CAPACITANCE PROBE INTERROGATOR
INSTRUMENT DESCRIPTION AND MAINTENANCE MANUAL

By

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April, 1971

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CAPACITANCE PROBE INTERROGATOR
INSTRUMENT DESCRIPTION AND MAINTENANCE MANUAL

INTRODUCTION

The Capacitance Probe Interrogator is an instrument which uses a capacitance probe detector to provide a visual readout and a recorder signal of the liquid level in a vessel. The instrument continuously interrogates the probe (measures its capacitance) then subtracts the "zero capacitance" (the capacitance of the probe with the liquid level below the probe) and displays this result.

A capacitance probe is a passive element made up of an "inner conductor", such as steel rod, encased in a dielectric, such as teflon or ceramic. The liquid, if it is conducting, acts as a variable "outer conductor" so that the probe displays a capacitance proportional to the liquid level.

INSTRUMENT DESCRIPTION

The Capacitance Probe Interrogator is made up of two separately housed parts: the transducer module and the readout module. The transducer module is mounted with the probe, interrogating it, and sending a signal proportional to the probe capacitance (liquid level) to the readout module. The electronics in the readout module condition and display this signal.

The transducer is an active circuit, completely encapsulated in a piece of stainless steel pipe. The pipe provides complete protection from corrosive atmospheres and adequate radiation shielding except in high gamma and neutron fields. Thus the transducer can usually be mounted directly on the capacitance probe which keeps the "zero capacitance" at a minimum. Because the signal from the transducer is a pulse-duration signal, coaxial cable should usually be used to

connect the transducer to the signal conditioner, although this is not necessary for short runs. More than 1,000 feet of coaxial cable may be used.

The readout module contains the readout, a frequency to voltage converter, and a dc power supply. Three readout options are presently available: a millivolt recorder output, an analog meter, and a digital panel meter (DPM). The instrument can be fabricated with any combination of these.

CIRCUIT OPERATION

For a description of the capacitance transducer circuit operation, see Appendix I, "An Indirect Digital Capacitance Transducer."

The frequency to voltage converter card is mounted in the readout module. The functions performed by this circuit are: decoupling the pulse train from the transducer power supply, converting the pulse train to a dc voltage, and conditioning this dc signal for readout.

As shown in Figure I, the pulse train from the transducer is decoupled from the power line to trigger the monostable circuit. At time T-1, the monostable circuit is in its normal state, Q-1 is off and Q-2 on, the voltage on C-5 is zero, and Q-3 and Q-5 are off. During the pulse train period, T_p , the ramp generating circuit develops a ramp across C-5 to a voltage proportional to T_p . At time T-2, the incoming pulse switches the monostable circuit. This turns on Q-5 in the sample-and-hold circuit, and the ramp voltage is transferred to C-6. At time T-3, the monostable returns to its normal state, Q-5 is turned off, and Q-3 is pulsed on to discharge C-5. The cycle then restarts. The voltage transferred to the sample-and-hold circuit is directly proportional to the period of the

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from
Original Document

pulse train. The computing circuit subtracts an amount set by the "zero" potentiometer (R-20) to compensate for the zero capacitance and amplifies the result by a factor set by the "span" potentiometer (R-19).

The power supply card provides the ± 15 volts for the frequency-to-voltage converter circuit and +21 volts for the transducer. As shown in Drawing H-2-35584 of Appendix II, IC-3, IC-4, and IC-5 are integrated circuits which provide the dc voltage regulation. In the 21 volt supply, R-26 and R-27 limit the current at approximately 30 milliamps. In the ± 15 volt supplies, R-31 and R-35 limit the current at approximately 80 milliamps.

The readouts provided for are a 1 milliamp analog meter, a 100 millivolt DPM with 100% overrange, and a 1 to 100 millivolt recorder output. A full scale reading on the analog meter corresponds to 10 volts on the output of the computing circuit. The recorder span can be adjusted over its range from a potentiometer on the back of the instrument, and the DPM can be adjusted to any full scale reading up to 1999 from potentiometer, R-52, on the frequency-to-voltage converter card.

CALIBRATION INSTRUCTIONS

When setting up the interrogator for use in a new installation, three adjustment potentiometers, R-8, R-19, and R-20 are used. Potentiometer R-8 controls the current source in the ramp generating circuit. Potentiometer R-19 provides the gain in the computing circuit. Adjusting this potentiometer adjusts the "span" of the instrument. Potentiometer R-20 provides the negative off-set which is subtracted from the output of the sample-and-hold circuit to allow for the zero capacitance. Adjusting this potentiometer "zeros" the readout.

