Westinghouse Energy Systems

Westinghouse Non-Proprietary Class 3

Westinghouse Energy Systems

WCAP-13787
Revision 2

WESTINGHOUSE CLASS 3 (Non-Proprietary)

ELIMINATION OF PRESSURE SENSOR RESPONSE TIME TESTING REQUIREMENTS

WOG Program
MUHP-3040 Revision 1

August, 1995

Westinghouse Safety System Operations

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ACKNOWLEDGEMENTS

The following personnel are recognized for their extended efforts in the preparation of this report and for their team participation and support in the validation of material for this report.

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1.0 EXECUTIVE SUMMARY

WOG Program MUHP-3040, Revision 1, deals with an effort by the industry to eliminate the specific Technical Specification requirements to perform periodic response time testing on pressure and differential pressure sensors in Reactor Trip System and Engineered Safety Features Actuation System instrumentation loops. These pressure type sensors are utilized for flow, level, and pressure process measurement functions. Eliminating the periodic response time test is justified by Failure Modes and Effects Analysis that show that component failures within the pressure sensor that can cause response time degradation will be detected by other routine tests such as sensor calibrations.

Specifically, MUHP-3040 Revision 1:

- o Utilizes the recommendations contained in EPRI Report NP-7243 Revision 1, "Investigation of Response Time Testing Requirements" for justifying elimination of response time testing surveillance requirements on certain pressure and differential pressure sensors identified in the report.

- o Contains similarity analysis to sensors in the EPRI report of sensors not identified in the report to establish justification for elimination of response time testing requirements for those sensors.

- o Qualifies as a Cost Beneficial Licensing Action (CBLA) as described in section 7.0.

- o Provides reasonable assurance that elimination of the specified response time testing requirements does not create a significant impact on the safety of the plant as described in section 8.0

- o Provides a methodology for substituting response times in lieu of values obtained from response time testing for each sensor covered by this WCAP.

WOG program MUHP-3041, completed in Nov of 1994 and documented in Ref 3, is complimentary to MUHP-3040. MUHP-3041 was conducted to eliminate the specific requirement to perform periodic response time testing on the process instrumentation and logic portions of the Reactor Trip System and Engineered Safety Features Actuation System instrumentation loops.

2.0 INTRODUCTION

Response Time Testing (RTT) of Reactor Trip System (RTS) instrumentation and Engineered Safety Features Actuation System (ESFAS) instrumentation has been required by Technical Specifications since the mid 1970's. The purpose of the RTT was to demonstrate that the instrumentation met the response time performance requirements assumed in the plant safety analyses.

Since its inception, RTT has proven to be resource intensive. RTT is generally performed in discrete steps, with the sensor response time being one of the steps. RTT of sensors is especially expensive, since many of the tests require special equipment and technical skills in addition to extensive test times. Furthermore, many of the sensors are located in radiation areas and substantial man rem exposure is incurred by plant maintenance staffs. A data review conducted by the EPRI has shown that RTT has not detected response time failures. This can be attributed in a large part to the fact that other surveillance (calibration) is typically performed first and has discovered failures that would affect response time. As a result, EPRI initiated a program to determine if RTT requirements could be eliminated for specific pressure and differential pressure transmitters and switches. The results of the EPRI program are delineated in EPRI Report NP-7243 Revision 1 (Ref. 1).

This WCAP provides the technical justification for deletion of periodic RTT of selected pressure sensing instruments using the EPRI report recommendations and additional analysis by Westinghouse for selected sensors not addressed by the EPRI report. An example "No Significant Hazards Consideration" evaluation is included as Appendix B to aid the utilities in preparation of a plant specific license amendment request.

3.0 BACKGROUND

In 1975 RTT requirements were added to the Westinghouse Standard Technical Specifications. As a result, all plants licensed after 1975 had to include RTT in routine surveillance testing. The first plant required by Technical Specifications to perform RTT was D. C. Cook Unit 1.

The Standard Technical Specifications contain definitions for both Reactor Trip System and Engineered Safety Features Actuation System Response Times. The response time definitions are:

> "The REACTOR TRIP SYSTEM RESPONSE TIME shall be the time interval from when the monitored parameter exceeds its trip setpoint at the channel sensor until loss of stationary gripper coil voltage."

