-stat terminal-board points 18 and 19 on 1TB. Do not change armature leads.

TIMED ACCELERATION (MOTOR NOT COUPLED TO MACHINE)

An adjustable timed acceleration circuit is provided as standard equipment on all SCR drives. The time required to accelerate from standstill to top rated speed is continuously adjustable from approximately 2.5 to 10 seconds.

Set the desired acceleration time by adjusting the TIME ACCEL potentiometer located on the front of the power unit. Turning this potentiometer clockwise increases the acceleration time.

The SCR drive also provides fixed timed deceleration. With the drive running at rated (pre-set) speed, if the operator's speed-control potentiometer is quickly turned to a lower speed (or to zero), the drive will decelerate to this new speed in three seconds, assuming that the coasting time of the drive (and load) is less than three seconds. It follows that if the load has high inertia and long coasting time, the decelerating time will be longer than three seconds as determined by the load inertia.

If timed acceleration is not desired for any reason, disable the timed acceleration circuit by connecting a resistor, 1500 ohms 1 watt or greater, between terminal board points 7 and 4 on the terminal board 2TB.

CURRENT LIMIT (MOTOR COUPLED TO LOAD)

A current-limit circuit is standard on all SCR drives. This circuit provides protection against excessive armature current and overload during acceleration and normal operation. The current limit is adjustable from approximately 60 percent to 150 percent of the rated armature current by means of the CUR LIMIT potentiometer located on the front of the conversion unit.

CAUTION

UNDER NO CONDITIONS SHOULD THIS EQUIPMENT BE OPERATED IN EXCESS OF 150 PERCENT RATED ARMATURE CURRENT. FAILURE TO OBSERVE THIS LIMIT MAY RESULT IN OPENING OF THE LINE FUSE OR PERMANENT DAMAGE TO THE SCR'S AND POWER RECTIFIERS. IF 150 PERCENT IS REACHED AND MAINTAINED FOR ONE MINUTE THE DRIVE SHOULD BE SHUT DOWN AND ALLOWED TO COOL FOR AT LEAST 20 MINUTES.

Normally the current limit is set at 150-percent rated current. However, current limit can also be used to control acceleration of the motor and maximum acceleration torque can be adjusted between 60 and 150-percent rated. Adjust the current limit to the desired value by means of the CUR LIMIT potentiometer located on the front of the conversion unit. Turning this potentiometer clockwise increases the current limit setting from approximately 60 to 150-percent of rated armature current.

IR COMPENSATION (MOTOR COUPLED TO LOAD)

NOTE

IF TACHOMETER FEEDBACK HAS BEEN ORDERED, OMIT THIS PROCEDURE.

Simplified Adjustment

The simplified adjustment of IR compensation is recommended where any one or more of the following conditions may exist.

1. It is difficult or impossible to change the driven machine load during the set-up procedure.

2. Where machine load does not change significantly.

3. Where speed regulation (due to load change) of 5-10 percent is acceptable.

The simplified adjustment of IR compensation is made by setting the IR COMP potentiometer on the unit at Position 1.0 or less.

If optimized adjustment of the IR compensation is required, set as indicated and proceed to the next step.

Optimized Adjustment

1. Start the drive by momentarily depressing the start button.

2. Turn the SPEED potentiometer so that the motor is rotating at the middle speed expected for your application. This speed should not be lower than 1/30 rated motor speed.

3. Adjust the driven machine for minimum load conditions. The value should not be less than 5 percent of rated current for smooth operation.

4. Read and record motor speed using a hand tachometer. Motor speed may be conveniently read by removing the dust cap on the commutator-end motor bearing.

5. Adjust the driven machine for maximum load (not exceeding 100-percent rated torque) and again read motor speed using the hand tachometer.

6. If the "maximum-load" speed is less than the "minimum-load" speed, turn the IR COMP potentiometer on the unit clockwise until they are equal.

7. Repeat steps 3, 4, 5 and 6.

SETUP AND ADJUSTMENT (CONT'D)

8. Turn the SPEED potentiometer to its maximum clockwise position and readjust the MAX SPEED potentiometer so that the motor is running at the maximum speed required for the application, but not in excess of the rated speed on the motor nameplate. (Motor voltage should not exceed 180 VDC).

MODIFICATIONS

Dynamic Braking.

No adjustment required.

Tachometer Feedback (Motor Not Coupled to Load)

NOTE

FOLLOW THIS PRECEDURE ONLY IF THE IMPROVED SPEED REGULATION MODIFICATION (TACHOMETER FEEDBACK) HAS BEEN ORDERED.

WARNING

EXCESSIVE SPEED CAN CAUSE DAMAGE TO MOTORS AND SERIOUS INJURY TO PERSONNEL. BEFORE ATTEMPTING TO OPERATE THE DRIVE,

1. THE CONNECTIONS OF THE TACHOMETER FEEDBACK MODIFICATION (PAGE 20) SHOULD BE CHECKED AT THE TERMINAL BOARD, KIT, AND TACHOMETER TO MAKE SURE THEY ARE CONNECTED.

2. THE MOTOR FIELD SHOULD BE CHECKED TO MAKE SURE IT IS CONNECTED, AT THE MOTOR AND AT THE TERMINAL BOARD. (TERMINAL 19 TO MOTOR LEAD F4 AND TERMINAL 18 TO LEAD F1).

3. ANY OVERSPEED OR FIELD LOSS PROTECTION WHEN PROVIDED, SHOULD BE CONNECTED.

1. Turn the IR COMP potentiometer on the front of the unit to the extreme counterclockwise position (zero).

2. Turn the MAX SPEED rheostat clockwise to the midpoint of its travel.

3. Turn the TACH FEEDBACK potentiometer on the tachometer feedback unit to the extreme counterclockwise position.

4. Set the SPEED potentiometer on the operator's station to zero.

5. Depress and release the start push button on the operator's station.

6. Adjust the ZERO ADJ. potentiometer (located on the unit) so that the motor begins to rotate, then "back off" adjustment until the motor just turns over.

7. Turn the SPEED potentiometer on operator's station to 100-percent speed.

8. Turn the TACH FEEDBACK potentiometer clockwise until the drive is running at the maximum speed required for the application. Drive speed may be measured directly using a hand tachometer, or the d-c voltmeter may be connected across points 9 and 10 in the power unit to obtain an indication of speed.

9. Depress and release the stop push button on the operator's station.

Proceed with the setup procedure on timed acceleration and current limit shown on Page 23. IR compensation procedure is not required since the IR COMP signal is not used with tachometer feedback.

VOLTAGE FOLLOWER DRIVES

NOTE

FOLLOW THIS PROCEDURE ONLY IF THE SCR DRIVE IS TO BE USED AS A VOLTAGE FOLLOWER (FOLLOWING AND EXTERNAL VOLTAGE SIGNAL).

1. Apply the voltage follower signal, of the proper voltage as indicated under INSTALLATION, to the drive. This signal is connected to terminal-board point 3 on operator station speed control and 13 on 1TB. (See Figure 13, Page 21).

2. If timed acceleration has been disabled, turn the TIME ACCEL potentiometer fully clockwise.

3. Follow the setup and adjustment procedure previously specified for either voltage regulated or tachometer feedback drives as appropriate. This procedure is summarized below.

Voltage Regulated	Tachometer Feedback (If ordered)
Speed Range	Current Limit
Current Limit	
IR comp	

4. Tracking Adjustment.

If the drive is to closely follow the signal voltage, the following adjustments must be made for tracking.

a. Apply the maximum voltage follower signal voltage that will be encountered on this application.

b. Turn the SPEED control potentiometer to the zero speed position.

SETUP AND ADJUSTMENT (CONT'D)

c. Depress and release the START push button.

d. Turn the SPEED control potentiometer (R7) to the 100-percent speed position.

e. Cause the voltage follower signal voltage to be reduced to the minimum operating value expected on this application. This signal level should not require the SCR drive to operate below 1/30 rated speed.

f. Adjust the ZERO ADJ. potentiometer on the unit to establish the same speed ratio between the master (follower signal) and the SCR drive as existed with "full" voltage follower signal.

g. Repeat steps (d) through (g) until satisfactory tracking is obtained.

OPERATION

NON-REVERSING DRIVES

REVERSING DRIVES

JOG

NON-REVERSING DRIVES

Apply a-c power to the SCR drive by closing the a-c line disconnecting device (if used). Set the desired preset speed on the SPEED potentiometer on the operator's station. Depress and release the START push button on the operator's station and the drive will accelerate to preset speed, either linearly with respect to time or under current limit, depending upon adjustments. Alternately, the SPEED potentiometer may be set initially at zero, the START button depressed and released, and the drive speed controlled manually by the SPEED potentiometer during acceleration.

Depress and release the STOP push button on the operator's station and the drive will coast to rest at a rate determined by the friction and inertia present in the drive system. If the dynamic-braking modification has been added, operation of the STOP push button on the operator's station will cause the drive to rapidly brake to a stop.

Sudden, excessive overloads (300 percent) or d-c faults (shorts) will cause the static IOC circuit to stop the drive. Reset by pressing the STOP push button; remove the condition causing the overload and restart.

REVERSING DRIVES

Apply a-c power to the SCR drive by closing the a-c line disconnecting the device (if used). Select the required direction of rotation with the FORWARD-REVERSE selector switch. Set the desired preset speed on the SPEED potentiometer on the operator's station. Depress and release the START push button on the operator's station and the drive will accelerate to preset speed, either linearly with respect to time or under current limit, depending upon adjustments. Alternately, the SPEED potentiometer may be set initially at zero, the START button depressed and released, and the drive speed controlled manually by the SPEED potentiometer during acceleration.

OPERATION (CONT'D)

If the FORWARD-REVERSE selector switch is operated with the drive running at preset speed, the drive will coast to rest, or dynamic brake to rest if this modification has been ordered. Depressing and releasing the START button will now cause the drive to accelerate to preset speed in the reverse direction.

If the START push button is held depressed while operating the FORWARD-REVERSE selector, the drive will stop and immediately accelerate in the reverse direction.

Sudden, excessive overloads (300 percent) or d-c faults (shorts) will cause the static IOC circuit to stop the drive. Reset by pressing the STOP push button, remove the condition causing the overload and restart.

JOG

When the jog modification is ordered, the operator's station will be equipped with a JOG-RUN selector switch. When this selector switch is in the jog position, depressing and holding the START button will cause the drive to accelerate and run at a jog set run speed as determined by the speed control setting.

MAINTENANCE

Maintenance of the SCR drive is primarily a matter of periodic inspection and cleaning of the three drive components; the power unit, motor and operator's station.

After removing the a-c power, clean the exterior and interior of the power unit by vacuuming or blowing accumulated dust and dirt. Do not use a highpressure air hose as this may damage the electrical components.

Check all electrical connections for tightness and examine the electrical contacts on the contactors. Both copper and silver contacts discolor and become roughened during normal operation. Generally contacts will not require attention but, if prominent beads form, due to severe arcing, dress the contact face with a fine file. Do not use sandpaper or emery cloth, and never oil any part of the power unit.

Keep the outside of the operator's station free from grease and dirt and do not oil the devices.

Motor ventilation openings must be kept free of dirt to allow adequate ventilation. Refer to the motor instruction book for lubrication recommendations.

TROUBLESHOOTING

GENERAL

Nearly all of the problems encountered in initial startup of adjustable-speed-drive equipment are caused by improper interconnection wiring. If difficulty is encountered, the first step should be a careful recheck of all interconnection wiring in accordance with the Interconnection Chart, Table III, Page 13. If modifications were installed recheck all wiring and interconnections per the appropriate modification connection diagram.

In the event that this check does not disclose the problem, proceed to the Troubleshooting Chart, Table V, performing each step in the sequence indicated.

WARNING

HIGH VOLTAGE. ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. THIS EQUIPMENT IS AT LINE VOLTAGE ANY TIME THE AC POWER IS CONNECTED TO THE POWER UNIT WHETHER THE EQUIPMENT IS IN OPERATION OR NOT IN OPERATION. BOTH SIDES OF THE AC POWER LINE MUST BE DISCONNECTED FROM THE POWER UNIT BEFORE IT IS SAFE TO TOUCH ANY INTERNAL PARTS OF THIS EQUIPMENT.

If the equipment operates, but operates improperly, refer to that portion of the Troubleshooting Chart titled "Operational Problems".