The following steps calibrate the interrogator:

- A. Determine the approximate zero capacitance (C_z) and the approximate full scale capacitance (C_f) for the capacitance probe and vessel.
- B. Substitute a variable capacitor or discrete capacitors of comparable value for C_z and C_f .
- C. Attach C_f to the "probe" end of the transducer. Attach the "power" end of the transducer to the BNC connector on the readout module.

CAUTION: Be careful not to attach the "probe" end of the transducer to the readout module.

- D. Turn R-8 fully clockwise.
- E. Turn the zero control fully clockwise.
- F. Turn the span control fully counterclockwise.
- G. Turn on the power.
- H. Adjust R-8 counterclockwise until the voltage at the output of IC-1 is 4.0 volts. (This point may be reached on the back of the board.)
- I. Replace C_f with C_z .
- J. Adjust the zero control counterclockwise until the meter reads zero.
- K. Replace C_z with C_f .
- L. Adjust the span control clockwise until the meter reads full scale. (If the instrument does not have an analog meter, which registers full scale at approximately 10V, you should monitor the output of IC-2, pin H, to be sure the range does not exceed 10V.)

- M. Repeat Steps I through L until no more adjustment is necessary.
- N. If the instrument has a DPM, use R-52 to adjust it to the approximate full scale reading desired. After installation, adjust the DPM to exact full scale reading desired with the span control.

After the interrogator is installed on the vessel, only minor adjustments should be required if C_z and C_f have been carefully chosen. If the meter cannot be adjusted to zero or full scale, potentiometer R-8 must be readjusted.

TROUBLESHOOTING

Trouble symptoms and their probable causes are listed below:

- A. Meter will not respond to capacitance change:
 - 1. Check the +21, +15, and -15 volt output of the power supply card. (The 21 volt supply should be between 20 and 21 volts and the 15 volt supplies between 14 and 15 volts.)
 - 2. Check the transducer by putting an oscilloscope across the transducer input connector. A pulse train similar to that shown on Figure I should be seen.
 - 3. Check the Frequency-to-Voltage Converter Card, referring to waveforms on Figure I.
- B. If the +21 volt supply is low:

NOTE: This supply will shut down if the current drawn from it exceeds approximately 30 milliamps. Therefore, a short circuit or a high leakage path in the transducer circuit will shut down the supply.

1. Disconnect the coax from the transducer input connector. If the voltage returns to normal, inspect the cable connection to the transducer and substitute a good transducer.
 2. If the voltage remains low with the transducer disconnected, replace IC-3 on the Power Supply Board.
- C. If the +15 and/or -15 volt supply is low:
- NOTE: Each supply will shut down if the current drawn from it exceeds approximately 80 milliamps. Therefore, a short circuit or a high leakage path on the Frequency-to-Voltage card will shut down either or both of these supplies.
1. Remove the Frequency-to-Voltage card and recheck the low voltage. If the voltage comes up, check Frequency-to-Voltage card by substituting new semiconductors.
 2. If voltage remains low with Frequency-to-Voltage card removed, replace IC-4 if +15 volt supply is low and IC-5 if the -15 volt supply is low.
 3. If output remains low, check voltage across R-22 and R-23. With no load, this voltage should be 25 to 35 volts with approximately 3 volts ripple.
- D. If the transducer pulse train is not similar to that shown on Figure I:
1. Monitor the 21 volt supply with a digital volt meter, then connect and disconnect the

transducer. If the voltage varies more than 0.5 volts, return to Section B and follow Steps 1 and 2.

2. Disconnect the capacitance probe from the transducer, and monitor the transducer pulse train. If the pulse train is now similar to that on Figure I, with approximately a 30 microsec period, then the capacitance probe is probably bad and should be replaced. If the pulse train does not meet this description with the probe removed, then the transducer is probably bad and should be replaced.

APPENDIX I

INVENTION REPORT: AN INDIRECT
DIGITAL CAPACITANCE TRANSDUCER

INVENTION REPORT:
AN INDIRECT DIGITAL CAPACITANCE TRANSDUCER

Introduction

Many places in the nuclear industry, liquid level measurement is required in a vessel containing a radioactive solution. To contain the solution, the vessel must be kept sealed. This consideration eliminates many methods of liquid level measurement.

A capacitance probe is one method of making a liquid level measurement while keeping a vessel sealed. A capacitance probe consists of a conductor, such as a steel rod, coated with a dielectric material, such as Teflon, or ceramic. Assuming the liquid is a conductor, an electrical capacitor is formed between the liquid and the inner conductor with a value directly proportional to the liquid level. The probe can be sealed into a vessel with standard piping techniques. The liquid level may be measured by measuring the capacitance of the probe.