> "The ENGINEERED SAFETY FEATURES RESPONSE TIME shall be that time interval from when the monitored parameter exceeds its ESF actuation setpoint at the channel sensor until the ESF equipment is capable of performing its safety function (i.e., the valves travel to their required positions, pump discharge pressures reach their required values, etc.). Times shall include diesel generator starting and sequence loading delays where applicable."

The Bases section states that the response time may be measured by any series of sequential, overlapping, or total steps such that the entire response time is measured. This approach is also consistent with ISA Standard 67.06. Given this guidance and the complexity of testing an entire instrument channel from the sensor to the final device, plant surveillance procedures typically test a channel in two or more steps. One individual step in most plant test methodologies is the instrument sensor. Separate procedure(s) using specialized test equipment and/or outside vendors are typically used solely for sensor testing.

The first industry RTT guidelines were established by the Institute of Electrical and Electronic Engineers in ANSI/IEEE Standard 338-1975, "Criteria for the Periodic Testing of Class 1E Power and Protection Systems." In 1977 this Standard was revised and accepted by the NRC as documented by NRC Regulatory Guide 1.118, "Periodic Testing of Electric Power and Protection Systems," Revision 1. Following Revision 2 of Regulatory Guide 1.118, the Instrument Society of America approved Standard ISA S67.06, "Response Time Testing of Nuclear Safety-Related Instrument Channels in Nuclear Power Plants," August 29, 1986. These guidelines have also been used by industry when developing plant specific test procedures.

4.0 Summary of EPRI Report NP-7243 Revision 1,"Investigation of Response Time Testing Requirements".

In May of 1991, EPRI issued a report "Investigation of Response Time Testing Requirements", Report No. NP-7243. The EPRI report was revised in 1994 to address review comments by the industry (Ref. 1). The EPRI report provides recommendations for reducing or eliminating RTT requirements which apply to typical pressure and differential pressure sensors used in safety-related protection system instrumentation in the nuclear power industry.

The primary purpose of the EPRI investigation was to determine if deleting RTT could be justified for specific pressure, level, and flow sensors. IEEE Standard 338-1977 defines a basis for eliminating RTT. Section 6.3.4 states in part:

> "Response time testing of all safety-related equipment, per se, is not required if, in lieu of response time testing, the response time of the safety system equipment is verified by functional testing, calibration check, or other tests, or both."

In addition, the standard states:

> "This is acceptable if it can be demonstrated that changes in response time beyond acceptable limits are accompanied by changes in performance characteristics which are detectable during routine periodic tests."

4.1 Program Organization

The EPRI report was developed through the efforts of EPRI, the RTT Utility Advisory Committee (UAC), 39 nuclear power plants, 6 pressure sensor manufacturers, Science Applications International Corporation (SAIC) and Performance Associates, Inc. EPRI coordinated the program and acted as technical director and reviewer. The RTT UAC acted as advisors on the formulation of the project and as reviewers during the development of the report. The 39 plants provided detailed response time data used in the investigation to determine failure trends, test methods and data repeatability. The 6 manufacturers, which supplied technical information regarding the design and performance of their product(s), represented the majority of manufacturers currently providing qualified pressure sensors to the nuclear industry. SAIC and Performance Associates, Inc. performed the RTT investigation and developed the report. Rosemount FMEA data included in the report was provided by the EPRI Project Manager.

4.2 Program Objectives

In support of industry efforts to improve plant availability and reduce plant personnel exposure levels, EPRI established a program to determine whether or not requirements for RTT of specific pressure and differential pressure transmitters and switches could be eliminated. The investigation included only the sensor since the premise for deleting RTT of the sensor was not directly applicable to the other components in the instrument loop. Therefore, the conclusions and recommendations of the EPRI report are applicable only to the sensor portion of the instrument loop.

The EPRI program was devised to determine: 1) how RTT performs as a unique indicator of sensor (pressure and differential pressure) response time degradation; 2) sensor failure modes, if any exist, which result in response time degradation that would not be detected by other periodic (non-RTT) testing methods; 3) the level of redundancy between RTT and other periodic tests; and, 4) the RTT methods best suited to detect, where necessary, response time degradation.