NOTE

DO NOT CHANGE ANY OF THE SETUP ADJUSTMENTS WITHOUT FIRST MAKING A NOTE OF THE SETTING SO THAT YOU CAN RETURN THE CONTROL TO THIS SETTING. THIS PROCEDURE WILL MINIMIZE TIME IN CORRECTING DIFFICULTY.

TABLE IV

VOLTAGE CHECK LIST

Direct Current

Circuit	Terminal Board Points	1/8 Speed DC Volts	Rated Speed DC Volts
Motor Armature	1TB-15-20	25	180
Motor Shunt Field	1TB-18-19	100	100
Reference	1TB- 7-13	1-2	12-15
Ref. Supply	2TB- 2-13	20	20
TG In	1TB- 9-10	25-32	175-250
TG Out	3TB- 1-18	2-3	20-25
AP Coil	R-6,1TB20	25	180

Alternating Current

Circuit	Voltage	Measure At
AC Input	230†	FU1 to FU2
CR Coil	115†	2TB points 20, 8
F Coil	115†	1T-X1,1TB1
R Coil	115†	1T-X1,1TB-5

† Minus 5%, Plus 10%

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TROUBLESHOOTING (CONT'D)

TABLE V
TROUBLESHOOTING CHART

DRIVE DOES NOT OPERATE

Difficulty	Possible Cause	Remedy
1. No a-c power to power unit. Bottom of FU1-FU2.	Open disconnect, breaker or fuse in a-c supply.	Locate and correct.
2. Blown fuses in power unit.*	Shorts or grounds in wiring, open motor field circuit.	Correct wiring and replace fuses.
3. No 115vac control power. Points X1-X2.	FU3 fuse blown, faulty 1T transformer, shorts or grounds in control wiring.	Replace fuse, correct wiring or replace 1T transformer.
	Open motor thermostat.	Check for cause of malfunction.
4. No d-c output from power unit (Points 1TB–15+, 20–).	D-c fault operating 10C circuit.	Remove fault and reset by pressing STOP button.
	No power supply voltage (1TB-13, 2TB-2). No reference (1TB-7,13)	Replace conversion unit (see footnote). Check wiring to speed pot and pot itself. If a-c supply and reference are present, conversion unit is defective (see footnote).*
5. No d-c output to motor (1TB-15,20).	F or R relay inoperative	Check for coil voltage at relay. If voltage is present, replace defective contractor.
	CR relay inoperative	Check for relay coil voltage 2TB-20 & 8. If voltage is present and relay inoperative, replace conversion unit. If no voltage, check wiring to START-STOP push button in operator's station.
6. Motor does not run.	Incorrect or defective Wiring.	Check armature and shunt field connections between power unit and motor. Be sure field coils have been properly connected in series. Check field circuitry for continuity
	No field supply (1TB-18, 19).	Replace conversion unit * (see footnote).
	Motor brushes not seated.	Free brushes in holder - see motor instructions.
	Defective motor.	Repair.
	Blown Fuses	Check for grounds in external connections.

* No attempt should be made to open or repair the sealed conversion unit. The conversion unit warranty becomes void if the unit has been opened or tampered with in any way (see WARRANTY). Defective conversion units or those which fail within the warranty period should be returned to the Company as indicated in the warranty instructions.

TROUBLESHOOTING (CONT'D)

TABLE V
TROUBLESHOOTING CHART

OPERATIONAL PROBLEMS

Difficulty	Possible Cause	Remedy
7. Motor will not reach top speed.	Improper setup.	Recheck.
	Low line voltage.	Correct.
	Motor overloaded.	Reduce load.
	Low reference voltage (1TB-7,13)	Should be approximately 15 volts with speed pot full CW. If low, check for grounds and shorts.
	High tachometer voltage (if used).	Check tachometer nameplate and setup procedure. Voltage from tachometer must not exceed 250 V d-c.
8. Motor runs at top speed. Does not respond to speed pot or has limited response.	Improper setup.	Recheck.
	Motor wired incorrectly.	Recheck wiring. Check response of reference (1TB-7,13) to speed pot position.
	Operator's station wired incorrectly	
	Tachometer signal (if used) is too low	Check tachometer nameplate and review setup procedure.
	Defective conversion unit.	Replace. * (see footnote).
9. Motor jumps upon starting - will not run at low speed.	Improper setup.	Recheck.
	Operator's station wired incorrectly.	Recheck wiring. Check response of reference (1TB-7,13) to speed pot position.
	High breakaway torque required.	Reduce if possible.
	Defective conversion unit.	Replace. * (see footnote).

* No attempt should be made to open or repair the sealed conversion unit. The conversion unit warranty becomes void if the unit has been opened or tampered with in any way (see WARRANTY). Defective conversion units or those which fail within the warranty period should be returned to the Company as indicated in the warranty instructions.

TROUBLESHOOTING (CONT'D)

TABLE V
TROUBLESHOOTING CHART

Difficulty	Possible Cause	Remedy
10. Motor speed changes excessively when load is applied.	Improper setup.	Recheck current limit (normal dial setting 7) and IR Comp. (normal dial setting (1.0 or less)
	Low line volts or excessive voltage regulation in a-c line.	Correct wire or transformer size.
	Motor overloaded.	Reduce load.
	Defective conversion unit.	Replace. * (see footnote)
11. Motor speed unstable.	Improper setup.	Check for too high IR comp (set at zero if TG is used).
	Excessive inertia	See specifications (page 32) and reduce inertia.
12. Motor overheats.	Motor overloaded.	See specifications (page 32) and reduce load
	Ambient temperature above 40 C (104F).	Reduce temperature or improve ventilation.
	Motor ventilation restricted.	Remove restrictions.
	Defective motor.	Repair.
13. Motor noise excessive.	Loose motor mounting or coupling.	Tighten.
	Damaged bearing.	Replace bearing.
	Defective conversion unit (half-wave).	Replace. * (see footnote)
14. Motor sparks excessively (some sparking is normal)	Motor overloaded.	Reduce load.
	Brushes worn too short.	Replace.
	Rough commutator.	Repair.
	Defective conversion unit (half-wave)	Replace. * (see footnote)
15. Motor stops for no apparent reason.	Sudden extreme overload or intermittent d-c fault.	Remove cause of overload or faul and reset by pressing STOP button.

* No attempt should be made to open or repair the sealed conversion unit. The conversion unit warranty becomes void if the unit has been opened or tampered with in any way (see WARRANTY). Defective conversion units or those which fail within the warranty period should be returned to the Company as indicated in the warranty instructions.

PART II

GENERAL DESCRIPTION

DRIVE SPECIFICATIONS

HOW THE SCR DRIVE WORKS

APPENDIX

SPARE AND RENEWAL PARTS

DESCRIPTION

BASIC DRIVE

The SCR adjustable-speed drive is a packaged, all-electric drive operated from a-c power. The drive consists of:

1. A wall-mounted power unit which contains the power conversion unit, necessary magnetic contractors, control power transformer and fuses. The power conversion unit provides conversion of incoming a-c power to d-c power, as well as necessary regulator functions.

2. An adjustable-speed d-c drive motor.

3. An operator's station which contains the speed-setting potentiometer and the necessary operating push buttons.

The power unit consists of terminal-board assemblies, the conversion unit, line contractor(s), fuses, control power transformer and associated wiring. These components are mounted in a convection-cooled enclosure.

The power conversion unit is the control center of the drive. It is mounted on two terminal-board assemblies, one of which is hinged at the bottom to allow it to be swung out approximately 90 degrees, providing easy access to the rear terminals. This unit contains two heat sinks on which are mounted the SCRs and diode rectifiers. The heat sinks support two printed circuit boards containing the firing and regulating circuits which control the SCRs (which in turn control the speed of the d-c motor). The unit is enclosed in a protective cover, which is open at the bottom and louvered at the top to allow proper ventilation. The warranty is void if the enclosure is removed or if the unit tampered with in any way (see WARRANTY). Four potentiometers which control the setting of zero speed, IR compensation, acceleration time and current limit are mounted in the unit. The control knobs for these potentiometers are located on the front of the unit so they can be adjusted while the unit is in the operating position. These potentiometers are labeled IR COMP, TIME ACCEL, ZERO ADJ, and CUR LIMIT.

The operator's station for a basic non-reversing drive contains (START-STOP) push buttons and a speed-control (SPEED) potentiometer.

MODIFICATIONS

For detailed information on wiring and interconnections of modifications refer back to Table 3, Page 13.

Jog

If the jog function is ordered, the operator's station will also contain a (RUN-JOG) switch.

Reversing (Selective Rotation)

Antiplugging protection and forward-reverse selector are provided. Direction may be selected before starting. Rapid reversing may be accomplished by operating selector and holding start button depressed until motor has changed direction of rotation complete.

Dynamic Braking

If dynamic braking is ordered, the braking resistor (complete with leads and mounting bracket) will be shipped with the power unit. It is installed in minutes, at the time the drive is placed in service. Complete instruction under Interconnection wiring.

Tachometer Feedback Unit

If improved speed regulation is ordered, the tachometer feedback unit will be shipped with the power unit. Connection of only four leads is done at time of installation. Complete instructions are included under INSTALLATION.

Line Transformer

The SCR drive is designed for 230-volt a-c 50/60 cycle, singlephase operation. Other power supply voltages require the use of a separate line transformer. If the transformer is ordered for 460- or 575-volt power supply, it will be shipped separately for mounting and wiring by the purchaser. Transformer ratings, catalog numbers and connection diagrams are included in the APPENDIX.

SPECIFICATIONS

BASIC DRIVE MODIFICATIONS

BASIC DRIVE

Power Supply

Voltage - 230v, 1 phase, -5 + 10%

Frequency - 50/60 cycles ±1 cps

Speed Range

TABLE VI

Motor Enclosure	Percent Rated Speed			
	60	50	40	5
	Continuous Torque (%)			
DP	100	100	92	65
TE	100	100	100	100

NOTE

IF CONTINUOUS FULL TORQUE AT SLOW SPEED IS REQUIRED (AND NOT PROVIDED ACCORDING TO ABOVE), SUPPLEMENTARY VENTILATION OR A DERATED MOTOR MUST BE SUPPLIED. REFER TO THE COMPANY FOR SPECIFIC RECOMMENDATION.

Speed vs Torque

SCR drives are suitable for constant torque loads as indicated under SPEED RANGE. Field weakening (constant horsepower range) is not available.

Speed Regulation

Deviation band of 2% of motor base speed due to 95% load change over the 30:1 controlled speed range. When properly adjusted, speed regulation may be adjusted for essentionally zero percent regulation at a set speed within the controlled speed range.

Steady-state motor speed may also be affected by changes in line voltage, frequency and ambient temperature. These variables (other than load) are referred to as "service conditions".

Variable	Range	Speed Change in Percent of Rated
Voltage	10%	15%
Frequency	2%	
Ambient Temp	15C	

Specified performance does not apply to transient changes in load or ambient conditions, nor when connected load inertia is in excess of twice motor inertia (referred to the motor shaft). See the motor dimension sheet for inertias.

Acceleration Control

Linear Timed

Total accelerating time (to full speed) is continuously adjustable from 2.5-10 seconds. This complete time range is, of course, only available when 150-percent rated torque is sufficient to accelerate the drive and load to rated speed in 2.5 seconds or less – modifications by adding special capacitors.

Decelerating time (when preset speed is reduced) is at a fixed rate of 3 seconds. If normal coast time exceeds 3 seconds, the load characteristics determine deceleration time.

Current Limit

Adjustable from 60-150-percent rated current. Timing may be set at minimum (or disabled) and current limit used to control accelerating (and running) torque - or the current-limit may be used with timed acceleration providing a maximum current (torque) limit. (Normal dial setting of 7 corresponds to approximately 150 percent current. 150% for no longer than 1 minute.

Protection

Fused 115vac Control-Power Transformer

CLF Fuses - Provides protection for the power unit.

Static IOC - An internal circuit providing d-c fault-current protection for the motor and power unit.

Current Limit - Limits operating overloads to 150-percent rated (or less as adjusted) for protection of motor and power unit. 150% for no longer than 1 minute.

Undervoltage - A-c operated d-c line contactor protects against automatic restarting following a-c power interruption.

Efficiency

The conversion efficiency (a-c to d-c) of the SCR drive is approximately 95 percent at full load, full speed and is high even at light load, low speed. The over-all drive efficiency is the product of the conversion and motor efficiency, or approximately 70 percent.