The most common method for measuring capacitance is a radio-frequency bridge, which is used almost exclusively in laboratory instruments. A bridge balances the unknown capacitance with a known capacitance to achieve a null. However, this method, applied to continuous process monitoring, has serious problems; some of which are cable capacitance, stability, and in most cases, the need for an electro-mechanical balance mechanism.

Another method for measuring capacitance is to charge the capacitor, then discharge it through a transformer to detect the pulse height. The pulse height is proportional to the amount of capacitance. This method is not linear due to the characteristics of the capacitance, resistance, and inductance in the circuit.

Statement of Invention

Basically, this method involves charging a capacitor with a constant current source, producing a linear ramp with a slope proportional to amount of capacitance. At a predetermined voltage, the capacitor is momentarily discharged to produce

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a pulse. By applying the constant current source continuously, a pulse train is generated whose period is directly proportional to the amount of capacitance. A block diagram is shown in Figure 1.

Circuit Analysis

The voltage on a capacitor is mathematically stated:

$$V_{t1} = \frac{1}{C} \int_{t0}^{t1} i \, dt + V_{t0}$$

Where: ' V_{t1} ' is the voltage on the capacitor at time $t1$ in volts

' C ' is the value of the capacitor in farads

' i ' is the current applied to the capacitor between time $t0$ and $t1$ in amperes

' V_{t0} ' is the voltage on the capacitor at time $t0$ in volts

If ' i ' is a constant, ' I ' then:

$$V_{t1} = \frac{I}{C} \int_{t0}^{t1} dt + V_{t0}$$

$$V_{t1} = \frac{I}{C} (t1 - t0) + V_{t0}$$

Let $(t1 - t0) = t$:

$$V_{t1} = \frac{I}{C} t + V_{t0}$$

$$C = \frac{I}{V_{t1} - V_{t0}} t$$

If V_{t1} and V_{t0} are constants:

Then, let $\frac{I}{V_{t1} - V_{t0}} = X$; a constant

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Therefore: $C = Xt$

Thus, the value of the capacitor is directly proportional to the period of the linear ramp. The period of the output pulse train is equal to the ramp period plus the time required to discharge the capacitor. The time required to discharge the capacitor is less than one percent of the ramp period in the worst case, and may be neglected. Therefore, the value of the capacitor is directly proportional to the period of the pulse train.

Referring to Figure II, D_1 , D_2 , R_1 , R_2 and Q_1 provide a constant current to drive the capacitance probe. The linear ramp develops across the probe to ten (10) volts. The uni-junction, Q_2 , fires, discharging the probe in three hundred (300) nanoseconds to two (2) volts. The ramp then starts over. As the probe discharges through Q_2 and R_4 , the driver transistor, Q_3 , is pulsed into saturation through D_3 . The output pulse is developed across R_5 and R_6 and transmitted through a decoupling capacitor, C_1 .

The pulse train can be transmitted long distances to a signal processor. Here the pulse train may be encoded to a digital code for digital instrumentation or converted to an analog signal for analog instrumentation.

Advantages of This Invention

This invention exhibits the following outstanding characteristics:

1. The transducer is linear.
2. The output signal is easily transmitted.
3. The circuit is simple and easily packaged with the probe.

Present Application

Figure III is a schematic of the circuit presently used. The transducer was matched with the voltage regulator to allow two wire interconnection with the signal processor and to improve the temperature stability. The temperature drift of the uni-junction circuit is offset by the drift of the regulator. The period of the output pulse train drifts less than two percent over the temperature range of 60 F. to 90 F.

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At this time, two capacitance probe transducers of this design are in use and two more installations are planned. In all of these installations, the top of the probe is in a radioactively contaminated, corrosive environment. To protect the circuit, it is potted inside a piece of stainless steel pipe and mounted directly to the top of the capacitance probe.

Figures IV and V show the output of the circuit of Figure III over the two ranges which are being used in the separations processing plants of the AEC-Richland Operations. The slight deviations from the curve are caused by variations in semiconductor parameters at different operating points.

Future Development

The applications to date have been in areas with relatively low gamma fields. There are locations here in relatively high gamma fields where this transducer might be applied advantageously.

The suitability of this circuit in high gamma fields is being tested for long-term service. Following determination of the radiation tolerance of the circuit as presently constructed, substitution of radiation tolerant components will be made as warranted.