Assessment of plant response time data and performance of FMEAs on sensor hardware provided the mechanisms for obtaining the necessary information. For the plant data assessment, evaluations were performed to establish any similarities and differences in response time testing at selected plants and to determine the repeatability of RTT measurements. Sensor types were identified as either having failed response time testing, or as trending toward failure. Root causes of known sensor failures were evaluated to determine if response time degradation was the key indicator of the failure. Additionally, the use of response time measurement data to identify sensors that were trending toward response time failures was evaluated.

FMEA considerations included the evaluation of sensor failure modes which could affect response time, the ways that sensors which are experiencing response time degradation exhibit other operability changes, and the identification of routine plant tests that essentially provide the same information as RTT for each response time failure mode.

4.3 Plant Data Collection and Assessment

For the EPRI investigation, 39 nuclear power plants supplied over 4200 RTT measurements including information regarding sensor type, sensor use, instrument range, trip setpoint, allowable response time, test method, and type of test system. The plant data covered all but one manufacturer (Statham) supplying safety-related pressure and differential pressure sensors to the nuclear industry. EPRI used this data to determine failure trends and evaluate test methods and data repeatability. Six manufacturers, including Statham, supplied EPRI with technical information regarding design and performance of their

products. Sensor failure modes affecting response time were evaluated to the guidelines provided in ANSI N41.4-1976/IEEE Std 352-1975 "IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Protection Systems" to confirm that response time failures could be detected by surveillance tests other than specific RTT.

Based on the 4200 measurements supplied, the EPRI investigation found "RTT has not identified any sensors that have failed response time requirements using hydraulic or electronic white noise analysis techniques. However, calibrations and other tests have detected transmitters with excessive response times".

The EPRI report concludes that the current RTT program for pressure and differential pressure sensors adds very little to the identification of failed sensors and verification of loop response times. With a few exceptions (noted in Section 4.5), the existing instrumentation surveillance requirements, such as channel checks and sensor calibrations, have proven effective in identifying failed sensors in a timely manner.

4.4 Failure Modes and Effects Analysis

The EPRI report included FMEAs on the following sensor-types:

Barton 288/289 Differential Pressure Indicating Switches
Barton 763 Gauge Pressure Transmitter
Barton 764 Differential Pressure Transmitter
Foxboro/Weed N-E11DM Differential Pressure Transmitter
Foxboro/Weed N-E13DM Differential Pressure Transmitter
Foxboro/Weed N-E13DH Differential Pressure Transmitter
Foxboro/Weed N-E11GH Gauge Pressure Transmitter
Foxboro/Weed N-E11GM Gauge Pressure Transmitter
Tobar 32PA1 Absolute Pressure Transmitter
Tobar 32PG1 Gauge Pressure Transmitter
Tobar 32DP1 Differential Pressure Transmitter
Rosemount Differential Pressure Transmitter Models 1151, 1152, 1153, 1154
Rosemount Pressure Transmitter Models 1151, 1152, 1153, 1154
Statham PD-3200 Differential Pressure Transmitter
Statham PG-3200 Pressure Transmitter
SOR Differential Pressure Switch
SOR Pressure Switch.

These sensor types were selected as being representative of the pressure and differential pressure sensor instrumentation being utilized in safety-related systems and are representative of the various sensor designs (e.g., bourdon tube, force-balance, capacitance and strain gauge).

The FMEA method of analysis provided a systematic approach for identifying failure modes. The FMEAs permitted the identification and analysis of failure modes associated with each principal design component of the pressure and differential pressure sensors that could affect response time.

4.5 Summary of EPRI Recommendations

The EPRI report provides recommendations for modifying the current RTT program for pressure and differential pressure sensors in the nuclear utility industry. These are recommendations to consider when enhancing or upgrading existing plant RTT programs and are not intended to require changes to current plant RTT programs.

The report also provides the basis for deletion of all periodic pressure and differential pressure sensor response time testing requirements subject to the following exceptions/limitations:

1. Perform hydraulic response time test prior to installation of new transmitter/switch or following refurbishment.

2. For transmitters and switches that use capillary tubes, RTT should be performed after initial installation and after any maintenance or modification activity that could damage the capillary tubes.