SPECIFICATIONS (CONT'D)

Power Factor

The SCR drive power factor is approximately 65 percent at full load, full speed and is reduced with speed.

Service Factor – 1.0

Minimum Load

5 percent power unit current (see Table 1, page 9).

Drives will generally operate satisfactorily without load coupled to the motor because motor losses approximate 5 percent current.

Service Conditions

Ambient temperature - 10C to 40C (50 to 104F)

Altitude - sea level to 3300 Ft.

MODIFICATIONS

Jog

Jog at set run speed, adjustable over full speed range.

Dynamic Braking

When dynamic braking is provided, the drive system shall be capable of braking a load (whose inertia equals that of the motor) at an initial current of 150 percent of rated armature current from full speed to standstill three times in rapid sucession with the dynamic braking resistor initially at ambient temperature.

Improved Speed Regulation (Tachometer Feedback)

When this modification is ordered providing a tachometer feedback unit for the power unit, speed regulation may be improved as follows:

Speed regulation of 1 percent of motor base speed for a 95-percent load change over a 50/1 speed range. Speed change due to "service conditions" (see Page 32) is improved to 3 percent.

Reversing (Selective Rotation)

Antiplugging protection and forward-reverse selector are provided. Direction may be selected before starting. Reversing is accomplished by contractor switching in the armature circuit.

SPARE AND RENEWAL PARTS

TABLE VIII

SPARE AND RENEWAL PARTS LIST

1-5 HP SINGLE-PHASE GP-100 SCR DRIVE

Part Name	Qty. Used	Drive Horsepower				
		1	1-1/2	2	3	5
Basic Non-reversing Power Unit						
* Power Conversion Unit	1	331X210 AAG01	331X210 AAG02	331X210 AAG02	331X210 AAG03	331X210 AAG04
** Fuses CLF 250V	2	15 Amp 104X109 AB002	20 Amp 104X109 AB003	20 Amp 104X109 AB003	30 Amp 104X109 AB004	40 Amp 104X109 AB005
F Relay	1	104X131 AB014	104X131 AB014	104X131 AB014	104X131 AB014	104X131 AB014
XI Choke	1	104X220 AA009	104X220 AA009	104X220 AA009	104X220 AA009	104X220 AA009
Control Power Trans.	1	104X150 AA115	104X150 AA115	104X150 AA115	104X150 AA115	104X150 AA115
Fuse	1	104X109 AD004	104X109 AD004	104X109 AD004	104X109 AD004	104X109 AD004
DRS Resistor	1	104X136 AD014	104X136 AD013	104X136 AD012	104X136 AD011	104X136 AD010
Power Unit Modifications						
R Relay	1	104X131 AB014	104X131 AB014	104X131 AB014	104X131 AB014	104X131 AB014
Anti-plugging Relay	1	104X131 AB003	104X131 AB003	104X131 AB003	104X131 AB003	104X131 AB003
Dynamic Braking Kit	1	331X207 AAG01	331X207 AAG02	331X207 AAG03	331X207 AAG04	331X207 AAG05
Tachometer Feedback Unit	1	331X200 AAG01	331X200 AAG01	331X200 AAG01	331X200 AAG01	331X200 AAG01

Operator's Station (Complete)		Remote	Drive Mounted
Non-reversing	1	331X208AAG01	G05
Non-reversing jog	1	331X208AAG02	G06
Reversing	1	331X208AAG03	G07
Reversing Jog	1	331X208AAG04	G08

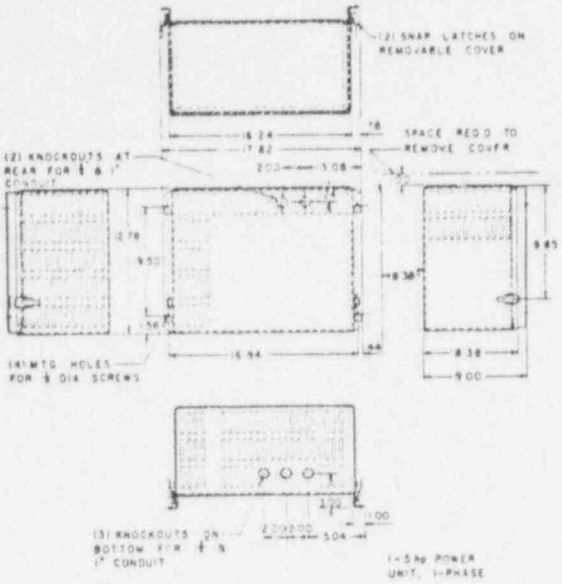
Order spare or renewal parts from your drive supplier or nearest General Electric sales office giving complete power-unit nameplate data, parts quantity and catalog number from the above tabulation.

*See SCR drive Warranty for replacing "in-warranty" failure of power conversion units.

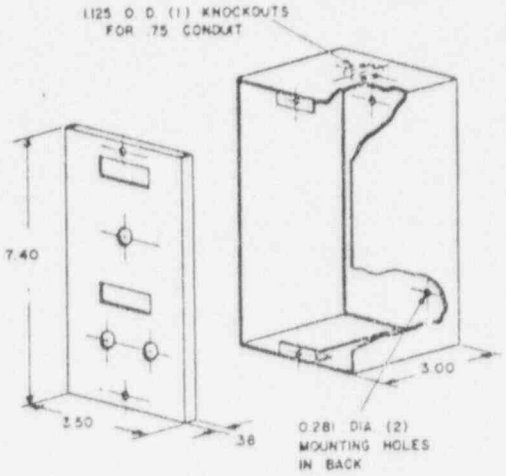
**Fuses not included in warranty (See warranty statement).

APPENDIX

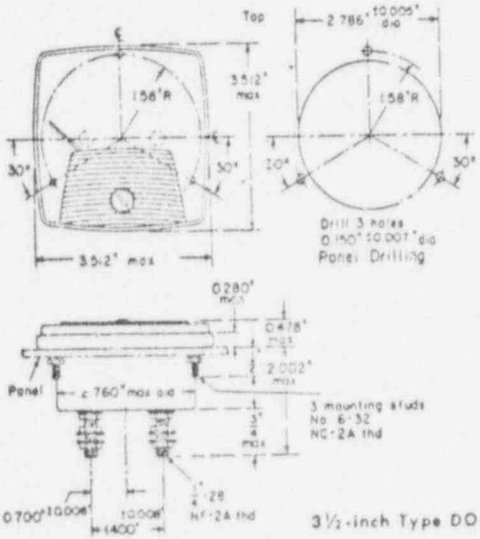
DIMENSIONS



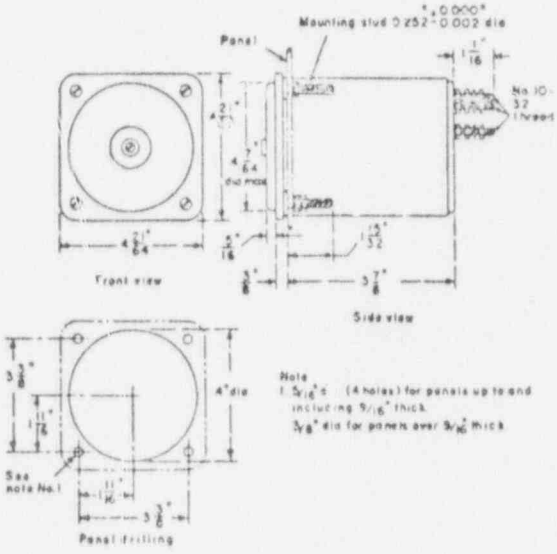
POWER UNIT DIMENSIONS

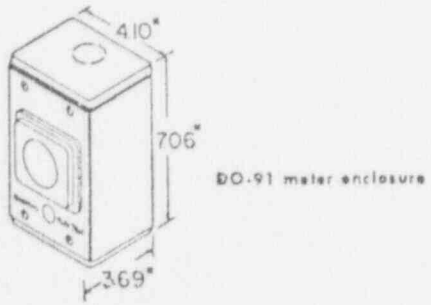


OPERATOR'S STATION DIMENSIONS

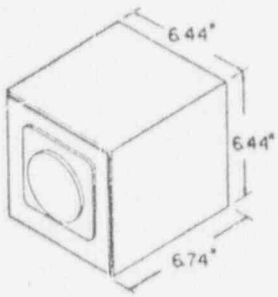


3½-inch Type DO-91 meter





DO-91 meter enclosure



SPEED INDICATOR (METER AND ENCLOSURE) DIMENSIONS
Figure 17

APPENDIX (CONT'D)

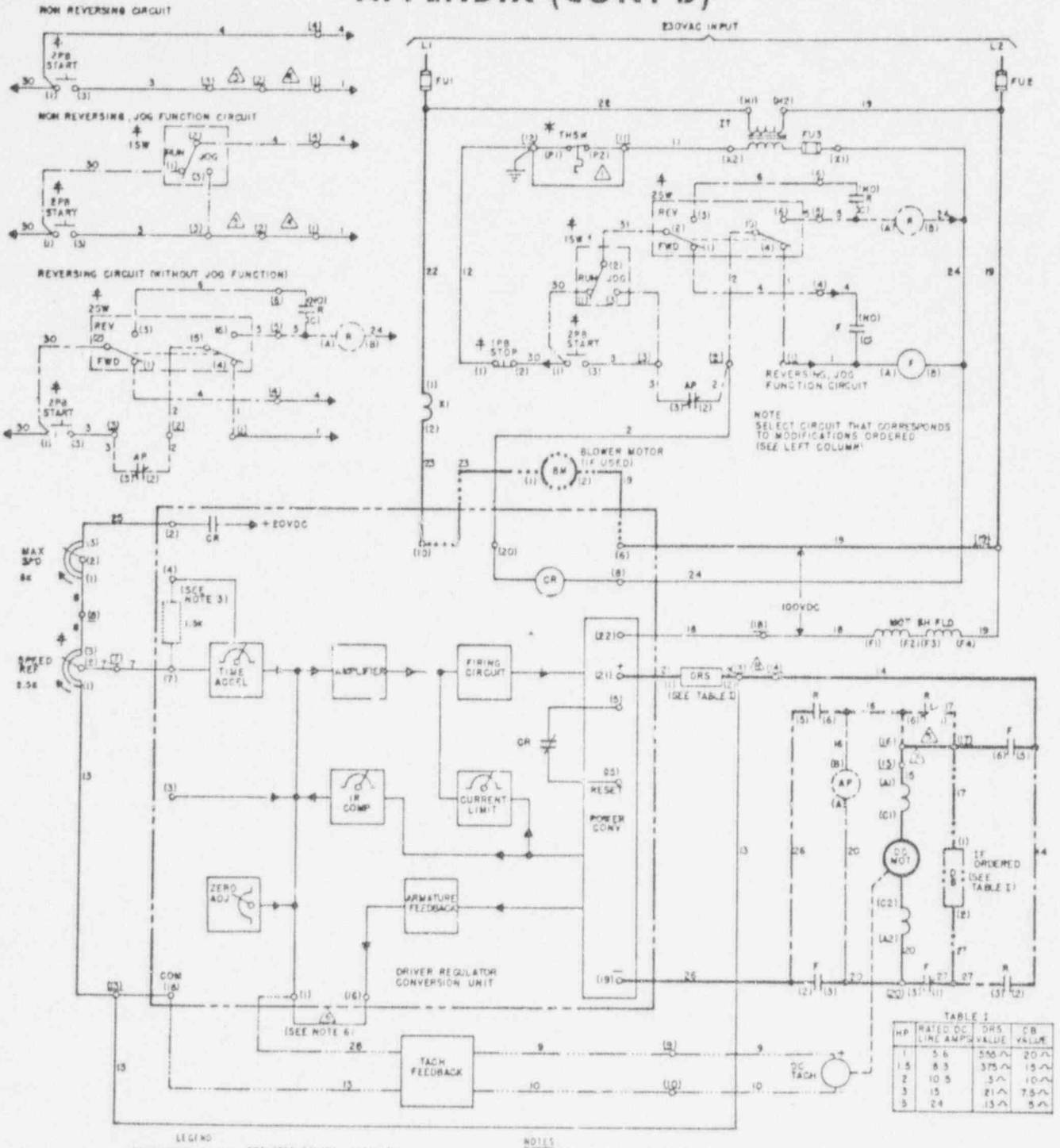


TABLE I

HP	RATED DC LINE AMPS	DRS VALUE	CB VALUE
1	5.6	550Ω	20A
1.5	8.3	375Ω	15A
2	10.5	3Ω	10A
3	15	2Ω	7.5A
5	24	1.3Ω	5A

LEGEND

- ——— = STANDARD CONTROL CIRCUITS
- ——— = STANDARD POWER CIRCUITS
- — — — = REVERSING CONTROL CIRCUITS
- — — — = REVERSING POWER CIRCUITS
- — · — · — = RUN-JOG SELECTION CIRCUIT KIT
- — · · · — = BLOWER MOTOR CIRCUIT KIT
- ——— = TACH FEEDBACK KIT
- ——— = DB CIRCUIT KIT
- — — — = SIGNIFY THAT CONNECTED SYMBOLS ARE PARTS OF THE SAME DEVICE
- ——— = OUTLINE OF A SUB-ASSEMBLY
- ✱ = TEMPERATURE SWITCH MOUNTED IN MOTOR
- 2,6,TD,ETC = INDICATE WIRE OR CIRCUIT NUMBERS
- (1),(3),(A),(B) ETC = INDICATE COMPONENT TERMINAL NUMBERS
- (11),(12),(13) ETC = INDICATE TERMINAL BOARD POINTS
- △ = INDICATE TERMINAL BOARD JUMPERS
- 4 = INDICATES DEVICES WHICH ARE MOUNTED IN OPERATOR'S STATION.