Application of this transducer to more locations may be expected in the future.

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FIGURE 1

AN INDIRECT DIGITAL CAPACITANCE TRANSDUCER
(CONCEPTUAL BLOCK DIAGRAM)

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FIGURE II

AN INDIRECT DIGITAL CAPACITANCE TRANSDUCER
(SCHEMATIC OF FIGURE I)

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FIGURE III

AN INDIRECT DIGITAL CAPACITANCE TRANSDUCER
(SCHEMATIC AS PRESENTLY USED)

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FIGURE IV
OUTPUT PERIOD vs CAPACITANCE

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FIGURE V
OUTPUT PERIOD vs CAPACITANCE

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APPENDIX II

INSTRUMENT DRAWING H-2-35583 SCHEMATIC

H-2-35583	Schematic
H-2-35584	Schematic
H-2-35585	Schematic
H-2-35556	Transducer Housing
H-2-35707	Transducer Housing
H-2-35557	Instrument Case
H-2-35593	Instrument Case
H-2-36046	Instrument Case

READOUT MODULE WITH DPM

READOUT MODULL SHOWING INSIDE

AEC RL RICHLAND WASH

APPENDIX V
MANUFACTURERS SPECIFICATIONS

LM201 operational amplifier general description

The LM201 is a general purpose operational amplifier built on a single silicon chip. It is identical to the LM101 except that operation is specified over a 0 to 70°C temperature range. The device features

- Frequency compensation with a single 30 pF capacitor
- Operation from $\pm 5\text{V}$ to $+20\text{V}$
- Low current drain: 1.8 mA at $\pm 20\text{V}$
- Continuous short circuit protection
- Operation as a comparator with differential inputs as high as $\pm 30\text{V}$

- No latch up when common mode range is exceeded
- LM709 lead configuration in metal cans and flat packages

The unity gain compensation specified makes the circuit stable for all feedback configurations, even with capacitive loads. However, it is possible to optimize compensation for best high frequency performance at any gain. As a comparator, the output can be clamped at any desired level to make it compatible with logic circuits. Further, the low power dissipation permits high voltage operation and simplifies packaging.

schematic and connection diagrams

typical applications

Voltage Comparator for Driving
DTL or TTL Integrated Circuits

Low Drift Sample and Hold

Metal Can

Flat Pack

Inverting Amplifier
with Balancing Circuit

Voltage Comparator for Driving
RTL Logic or High Current Driver

**Pin numbers shown are for metal can package

MOTOROLA

Semiconductors

BOX 20912, PHOENIX, ARIZONA 85036

MONOLITHIC VOLTAGE REGULATOR

... designed to deliver continuous load current up to 500 mA without use of an external power transistor.

- Electronic "Shut-Down" Control and Short-Circuit Protection
- Excellent Load Regulation (Low Output Impedance = 20 milliohms typ from dc to 100 kHz)
- High Power Capability: To 17.5 Watts
- Excellent Transient Response and Temperature Stability
- High Ripple Rejection = 0.002 %/V typ
- Single External Transistor Can Boost Load Current to Greater than 10 Amperes
- Input Voltages to 40 Volts (MC1561)

MC1560, MC1561

MC1460, MC1461

POSITIVE-POWER-SUPPLY VOLTAGE REGULATOR INTEGRATED CIRCUIT EPITAXIAL PASSIVATED

APRIL 1980 DS 9104 R1
(Replaces DS 9104 and DS 9116)

G SUFFIX
CASE 602A
(Formerly Case 71A)

R SUFFIX
CASE 614

TYPICAL APPLICATION

15 Vdc COMPLEMENTARY REGULATED POWER SUPPLY
WITH CURRENT LIMITING

RESISTANCE IS EXPRESSED IN OHMS. CAPACITANCE IN MICROFARADS
FOR OTHER TYPICAL APPLICATIONS SEE FIGURES 1b THRU 29

CIRCUIT SCHEMATIC

*"G" package - pin 10 is ground, "R" package - case is ground.