NOTES

1. CIRCUITRY OF A NON-REVERSING DRIVE IS DEPICTED BY SOLID LINES. OPTIONAL MODIFICATIONS ARE DEPICTED BY LINES PER LEGEND OR ARE LABELED. (IF ORDERED). REFER TO THE CONTRACT FOR MATERIAL TO BE SUPPLIED BY THE GENERAL ELECTRIC COMPANY. THE AMOUNT OF SUCH MATERIAL IS NOT INCREASED BY ANYTHING SHOWN ON THIS DRAWING.
2. REFER TO THE INSTRUCTION BOOK FOR DETAILED OPERATION, INSTALLATION, AND ADJUSTMENT OF DC115E SCR DRIVE.
3. IF TIME ACCELERATION IS NOT DESIRED, CONNECT A 1,500 OHM (1) ONE WATT RESISTOR FROM POINT (4) TO POINT (7) ON DRIVER REGULATOR CONVERSION UNIT TERMINAL BOARD (2TB).
4. STANDARD MOTOR ROTATION IS COUNTER-CLOCKWISE LOOKING AT THE COMMUTATOR END. TO REVERSE THE STANDARD ROTATION INTERCHANGE MOTOR LEADS (F1 AND F4).
5. IF TEMPERATURE SWITCH IS NOT SUPPLIED, JUMPER △ MUST BE ADDED (POINT 11 TO POINT 12).
6. REMOVE △ JUMPER (POINT 1 TO POINT 16), ON 3TB, WHEN TACH FEEDBACK IS ORDERED.
7. REMOVE △ JUMPER (POINT 3 TO POINT 2), △ JUMPER (POINT 12 TO POINT 1) AND △ JUMPER (POINT 16 TO POINT 17) WHEN REVERSING KIT IS ORDERED.
8. PROVISION IS MADE FOR USE OF AMMETER OR VOLTMETER. BI-DIRECTIONAL CURRENT MAY BE MONITORED BY REMOVING THE JUMPER △ FROM 3TB (15) TO 3TB (16) AND INSERTING A ZERO CENTER AMMETER. UNI-DIRECTIONAL CURRENT MAY BE MONITORED BY REMOVING THE JUMPER △ FROM 3TB (13) TO 3TB (14) AND INSERTING AN AMMETER. BI-DIRECTIONAL VOLTAGE MAY BE MONITORED BY A ZERO CENTER VOLTMETER ATTACHED BETWEEN POINTS 3TB (15) AND 3TB (20). UNI-DIRECTIONAL VOLTAGE MAY BE MONITORED BY ATTACHING A VOLTMETER TO POINTS 3TB (15) AND 3TB (17) ON NON-REVERSING DRIVES. CONSULT FACTORY FOR UNI-DIRECTIONAL VOLTAGE ON REVERSING DRIVES.

ELEMENTARY DIAGRAM, SCR DRIVE, ALL MODIFICATIONS SHOWN
Figure 18

VII. CONTROL MODULE COMPONENTS

GENERAL ELECTRIC

TRANSISTORIZED STATIC CONTROL

INTRODUCTION
SECTION 1.0

Static Control is a system that electrically controls machines and processes with logic elements and accessories that have no moving parts. Logic elements perform the same function in static control that relays do in a conventional control system. The advantages that General Purpose Transistorized Static Control has over conventional relays are:

(a) Circuit reliability—the ability to produce an output when and only when an output is called for.
(b) Life independent of the number of operations performed.
(c) Operates in adverse environments.
(d) High speed of operation.
(e) Simplified circuit design.

1.1 EXPLANATION OF CONTROL FUNCTION

A control system consists of three basic sections, Information, Decision, and Action.

The INFORMATION section of control is comprised of limit switches, push buttons, pressure switches, temperature sensors and other such pilot devices which receive and transmit information to the DECISION section of the control.

When INFORMATION has been received, it must be assimilated and correlated in order to arrive at a DECISION.

Once a DECISION has been reached, the control must take ACTION, in terms of energizing a solenoid, contactor or starter, an indicating light or other electrical apparatus where ACTION takes place.

1.2 THE "DECISION" MAKING AREA OF CONTROL

Static control performs the decision-making function in a static system as relays do in a conventional magnetic system.

Relays convert a single input to a coil into multiple outputs by means of a movable armature closing and opening contacts. Static control logic elements convert a single input or combination of inputs into a single output by controlling a transistor.

Static control requires a different approach to circuit design which involves designing by logic functions. Five basic logic functions can be used to perform all decisions. They are—AND, OR, NOT, MEMORY and DELAY.

1.21 AND Function

The AND function produces an output only when every input is energized. In Fig. 1-1, if an input signal is present at input A and input B and input C, an output will be produced. The absence or removal of any input signal will stop the output. This function is referred to as a 3-input AND logic function.

3 Input AND Symbol

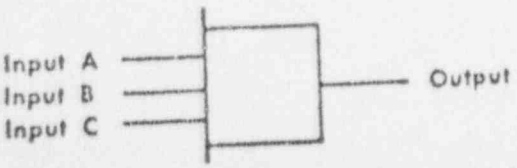


Fig. 1-2 is the symbol for a 7-input AND function. It is similar to the 3-input AND function except it requires more inputs to produce an output. If an input signal is present at A and B and C and D and E and F and G the function will produce an output.

7 Input AND Symbol

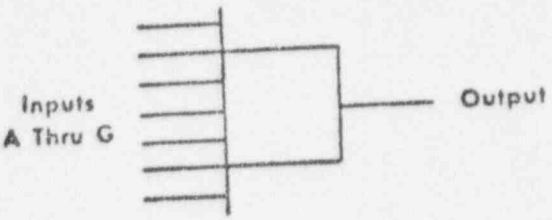


Fig. 1-2

An AND function may also have an Inverted Output as shown in Figure 1-2a. An Inverted Output produces an output any time the standard output is not on, and visa-versa.

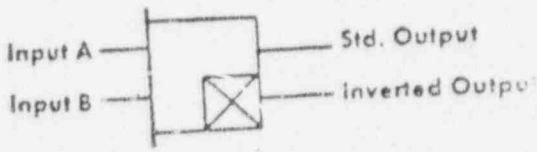


Fig. 1-2a

AND functions come in the following forms:

2-input AND with std. and inverted outputs.
3-input AND with std. output.
6-input AND with std. and inverted outputs.
7-input AND with std. output.

1.22 SEALED AND Function

The SEALED AND function produces an output only when every input is energized. However, it *continues* to produce an output when one (or two) particular input signals are removed. Figure 1-3 is the symbol for a single-seal SEALED AND. The unit will produce an output when input signals are present at A and B and C, and the output will continue to be present when the signal at A is removed. Removing the input signals at B and C will remove the output. All inputs must again be present to produce an output.

Single-seal SEALED AND Symbol

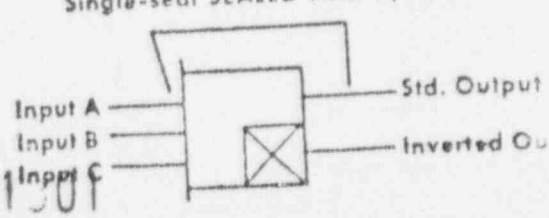


Fig. 1-3

Figure 1-3a is the symbol for a double-seal SEALED AND. Here, the unit will produce an output when input signals are present at A and B and C, and the output will continue to be present when the signals at A and B are removed. Removing the input signal at C will remove the output.

Double-seal SEALED AND Symbol

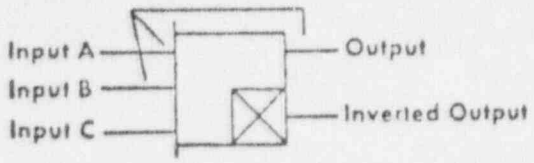


Fig. 1-3a

1.23 OR FUNCTION

The OR function produces an output when one (or more) inputs are energized. Fig. 1-4 shows the symbol for the OR.

If there is an input signal present at A *or* B *or* C or any combination of these, an output will be produced. Removal of all input signals will remove the output.

3 Input OR Symbol

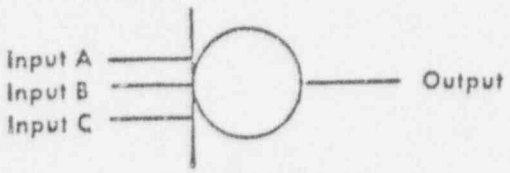


Fig. 1-4

1.24 NOT Function

The NOT is a function which produces an output only when the input is not energized. In Fig. 1-5 if an input signal exists at A there will not be an output signal. An output signal exists only when there is no input signal at A.

NOT Symbol

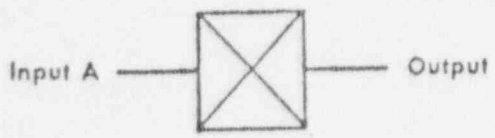


Fig. 1-5

1.25 MEMORY Function

The MEMORY function has a "turn on" input and a "turn off" input, and retains the condition of the output corresponding to the input last energized. In Figure 1-6, a momentary input signal present at Input A will produce an output at output A, and there will not be an output at Output B. The input at A can be removed and no change in the output condition will occur. Application of an input signal at Input B will result in an output at Output B (and no output at Output A). The input signal at B can be removed with no change occurring in the output condition.

RETENTIVE MEMORY Symbol

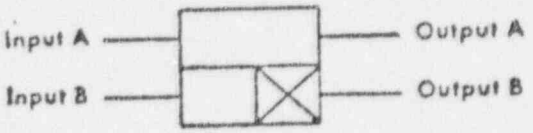


Fig. 1-6

Two types of memories are available which function differently upon interruption of power. The RETENTIVE MEMORY (Fig. 1-6) resumes the output condition present prior to power interruption when power is restored. The OFF RETURN MEMORY (Figure 1-7) returns to the off condition (Output A off, Output B on) upon restoration of power after an outage, regardless of output condition prior to power interruption.

OFF RETURN MEMORY Symbol

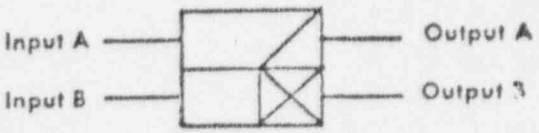


Fig. 1-7

These memory devices operate on a first input received, first served basis. For example, if an input signal is applied at input A (Fig. 1-7), and *maintained*, the memory will continue to produce an output at output A even though another input signal is applied to input B.

Referring to Fig. 1-3, notice the SEALED AND function behaves in a manner similar to these MEMORIES—the SEALED AND continues to produce an output with the removal of an input signal. However, the two functions lose their outputs differently. The MEMORY loses its output by application of an input signal (at input B) while the SEALED AND loses its output by removal of an input signal (at input B or C).

1.26 DELAY Function

Control circuitry often requires that an operation occur after a given time delay. The DELAY function produces an output following a definite, intentional time delay after its input is energized. Thus the function is "time delay at energization" (TDE). Fig. 1-8 shows the DELAY function.

An input signal present and remaining at input A will produce an output signal at output A after a time delay. Removal of the input to the DELAY immediately removes any output existing at output A and resets the device. With an output existing at output A there will not be an output at output B and, conversely, with no output at output A, and output will exist at output B. Output B is often referred to as the NOT portion of output A or the NOT output of the device.

The Delay function comes in four ranges (each adjustable by screw potentiometer over its entire range): 0.00—0.3 sec., 0.05—2 sec., 0.4—12 sec., and 8—300 sec.

DELAY Symbol

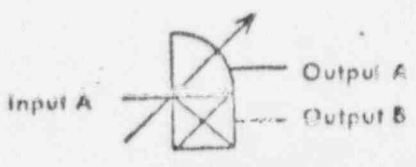


Fig. 1-8

1.27 Accessory Units

Decision making & any control requires transition units to receive information and to initiate action. The low power and voltage levels induced in static control are not sufficient for proper functioning of pilot devices and are too low to directly energize a power device directly. An ORIGINAL INPUT converts the pilot device incoming information signal to a usable logic input, and an AMPLIFIER converts a logic signal to a useable power output.

ORIGINAL INPUTS

Three types of ORIGINAL INPUTS are available which change the pilot device signals to logic level signals. The AC ORIGINAL INPUT, Fig. 1-9, converts a 115V AC contact closure to a useable logic input signal.

AC Original Input Symbol

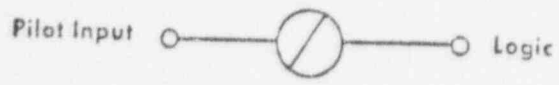


Fig. 1-9

The —125V DC ORIGINAL INPUT, Fig. 1-10, converts a 125V DC contact closure to a useable logic input signal.

DC Original Input Symbol

Fig. 1-10

The —24V DC ORIGINAL Input (also Figure 1-10) converts a 24V DC contact closure to a useable logic input signal.

Other ORIGINAL INPUTS are also available to convert from signals such as the output of a photocell or proximity switch or a changing resistance to a useable logic input signal. See Section 2 for details.

OUTPUT AMPLIFIERS

Three types of OUTPUT AMPLIFIERS are available which convert low-power logic signals to useable power outputs in order to drive relays, solenoids, starters, or other power devices.

Figure 1-11 is the functional symbol for the AC OUTPUT AMPLIFIER. This amplifier acts essentially as an AC power switch to control 115V power devices. A signal present at Input A (from other static circuitry) will turn on power to the load. Absence of an input signal will switch off power to the load.

AC OUTPUT AMPLIFIER Symbol

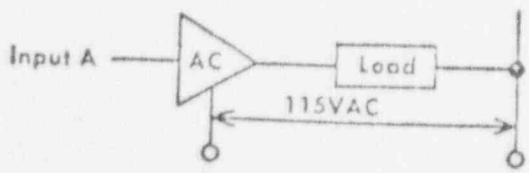


Fig. 1-11

Figure 1-12 is the functional symbol for the DC OUTPUT AMPLIFIER. This amplifier acts as a DC power switch to control DC power devices at any voltage rating up to 150 (usually 24V DC is chosen). A signal at Input A will turn on power to the DC load. Absence of an input signal will switch off power to the load. A DC amplifier called the PILOT LIGHT OUTPUT AMPLIFIER is also available to drive 24V DC pilot lights.

DC AMPLIFIER Output Symbol

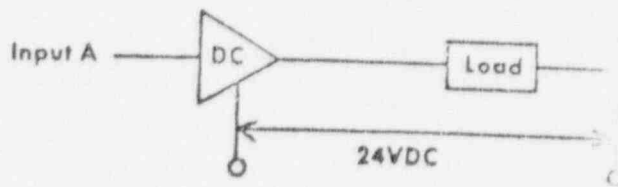


Fig. 1-12

Figure 1-13 is the functional symbol for the RELAY OUTPUT AMPLIFIER. This amplifier contains a long-life DC relay and is used in applications where an independent *dry contact* output is required to switch remote 115V AC circuits. A signal at Input A will actuate the relay as long as the signal is present.

RELAY AMPLIFIER Output Symbol

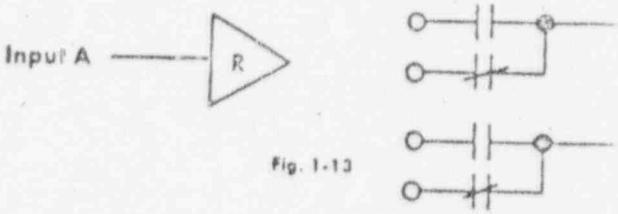


Fig. 1-13

1.3 Application of Logic Functions to Control Circuits

1. Method

The design of circuits using logic functions is considerably easier than the design of a relay circuit. To design static control circuits, simply convert the verbal description of machine or process functions into "English logic" symbols.

Every control requirement should be expressed in some descriptive manner prior to any circuit design-relay or static. To produce a static control functional diagram (equivalent to a relay circuit elementary) the circuit requirements should be divided into Information and Action, with the remainder being the requirements of the static circuits. The entire machine function or process should be thoroughly understood and the control operation be divided into simple sequences. Each sequence can be drawn using logic symbols directly from the English description. Then the individual sequences are integrated and interconnected where necessary to form the total control circuit. The circuit can then be reviewed for obvious component economies and any conflicts existing between individual sequences. This functional diagram is, then, the final drawing and can also be conveniently used to describe the control operation since ANDs, ORs, NOTs, DELAYs, and MEMORIES are shown and the "English" symbol spells out the whole story.

2. Example

Consider the following hypothetical application which can be one sequence of operation of a total control requirement.

A pressure switch and Limit switch #1 must be closed to automatically energize solenoid valve #1 or a push button, PB#1, can directly operate SOL #1. If SOL #1 was once energized and is then not energized, (de-energized), SOL #2 will operate for 10 seconds and SOL #1 cannot be re-energized automatically for that 10 second period.

Relay Elementary Diagram

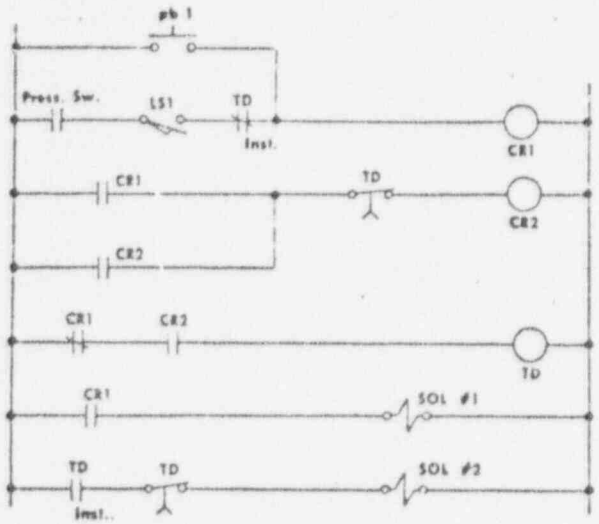


Fig. 1-14

Static Functional Diagram

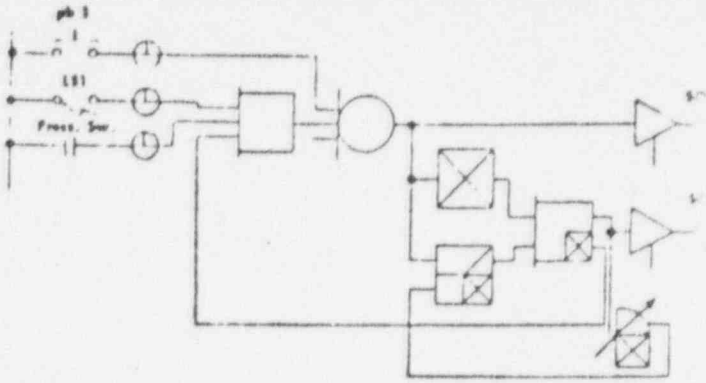


Fig. 1-15

1.4 ADVANTAGES OF STATIC CONTROL OVER RELAY SYSTEMS

In the decision-making area of a control system General Electric's Transistorized Static Control offers these advantages over other control methods:

A. More Reliable

Static control provides maximum circuit reliability because it has no moving parts to wear and uses conservatively rated and proven components. Since static control has no moving contacts, foreign material cannot form or collect on contact tips to hold circuits open. An oily, dusty, dirty or other adverse environment does not effect static control.

B. Longer-Lasting

The life of logic elements is independent of the number of operations performed.

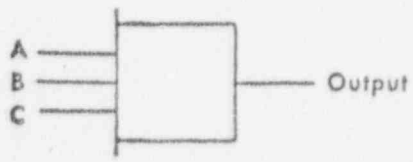
C. Fast Response

Transistorized static control provides extremely fast response which easily meets industry requirements for tomorrow's most-advanced complex machines.

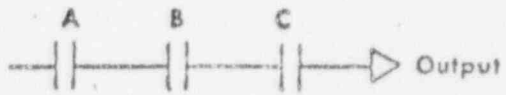
D. Simplified Circuit Design

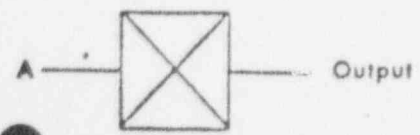
General Electric's system is the easiest to understand and apply; it's based on "English" logic functions—AND, OR, NOT, MEMORY, and DELAY. These logic functions maintain their identity on the drawing board and in the panel with no additional conversion necessary.