THE FREQUENCY TO VOLTAGE CONVERTER AND READOUT CKT.
FIGURE I

① SEE NOTE #1 & 2

QTY.	NO.	SYMBOL	DESCRIPTION
	1		ARRANGEMENT
1	2	T-2	TRANSFORMER, SIGNAL TRANS. PC-40-HO
2	3	R-22, R-23	RESISTOR, 10K, 1/2 WATT
1	4	R-24	RESISTOR, 33K
3	5	R-25, R-26, R-27	RESISTOR, 6.8K
2	6	R-31, R-32	RESISTOR, 5.8
1	7	R-26	RESISTOR, 27
1	8	R-27	RESISTOR, 200
3	9	R-28, R-32 R-36	RESISTOR, 2.7
2	10	R-29, R-33	RESISTOR, 22K
2	11	C-9, C-10	CAPACITOR, 100, MALLORY PNP065-9A
3	12	C-11, C-14 C-17	CAPACITOR, .1, 50V, MINATURE CERAMIC, TEX-CAP
3	13	C-12, C-18 C-18	CAPACITOR, .056, 50V, MINATURE CERAMIC, TEX-CAP
3	14	C-13, C-16 C-19	CAPACITOR, 10, 50V, TANTALUM
2	15	8A-1, 8A-2	BRIDGE RECTIFIER, 1R 8082A
3	16	IC-3, IC-4 IC-5	INTEGRATED CKT. MOTOROLA MC14616
3	17	J-15, J-16 J-17	SOCKET, 10PIN, BARNES DEV #MGR-102

NOTES

1. ALL RESISTORS; VALUES IN OHMS, TOLERANCE, 5%
 $\frac{1}{8}$ WATT UNLESS OTHERWISE SPECIFIED
2. ALL CAPACITORS; VALUES IN MICROFARADS, UNLESS
OTHERWISE SPECIFIED.

[illegible]

① ARRANGEMENT
CAPACITANCE TRANSDUCER SCHEMATIC
SEE NOTE 1 & 2

TO F-V CONVERTER
TO CAPACITANCE PROBE

QTY.	SYMBOL	DESCRIPTION
1	T-3	TRANSFORMER PULSE ENGR 80362
1	R-37	RESISTOR, 200
2	R-39, R-39	RESISTOR, 10K
1	R-40	RESISTOR, 2.2K
1	R-41	RESISTOR, 2K
2	R-42, R-43	RESISTOR, 120
2	R-44, R-45	RESISTOR, 470
1	R-46	RESISTOR, 22K
1	R-47	RESISTOR, 4.7K
2	C-20, C-21	CAPACITOR, .1, CERAMIC MINILAB WEST CO
1	C-22	CAPACITOR, .056
1	Q-6	TRANSISTOR, 2N3906
3	Q-8, Q-8, Q-8	TRANSISTOR, 2N3904
1	Q-10	TRANSISTOR, 2N4591
1	Q-11	TRANSISTOR, 2N4250
5	D-4, D-5, D-6, D-7, D-8	DIODE, 1N94
1	D-9	DIODE, 1N23
1	C-23	CAPACITOR, .47 PF, CERAMIC DISC
2	J-1, J-2	CONNECTOR, SEE H-2-35586 & H-2-35587
2	U-3, U-4	CONNECTOR, AMPH 143-022-01-110
1	U-5	CONNECTOR, MSB 02A-143-1P
1	U-6	CONNECTOR, MSB 02A-143-9S
1	U-7	CONNECTOR, SINC, 31-102
1	R-48	POTENTIOMETER, COX, HELIPOT 63W

NOTES

1. ALL RESISTORS; VALUES IN OHMS, TOLERANCE, 5%
1/2 WATT UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS; VALUES IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
3. WHEN WIRING THE CABINET, TIE ALL GROUNDS TO ONE POINT, THE GROUNDING LUG ON THE BACK OF J-7

4-2-35584	CAPACITANCE TRANSDUCER	4-2-35585	INTERFACATOR
4-2-35586	TRANSISTOR	4-2-35587	TRANSUCER & CHASSIS
4-2-35588	DIODE	4-2-35589	SCHEMATIC
4-2-35590	RESISTOR	4-2-35591	200 354
4-2-35592	CAPACITOR	4-2-35593	500 355
4-2-35594	CONNECTOR	4-2-35595	NONE
4-2-35596	POTENTIOMETER	4-2-35597	4-2-35598
4-2-35598	TRANSFORMER	4-2-35599	4-2-35600
4-2-35600	DIODE	4-2-35601	4-2-35602
4-2-35602	RESISTOR	4-2-35603	4-2-35604
4-2-35604	CAPACITOR	4-2-35605	4-2-35606
4-2-35606	CONNECTOR	4-2-35607	4-2-35608
4-2-35608	POTENTIOMETER	4-2-35609	4-2-35610
4-2-35610	TRANSFORMER	4-2-35611	4-2-35612
4-2-35612	DIODE	4-2-35613	4-2-35614
4-2-35614	RESISTOR	4-2-35615	4-2-35616
4-2-35616	CAPACITOR	4-2-35617	4-2-35618
4-2-35618	CONNECTOR	4-2-35619	4-2-35620
4-2-35620	POTENTIOMETER	4-2-35621	4-2-35622
4-2-35622	TRANSFORMER	4-2-35623	4-2-35624
4-2-35624	DIODE	4-2-35625	4-2-35626
4-2-35626	RESISTOR	4-2-35627	4-2-35628
4-2-35628	CAPACITOR	4-2-35629	4-2-35630
4-2-35630	CONNECTOR	4-2-35631	4-2-35632
4-2-35632	POTENTIOMETER	4-2-35633	4-2-35634
4-2-35634	TRANSFORMER	4-2-35635	4-2-35636
4-2-35636	DIODE	4-2-35637	4-2-35638
4-2-35638	RESISTOR	4-2-35639	4-2-35640
4-2-35640	CAPACITOR	4-2-35641	4-2-35642
4-2-35642	CONNECTOR	4-2-35643	4-2-35644
4-2-35644	POTENTIOMETER	4-2-35645	4-2-35646
4-2-35646	TRANSFORMER	4-2-35647	4-2-35648
4-2-35648	DIODE	4-2-35649	4-2-35650
4-2-35650	RESISTOR	4-2-35651	4-2-35652
4-2-35652	CAPACITOR	4-2-35653	4-2-35654
4-2-35654	CONNECTOR	4-2-35655	4-2-35656
4-2-35656	POTENTIOMETER	4-2-35657	4-2-35658
4-2-35658	TRANSFORMER	4-2-35659	4-2-35660
4-2-35660	DIODE	4-2-35661	4-2-35662
4-2-35662	RESISTOR	4-2-35663	4-2-35664
4-2-35664	CAPACITOR	4-2-35665	4-2-35666
4-2-35666	CONNECTOR	4-2-35667	4-2-35668
4-2-35668	POTENTIOMETER	4-2-35669	4-2-35670
4-2-35670	TRANSFORMER	4-2-35671	4-2-35672
4-2-35672	DIODE	4-2-35673	4-2-35674
4-2-35674	RESISTOR	4-2-35675	4-2-35676
4-2-35676	CAPACITOR	4-2-35677	4-2-35678
4-2-35678	CONNECTOR	4-2-35679	4-2-35680
4-2-35680	POTENTIOMETER	4-2-35681	4-2-35682
4-2-35682	TRANSFORMER	4-2-35683	4-2-35684
4-2-35684	DIODE	4-2-35685	4-2-35686
4-2-35686	RESISTOR	4-2-35687	4-2-35688
4-2-35688	CAPACITOR	4-2-35689	4-2-35690
4-2-35690	CONNECTOR	4-2-35691	4-2-35692
4-2-35692	POTENTIOMETER	4-2-35693	4-2-35694
4-2-35694	TRANSFORMER	4-2-35695	4-2-35696
4-2-35696	DIODE	4-2-35697	4-2-35698
4-2-35698	RESISTOR	4-2-35699	4-2-35700
4-2-35700	CAPACITOR	4-2-35701	4-2-35702
4-2-35702	CONNECTOR	4-2-35703	4-2-35704
4-2-35704	POTENTIOMETER	4-2-35705	4-2-35706
4-2-35706	TRANSFORMER	4-2-35707	4-2-35708
4-2-35708	DIODE	4-2-35709	4-2-35710
4-2-35710	RESISTOR	4-2-35711	4-2-35712
4-2-35712	CAPACITOR	4-2-35713	4-2-35714
4-2-35714	CONNECTOR	4-2-35715	4-2-35716
4-2-35716	POTENTIOMETER	4-2-35717	4-2-35718
4-2-35718	TRANSFORMER	4-2-35719	4-2-35720
4-2-35720	DIODE	4-2-35721	4-2-35722
4-2-35722	RESISTOR	4-2-35723	4-2-35724
4-2-35724	CAPACITOR	4-2-35725	4-2-35726
4-2-35726	CONNECTOR	4-2-35727	4-2-35728
4-2-35728	POTENTIOMETER	4-2-35729	4-2-35730
4-2-35730	TRANSFORMER	4-2-35731	4-2-35732
4-2-35732	DIODE	4-2-35733	4-2-35734
4-2-35734	RESISTOR	4-2-35735	4-2-35736
4-2-35736	CAPACITOR	4-2-35737	4-2-35738
4-2-35738	CONNECTOR	4-2-35739	4-2-35740
4-2-35740	POTENTIOMETER	4-2-35741	4-2-35742
4-2-35742	TRANSFORMER	4-2-35743	4-2-35744
4-2-35744	DIODE	4-2-35745	4-2-35746
4-2-35746	RESISTOR	4-2-35747	4-2-35748
4-2-35748	CAPACITOR	4-2-35749	4-2-35750
4-2-35750	CONNECTOR	4-2-35751	4-2-35752
4-2-35752	POTENTIOMETER	4-2-35753	4-2-35754
4-2-35754	TRANSFORMER	4-2-35755	4-2-35756
4-2-35756	DIODE	4-2-35757	4-2-35758
4-2-35758	RESISTOR	4-2-35759	4-2-35760
4-2-35760	CAPACITOR	4-2-35761	4-2-35762
4-2-35762	CONNECTOR	4-2-35763	4-2-35764
4-2-35764	POTENTIOMETER	4-2-35765	4-2-35766
4-2-35766	TRANSFORMER	4-2-35767	4-2-35768
4-2-35768	DIODE	4-2-35769	4-2-35770
4-2-35770	RESISTOR	4-2-35771	4-2-35772
4-2-35772	CAPACITOR	4-2-35773	4-2-35774
4-2-35774	CONNECTOR	4-2-35775	4-2-35776
4-2-35776	POTENTIOMETER	4-2-35777	4-2-35778
4-2-35778	TRANSFORMER	4-2-35779	4-2-35780
4-2-35780	DIODE	4-2-35781	4-2-35782
4-2-35782	RESISTOR	4-2-35783	4-2-35784
4-2-35784	CAPACITOR	4-2-35785	4-2-35786
4-2-35786	CONNECTOR	4-2-35787	4-2-35788
4-2-35788	POTENTIOMETER	4-2-35789	4-2-35790
4-2-35790	TRANSFORMER	4-2-35791	4-2-35792
4-2-35792	DIODE	4-2-35793	4-2-35794
4-2-35794	RESISTOR	4-2-35795	4-2-35796
4-2-35796	CAPACITOR	4-2-35797	4-2-35798
4-2-35798	CONNECTOR	4-2-35799	4-2-35800