LOGIC FUNCTIONS AND RELAY EQUIVALENTS

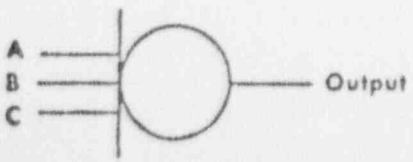


3 Input
AND

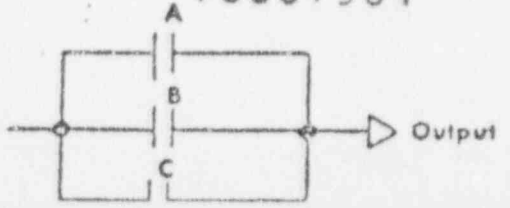


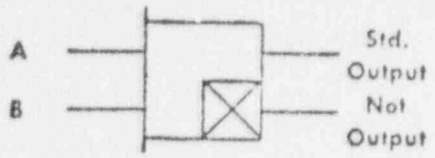


1 Input
NOT

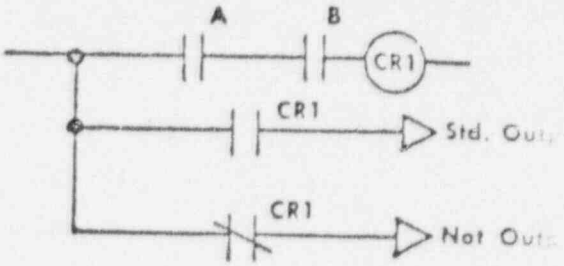


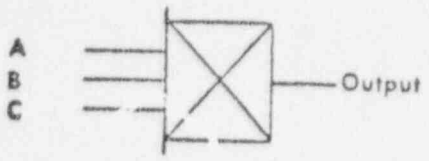
3 Input
OR



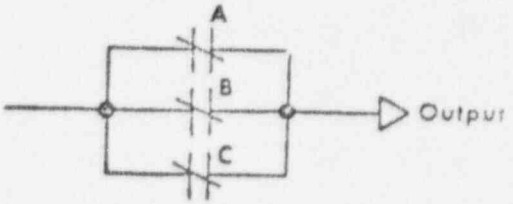


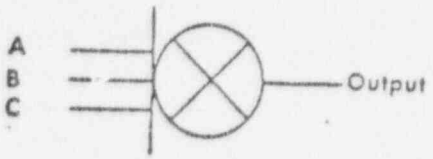
2 Input
AND
With Additional
Not Output



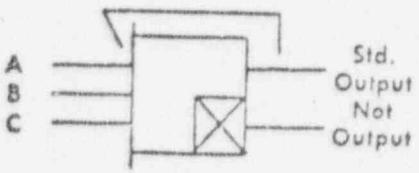


3 Input
AND NOT

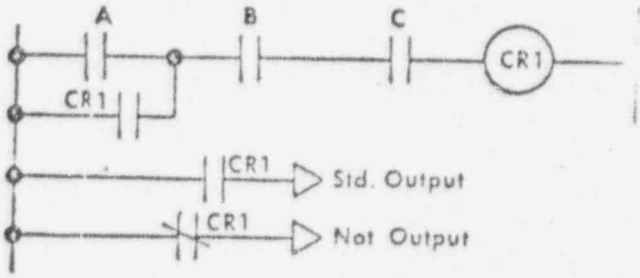


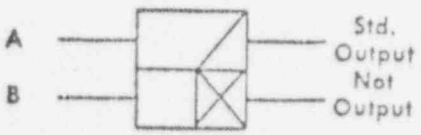


3 Input
OR NOT

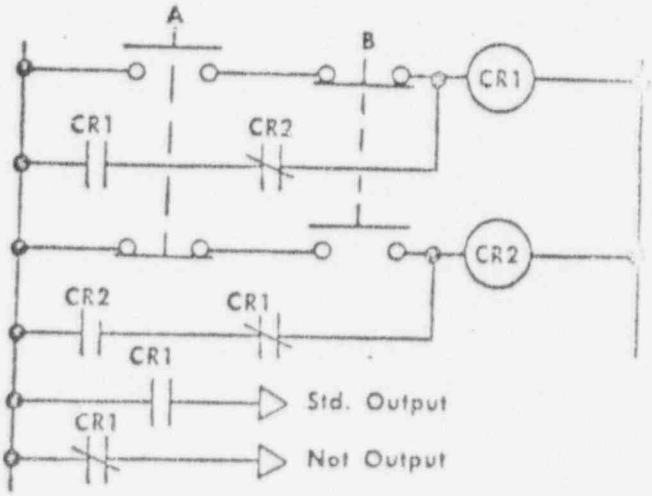


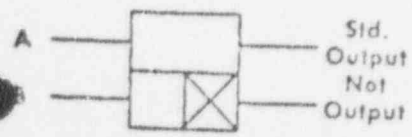
SEALED AND



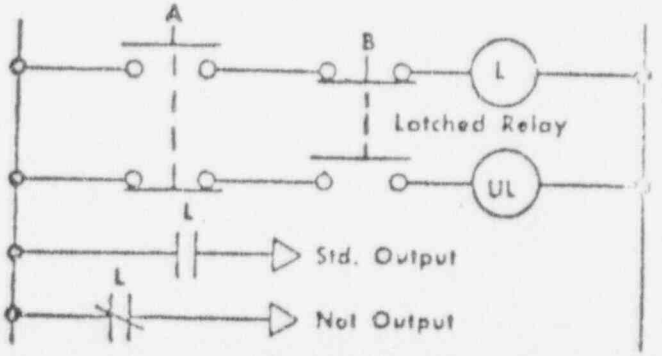


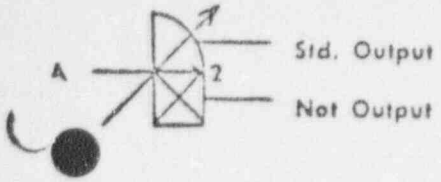
OFF RETURN
MEMORY



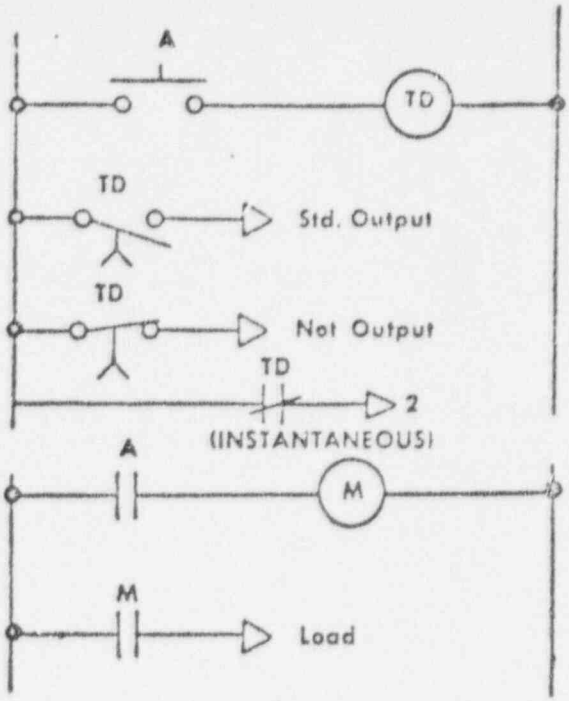


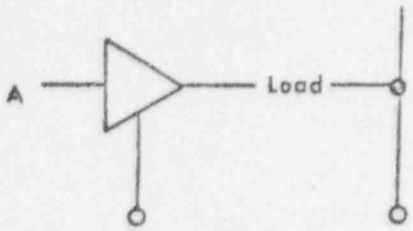
RETENTIVE
MEMORY



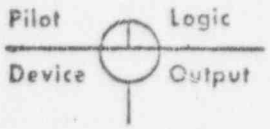


DELAY
(AT ENERGIZATION)



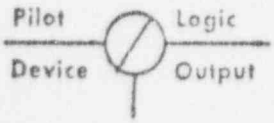


AMPLIFIER



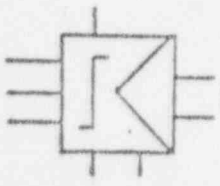
D.C. ORIGINAL INPUT

Auxiliary devices which convert input signal from a contact to a logic level signal.



A.C. ORIGINAL INPUT

LOGIC FUNCTIONS—SPECIAL FORMS

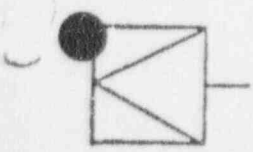


STEP MEMORY

A STEP MEMORY may be turned on or off by the application of a signal to its "Step" input. Which way the memory will go is determined by the signals present at the "Steer" inputs the moment a "step" signal is applied. Step Memories are used in counting circuits and shift registers.

BI-STEP MEMORY

The BI-STEP MEMORY is similar to the Step Memory except that it has two complete "Steering" networks in place of one. It is used in add-subtract counters and reversible shift registers.



UNIT RESET

A Unit Reset supplies a delayed input signal (ON signal) after application of system power. Logic functions with "flip-flops" require this auxiliary connection.

VIII. LIQUID LEVEL SWITCH

FLUID COMPONENTS, INC.

OPERATING MANUAL

MODEL 8-66 LIQUID LEVEL SWITCH

TABLE OF CONTENTS

Issued: March 1978
Rev. _____

8740 Rommet Avenue, Canoga Park, California 91304 (213) 341-7722

FLUID COMPONENTS, INC.

OPERATING MANUAL - LIQUID LEVEL SWITCH

MODEL 8-66

1. SCOPE

1.1 This manual describes the method for making field adjustments to the Model 8-66 Liquid Level Switch. It also provides information relevant to proper operation of the switch in the field.

2. APPLICATION

2.1 The Model 8-66 Liquid Level Controller will detect the presence, or absence of any liquid regardless of type, viscosity, density, temperature, pressure or other characteristics. It is also able to detect interfaces between dissimilar liquids, and between liquids and slurries.

2.1.1 The liquid level, or interface may be controlled within ±⅛ inch of the trip point.

3. DESCRIPTION

3.1 Functional components of the Model 8-66 consist of a separate low-powered heater probe and two resistive temperature sensors wired into a Wheatstone bridge circuit.

3.1.1 In the operating position the two temperature sensitive probes are mounted in a level position in order that the liquid can come into contact with both probes simultaneously. When the probes are immersed the bridge will be in a reduced voltage condition, (sensor "wet" signal), see Figure 1. Conversely, the absence of liquid on the probes results in a temperature differential that creates a substantial imbalance in the bridge circuit, (sensor "dry" condition), see Figure 1. This imbalance increases the bridge signal to actuate an SPDT relay and turn on the relay indicator light.

4. INSTALLATION

4.1 Install the controller with the sensor head up and level as noted on the machined flat, see Figure 1. Connect the leads to a 115 VAC power source; connect relay output contacts as required.

4.1.1 The customer supplied external circuit may be connected to either the normally open or normally closed position of the relay.

4.1.1 Continued:

The relay is energized in the "wet" and de-energized in the "dry" condition.

4.1.2 Lug location no. 4 is normally open; lug location no. 6 is normally closed when sensor is dry.

5. FIELD ADJUSTMENT

5.1 The switch point has been set at the Factory. To check its function, turn on the power and wait for approximately five minutes for the sensor head to become active. After it becomes active, check to see if it verifies the encountered condition. Reverse the condition if possible and note if the sensor reacted accordingly.

5.1.1 If the switch did not verify the actual condition, or if the liquid level cannot be changed, then the switch must be manually adjusted in accordance with the instructions which follow.

NOTE: During the period required for warm-up the switch will indicate a "wet" condition even when the sensor is dry.

5.2 Adjustment With Sensor Head "Wet"

5.2.1 Turn on power and allow sensor head to become active, ref. para. 5.1. If relay light (LED) is on, turn the potentiometer adjusting screw counterclockwise until the light just goes off. Then, turn the screw one additional full turn counterclockwise. This will provide the fastest, safe switching action from wet to dry.

5.3 Adjustment With Sensor Head "Dry"

5.3.1 Field adjustments performed in the dry condition should be conducted in the actual service condition or in one that closely approximates it.

5.3.2 With the sensor head "dry", turn on the power and allow the sensor head to become active, ref. para. 5.1. The adjustment must be initiated with the relay light (LED) off. If the light is on, turn the potentiometer adjusting screw counterclockwise until the light goes off. With the light off turn the turn the adjusting screw slowly clockwise until the light just goes on. Then turn the screw two complete revolutions in the clockwise direction.

90001510

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5.3.2 Continued:

NOTE: IN CASES WHERE THE SERVICE PRODUCT IS HIGHLY VISCOUS SWITCH ADJUSTMENTS SHOULD BE MADE IN THE "WET" CONDITION ONLY.

6. SPECIAL INSTALLATION REQUIREMENTS

6.1 In certain applications special installation procedures may be required. In such cases installation may be varied to best suit the operating conditions. Unless such procedures are necessary the installation details described in the preceding paragraphs shall be followed.

7. INTERFACE APPLICATIONS

4.1 The signal output of the sensor head is dependent upon the thermal conductivity of the liquid surrounding the probes. Liquids that are good coolants, (good thermal conductors), result in low signal outputs. Conversely, liquids that are poor coolants, (poor thermal conductors), result in high signal outputs.

4.1.1 Products such as water, aqueous solutions, glycol, etc., are good thermal conductors. Organic solvents and solutions, hydrocarbons, and most viscous products are poor thermal conductors.

4.2 Installation

4.2.1 Switch point adjustments for interface applications are conducted in the same manner as described in paragraph 5. with the exception that good thermal conductors are considered as being in the "wet" conditions. Poor conductors are considered as being in the dry condition.

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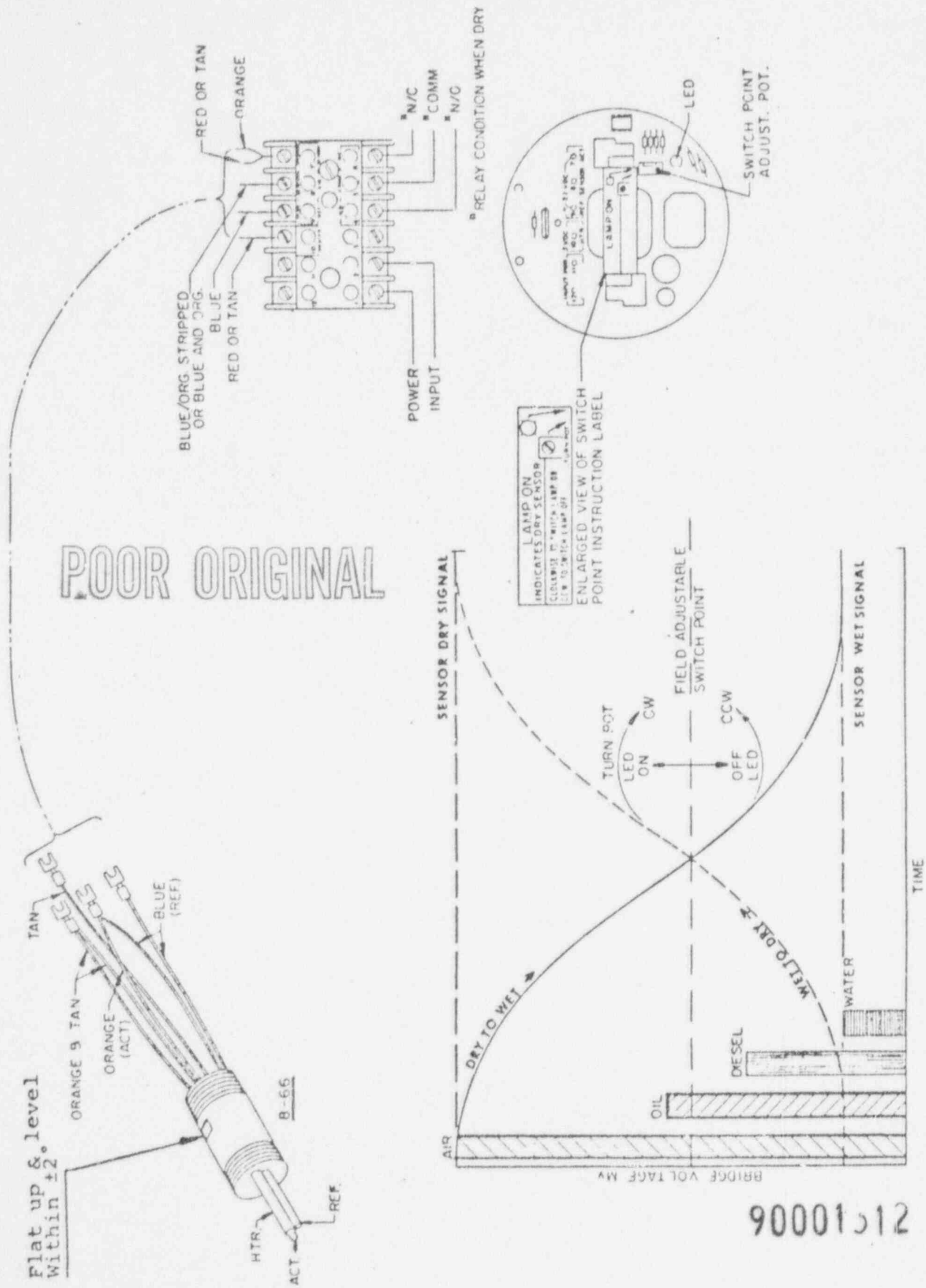


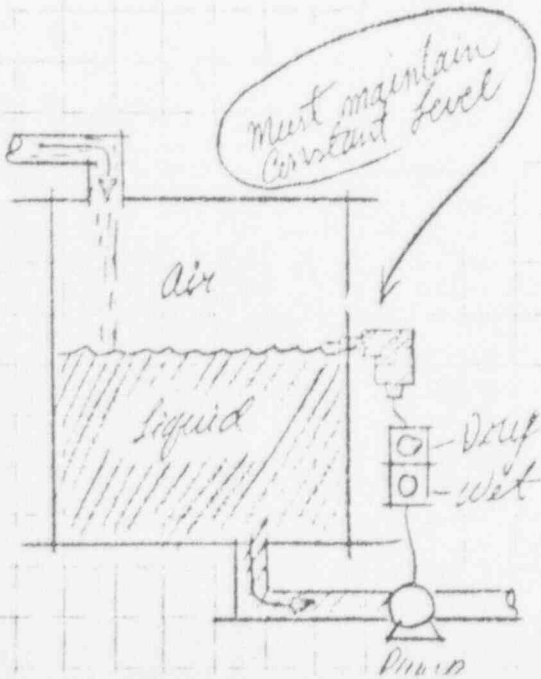
FIGURE 1.

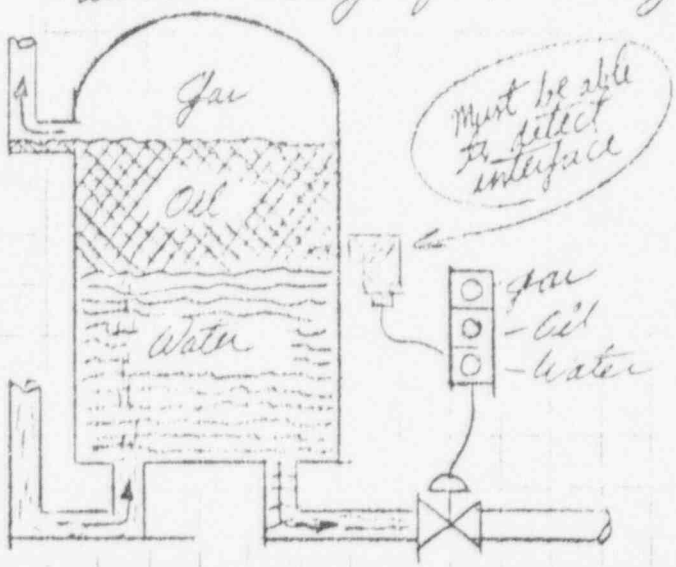
90001512

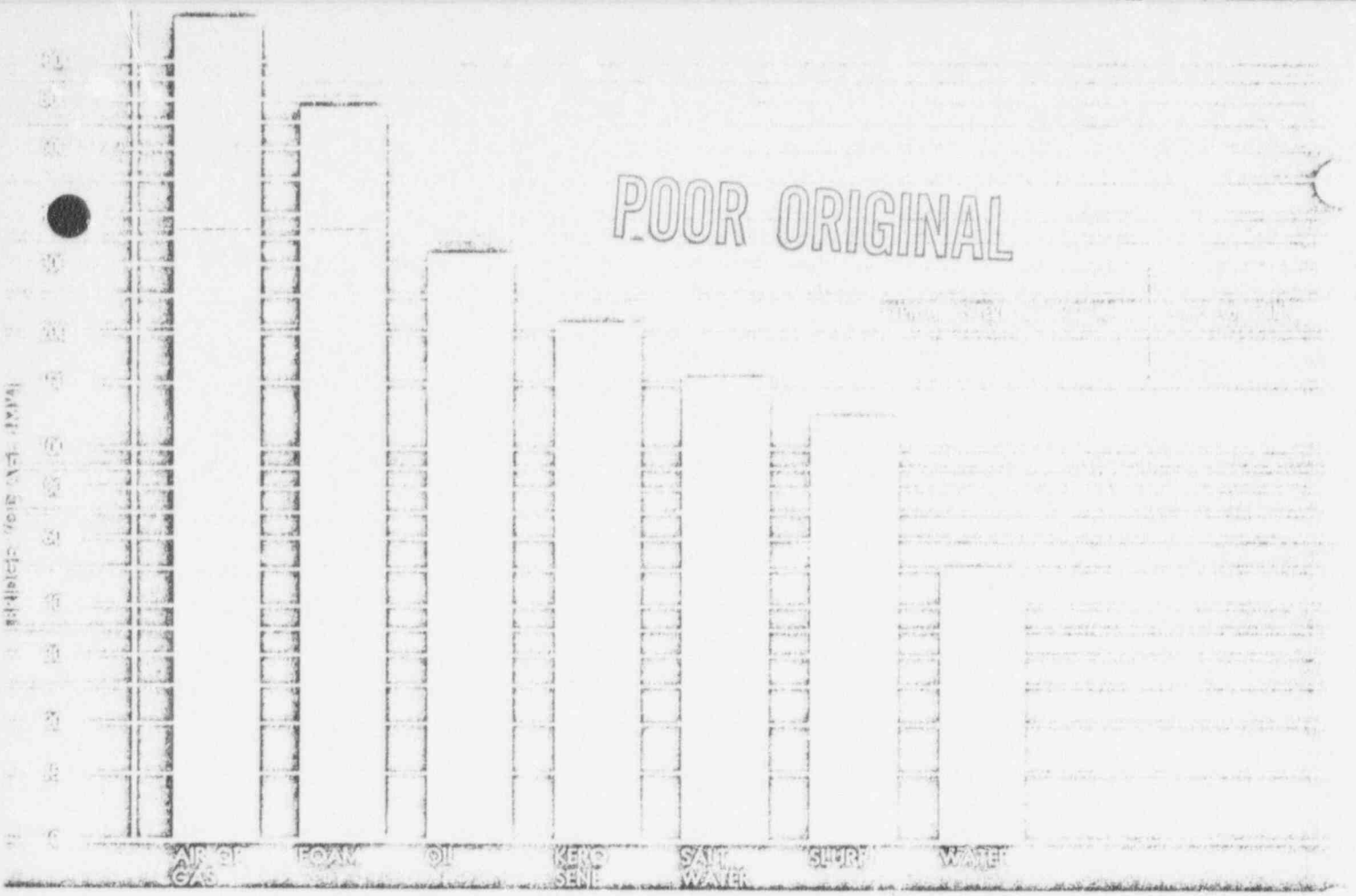
Heat Actuated Liquid Level Controller
Model 8-66

90001313

- No Moving Parts
- Easy to install
- Explosion Proof Design
- Field Adjustable Switch Point
- Usable with any liquid or slurry







Heat Actuated Liquid Level Controller for All Types of Fluids and Slurries

Features • No moving parts • Identifies interfaces • Maintenance free • Switch point is not affected by changes in pressure or temperature • Reliable

General Description

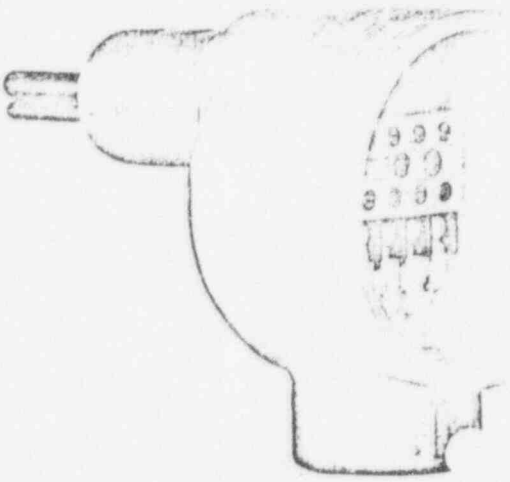
The Model 8-66 Liquid Level Controller will detect the presence or absence of any liquid regardless of type, viscosity, density, temperature pressure or other characteristic. It will also detect interfaces between dissimilar liquids, and between liquids and slurries.

The liquid level or interface may be controlled to within ± 1/4 inch of the trip point. A valve, pump control circuit, alarm or other external control system may be actuated from either the normally open or normally closed position of the controller relay.

The controller is heat actuated and has no moving parts. The trip point is readily field adjustable. After the trip point has been set for a specific application, no further adjustment is required regardless of a change in the temperature or pressure of product. Both product and air or gas blanket may be under heavy agitation.

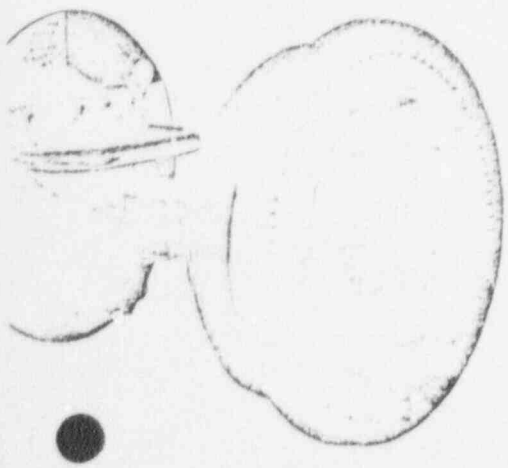
The heat source, which is maintained at a minimum level for the operation of the controller, serves to self clean the probes in a meltable product and reduce build-up in a non-meltable product. Thus, the operation of the controller is not affected by the accumulation of product on the surface of the probe.

All parts of the controller exposed to the product are of stainless steel. Probes are also available with special coatings for specific applications. All electronic circuitry is solid state and contained on a plug-in module.



Principle of Operation

The sensing elements of the Model 8-66 Liquid Level Controller consist of two temperature sensitive probes connected in a Wheatstone bridge, plus a low powered heating element adjacent to the active sensor.



When the probes are in air or gas, a maximum temperature differential exists between the active and reference sensors, which results in a great imbalance in the bridge circuit and a correspondingly high bridge voltage. When the probes are submerged in a liquid, the temperature differential between the sensors is considerably less. The bridge is brought more nearly into balance, and the bridge voltage is lowered.

The temperature differential between the probes is a function of the thermal conductivity of the product in which the probes are submerged. Consequently, the bridge voltage varies in accordance with the thermal conductivity of the products at the probes. Therefore, since the trip point may be adjusted to actuate the controller relay at any given point within the wide range of the bridge voltage, the controller will detect and respond to interfaces between products of different types as well as to the presence or absence of a liquid.