QTY	UNIT	DESCRIPTION
1	ASSEMBLY	
AR 2	PT# 3	SC-40
1	3	COAXIAL CONNECTOR SEA W/ 2 JG.
1	4	COAXIAL CONNECTOR PANEL RECEPTACLE, J# 3, PT# 82-795, MOD F (SEE DETAIL II)
6	5	FLAT HD SCREW #2-56 UNC-1A SST

DETAIL I

DETAIL II

1 ASSEMBLY

WAS DWG SK-2-22032

APPROVED FOR CONSTRUCTION	DATE	U. S. ATOMIC ENERGY COMMISSION
W. H. HARRIS	1/1	RICHMOND OPERATIONS OFFICE
W. H. HARRIS	1/1	Atlantic Richfield Hamford Company
W. H. HARRIS	1/1	Richmond, Washington 20022
W. H. HARRIS	1/1	CAPACITANCE PROBE
W. H. HARRIS	1/1	INTERGRATOR TRAINING
W. H. HARRIS	1/1	HOUSING MODEL I
W. H. HARRIS	1/1	WAS NO 20022
W. H. HARRIS	1/1	H-2-35556

REV	DATE	BY	DESCRIPTION
1	1/1	W. H. HARRIS	DRILL(S) 1/8 DIA HOLES IN PT# 2 EQUALLY SPACED ON PERIMETER AND C SINK FOR PT# 7
2	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
3	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
4	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
5	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
6	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
7	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
8	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
9	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
10	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
11	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
12	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
13	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
14	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
15	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
16	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
17	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
18	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
19	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
20	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
21	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
22	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
23	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
24	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
25	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
26	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
27	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
28	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
29	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
30	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
31	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
32	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
33	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
34	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
35	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
36	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
37	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
38	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
39	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
40	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
41	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
42	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
43	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
44	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
45	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
46	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
47	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
48	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
49	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
50	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
51	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
52	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
53	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
54	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
55	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
56	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
57	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
58	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
59	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
60	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
61	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
62	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
63	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
64	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
65	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
66	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
67	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
68	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
69	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
70	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
71	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
72	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
73	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
74	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
75	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
76	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
77	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
78	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
79	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
80	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
81	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
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84	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
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89	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
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91	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
92	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
93	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
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96	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
97	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
98	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
99	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2
100	1/1	W. H. HARRIS	ADD 1/8 DIA HOLES IN PT# 2