The trip point may also be adjusted to delay operation of the relay for a limited period of time after the probes have been exposed to an interface, or have detected the presence or absence of a liquid. Thus, the level of a liquid or interface may also be controlled within a specified range, depending on the dynamics of the system.

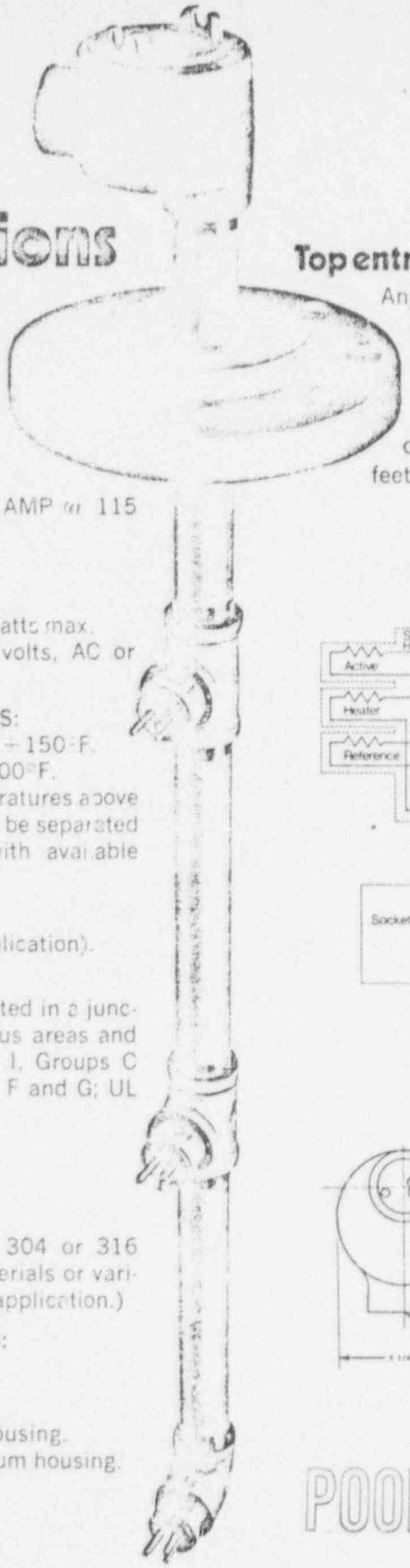
Installation

The controllers may be installed through the side wall of a tank or pipe, or assembled together on a self-supporting mounting and suspended through the top entry of a tank. The position of the controllers should be selected to provide the type of response required; i.e., high and/or low level alarm, level control, etc.

The controllers may be installed through virtually any fitting or mounting device that permits the probes to come into contact with the product. A flat on the controller housing indicates the position of the probes and serves to facilitate the proper positioning of the controller.

The controller, including all electronic circuitry, is contained in an explosion-proof housing. The solid state electronic circuitry, which is mounted on a plug-in card, may also be located a few hundred feet from the controller.

Specifications



Top entry, multipoint, liquid level controller

Any number of liquid level probes may be mounted on a single supporting pipe and positioned in a tank through a top entry port to read any combination of desired levels. Electronic control circuitry for all probes is located outside the tank, and may be as far as 200 feet from the probes.

CIRCUIT COMPONENTS:
All solid state electronics.

RELAY:
SPDT contacts rated at 2 AMP @ 115 VAC or 24 VDC resistive.
10 AMP on application.

POWER INPUT:
90-130 VAC, 60 Hz, 6 watts max. (models available for 24 volts, AC or DC).

OPERATING TEMPERATURES:
Electronic control: −50 to +150°F.
Sensor head: −100 to +300°F.
(Note: When used in temperatures above 150°F, sensor head should be separated from electronic control with available interconnecting cable.)

OPERATING PRESSURE:
To 3000 psi (higher on application).

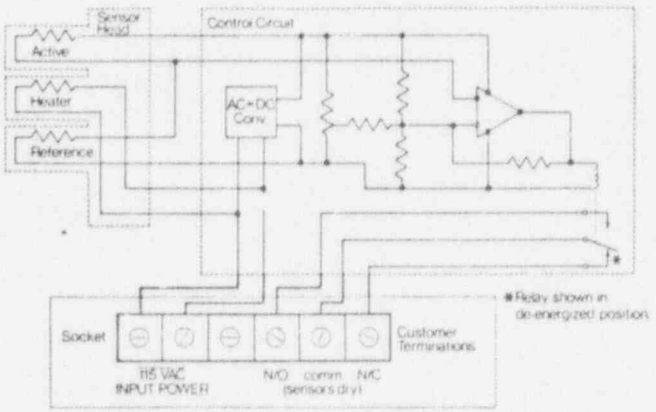
ELECTRICAL RATING:
The control circuit is mounted in a junction box rated for hazardous areas and complies with: NEC Class I, Groups C and D; Class II, Groups E, F and G; UL standard: 866.

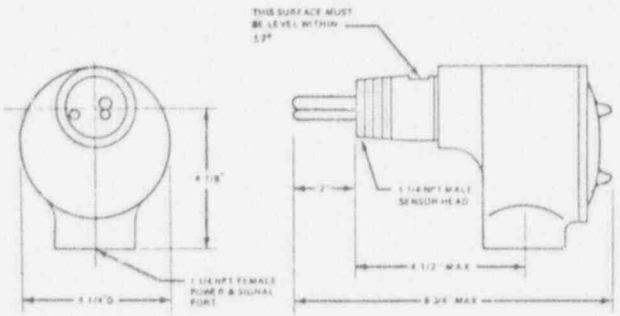
PIPE CONNECTIONS:
1¼-inch male NPT

MATERIAL:
All wetted surfaces Type 304 or 316 stainless steel. (Other materials or various coatings available on application.)

ELECTRICAL CONNECTIONS:
1¼-inch female port.

WEIGHT:
7 pounds with cast steel housing.
5 pounds with cast aluminum housing.





MANUFACTURED BY

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IX. 55 GALLON DRUM STANDARDS

American National Standard Specifications for 55-Gallon Full-Removable-Head Universal Drum (DOT-17H)

ANSI
MH2.5-1974
Revision of
MH2.5-1968

1. General

The drum covered by this standard:

(1) Must comply with Department of Transportation Specification 17H.

(2) Also complies with Rule 40 of Uniform Freight Classification and Item 260 of National Motor Freight Classification.

DOT Specification 17H is published in the *Code of Federal Regulations,* Title 49, Part 178; Rule 40 by the Uniform Classification Committee, agency of the railroads; Item 260 by the National Classification Board of the motor carrier industry. Those supplements, amendments, or reissues to these specifications as in effect apply.

2. Material

18-gage body and bottom head
16-gage top head
12-gage closing ring
Steel, to Manufacturers' Standard Gages as follows:

Gage No.	*Nominal Thickness (inch)*	*Minimum Thickness (inch)*
12	0.1046	0.0946
16	0.0598	0.0533
18	0.0478	0.0428

Sheet steel thickness is measured at any point no less than 3/8 inch from the edge.

3. Construction

The bottom head shall be double-seamed to the body, using a non-hardening seaming compound. The side seam shall be welded. The top of the shell, or body, shall be of metal rolled to form 1/2-inch false wire. The top head shall be fully removable, convex, 7/8-inch deep, with one or more corrugations near the periphery. The top head shall fit over the rolled false wire at the open end of the drum, be sealed with a gasket of material resistant to the product to be packed, and be secured to the rolled false wire by a closing ring or other device. Three rolling hoops, expanded or rolled in the drum body, shall be located as shown in the figure. There shall be no other corrugations in the sides.

4. Embossing

Manufacturers' embossing marks on the bottom head shall be in accordance with the applicable Items, Rules, and Regulations.

5. Shipping Data

Capacity
- Minimum volumetric content: 57.20 gallons (216 litres)
- Maximum volumetric content: 57.75 gallons (219 litres)

Tare weight:[1] 55.5 pounds (25.2 kilograms)

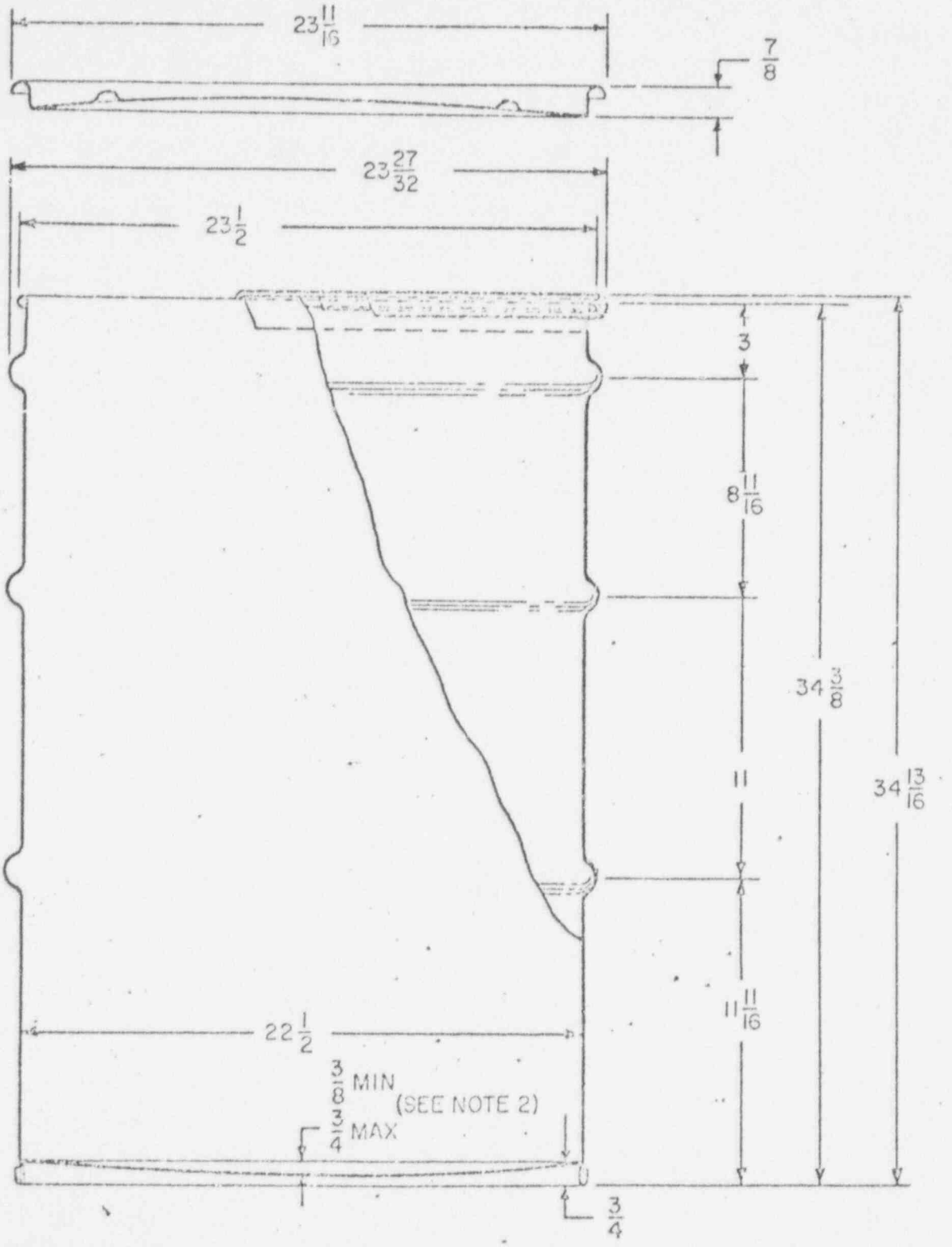
Container weight may vary in proportion to the allowable thickness limits prescribed for Manufacturers' Standard Gages.

Ocean shipping cube
- Tweed's Accurate: 11.667 cubic feet (0.33 cubic metre)

6. Tolerances (in Inches)

Diameter over rolling hoops:	23-27/32 ± 1/16
Diameter over false wire:	23-1/2 ± 1/16
Overall height:	34-13/16 ± 1/8
Height, cover off:	34-3/8 ± 1/8
Convexity of each head:	9/16 ± 3/16
All other height dimensions:	± 1/8
All other dimensions:	± 1/16

[1] Calculated on the basis of steel being nominal thickness plus a 12-gage DOT-17H bolted ring.



NOTES:
(1) All dimensions are in inches.
(2) These dimensions are applicable to both the top and bottom heads. Minimum convexity of each head is 3/8 inch.