③ END PLATE - PROBE END

④ END PLATE - POWER END

① ASSEMBLY

ITEM NO.	DESCRIPTION
1	ASSEMBLY
2	PIPE 1-SCH 80 3/4\"/>

GENERAL NOTES

1. GROUNDING: WHEN WIRING TRANSDUCER PC BOARD INTO HOUSING SOLDER GROUND WIRE FROM "PROBE END" OF THE BOARD TO PT#5 AND THE GROUND WIRE FROM "POWER END" OF THE BOARD TO PT#10.
BE CAREFUL TO ALLOW SOME OF THE HOUSING THREAD (1/16") TO MAKE GOOD ELECTRICAL CONTACT AS THIS PROVIDES THE GROUND CONNECTION TO THE TANK.
2. PT#5 & PT#10 MAY BE ELIMINATED AND A COAXIAL CABLE WIRED DIRECTLY TO THE BOARD, ROUTED THROUGH PT#4 AND POTTED IN.

APPROVED FOR CONFORMANCE	DATE	U. S. ATOMIC ENERGY COMMISSION
BY		RICHLAND OPERATIONS OFFICE
APPROVED	DATE	Atlantic Richfield Hanford Company
BY		Hanford, Washington 99302
CAPACITANCE PROBE		
INTERROGATOR TRANSDUCER		
HOUSING - MODEL II		
REVISIONS	DATE	BY
1	10-1-64	W. J. M. / J. M. S.
2	10-1-64	W. J. M. / J. M. S.
3	10-1-64	W. J. M. / J. M. S.
4	10-1-64	W. J. M. / J. M. S.
5	10-1-64	W. J. M. / J. M. S.
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95	10-1-64	W. J. M. / J. M. S.
96	10-1-64	W. J. M. / J. M. S.
97	10-1-64	W. J. M. / J. M. S.
98	10-1-64	W. J. M. / J. M. S.
99	10-1-64	W. J. M. / J. M. S.
100	10-1-64	W. J. M. / J. M. S.

[illegible]

LOCATE BOX SEAM
ON THIS CORNER

1" 1" 1/2"

1/2" 1/4"

1/2" DRILL - 2 PLACES
EACH END

⑤ CABINET SHELF

SECTION "A-A"

① ASSEMBLY

QTY	P/N	DESCRIPTION
	1	ASSEMBLY
1	2	PANEL - 200 PA 32 ALUM
1	3	UTILITY CABINET-AU-1060, 200 PADDING ALUM
2	4	PC BOARD CONNECTOR, AMP # 3-022-0 - 12
1	5	CABINET SHELF, #16 GA ALUM
4	6	#6 SHEET METAL SCREW, RD HD
1	7	POTENTIOMETER (SPAN ADJUSTMENT)
1	8	POTENTIOMETER (ZERO ADJUSTMENT)
1	9	DPDT SWITCH, ALCO MST-25L
1	10	INDICATOR LAMP, DIALCO 249754-0712-574
1	11	CONNECTOR, MS3102A-14S-9S (RECORDER)
1	12	POTENTIOMETER (RECORDER SPAN ADJUSTMENT)
1	13	CONNECTOR, BNC 31-102
1	14	GROUNDING LUG, AMPHENOL #31-759
1	15	CONNECTOR, MS3102A-14S-1P (POWER)
1	16	FUSE POST, LITTLE FUSE MS344125
3	17	TRIMPOT BRACKET, BECKMAN #55 8W
1	18	DIGITAL PANEL METER, 199.9 MV, API #4304-4703-0200 WITH ACC. 1126-278, 345-207 AND 1125-208

GENERAL NOTES

1. PART NUMBERS 2, 6, 7, 8, 9, 10, 11, 12, 13, 15, AND 16 ARE AVAILABLE FROM STORES.
2. WHEN INSTALLED IN CORROSIVE ENVIRONMENT INSTALL A PURGE ROTAMETER TO KEEP CABINET AT POSITIVE PRESSURE.
3. WHEN WIRING DPM PUT A HOLE WITH A GROMMET ABOVE POWER SUPPLY FOR THE POWER LINE.

H-2-3667		CABIN AIR PRESSURE		REVISED DWG. DI-5781		I		INTERROGATOR	
H-2-3667		CABIN AIR PRESSURE		DESCRIPTION		REV		CASE MODEL II	
DW TO		DRAWING STATUS		REVISIONS		DATE LAST		NOKE	
REFERENCE - DP 5000		DRAWING STATUS		DATE CHECKED		DATE LAST		H-2-3667	
NEXT USED ON		DRAWING STATUS		DATE CHECKED		DATE LAST		H-2-3667	