3. Perform periodic drift monitoring on all Rosemount pressure and differential pressure transmitters in accordance with Rosemount Technical Bulletins and NRC Bulletin 90-01 (affects certain model numbers only).

   Note: NRC Bulletin 90-01 has been superseded by NRC Bulletin 90-01 Supplement 1.

4. Assure that variable damping (if used) is at the required setting and cannot be changed or perform hydraulic or white noise response time testing of sensor, following each calibration.

5.0 Westinghouse Owners Group Analyses

The primary objective of the following similarity analysis is to provide justification for deleting Technical Specifications requirements for RTT on pressure and differential pressure sensors not included in EPRI Report NP-7243 Revision 1.

In 1991 a survey was made of Westinghouse Owners Group plants to provide information identifying those pressure and differential pressure sensors currently in operation with periodic Technical Specifications RTT requirements. Following is a list of pressure and differential pressure sensors identified from that survey which are in addition to those evaluated in the EPRI report:

Barton 752 Differential Pressure Transmitter
Barton 332 Differential Pressure Transmitter
Barton 763A Gauge Pressure Transmitter
Barton 351 Sealed Sensor
Foxboro/Weed N-E11AH Absolute Pressure Transmitter
Foxboro E11GM Gauge Pressure Transmitter
Foxboro E13DH Gauge Pressure Transmitter
Tobar 32DP2 Differential Pressure Transmitter
Tobar 32PA2 Absolute Pressure Transmitter
Veritrak 76DP1 Differential Pressure Transmitter
Veritrak 76PG1 Gauge Pressure Transmitter
Veritrak 76PH2 Absolute Pressure Transmitter.

Similarity analyses were utilized to compare the design and the functionality of the principal components of each pressure and differential pressure unit, to those evaluated in the EPRI report. For those instruments where similarity could not be shown, other techniques (FMEA, historical approach, circuit testing) were utilized to justify elimination of the RTT requirements. The respective sensor manufacturer has reviewed/approved each Westinghouse analysis contained herein. The documentation of the reviews are contained in Appendix C.

5.1 BARTON MODEL 752 SIMILARITY ANALYSIS REPORT

5.1.1 Description

The Barton Model 752 differential pressure transmitter combines a differential pressure unit (Figure 5.1-1) with an electronic signal processing circuit contained within a transmitter housing. The model 752 block diagram is depicted in Figure 5.1-2.

The mechanical actuating device for the electronic transmitter is a dual bellows assembly enclosed by a set of two pressure housings. The bellows assembly consist of two bellows connected by a valve shaft. The bellows move in proportion to the difference in pressure applied across the bellows unit assembly. The linear motion of the bellows is transferred to the valve shaft which deflects the tip of a strain gauge beam installed in a cutout in the shaft. Movement of the strain gauge beam acts upon two strain gauges which are bonded to opposite sides of the beam. The two strain gauges are connected to form two active arms of a resistive bridge circuit within the transmitter electronics. The bridge output signal is conditioned and converted to a loop current output signal by a hybrid electronics circuit. This circuit is basically a loop current regulating device, where the loop current (4-20 mA or 10-50 mA) is controlled by the mechanical force or motion over the calibrated differential pressure range of the differential pressure unit. Within the circuit, the transmitter power supply and load line connect in series. The current from the power supply enters the transmitter, passes through the reverse polarity diode, then divides into two separate paths. The main current flows through the current amplifier and returns to the loop. The remainder of the current passes through the electronic regulator where it again divides to take two separate paths: one to the strain gauge bridge network, the other to the signal amplifier. The bridge output signal is amplified by the signal amplifier which is an integrated circuit operational amplifier. The output voltage of the signal amplifier is the input for the current amplifier circuit which converts this voltage to current. The amount of current is precisely regulated with a feedback network to make it proportional to the bridge current. After passing through these respective stages, the total current flows through the load and back to the power supply.

If the bellows are subjected to a pressure greater than the differential pressure range of the DPU, the bellows will move through their normal range of travel, plus a small additional amount of over-travel, until the valve on the shaft seals against its valve seat. As the valve closes on the seat, it traps the fill fluid in the bellows, protecting the unit from damage or shift in calibration.

5.1.2 Similarity Analysis

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5.1.3 Summary

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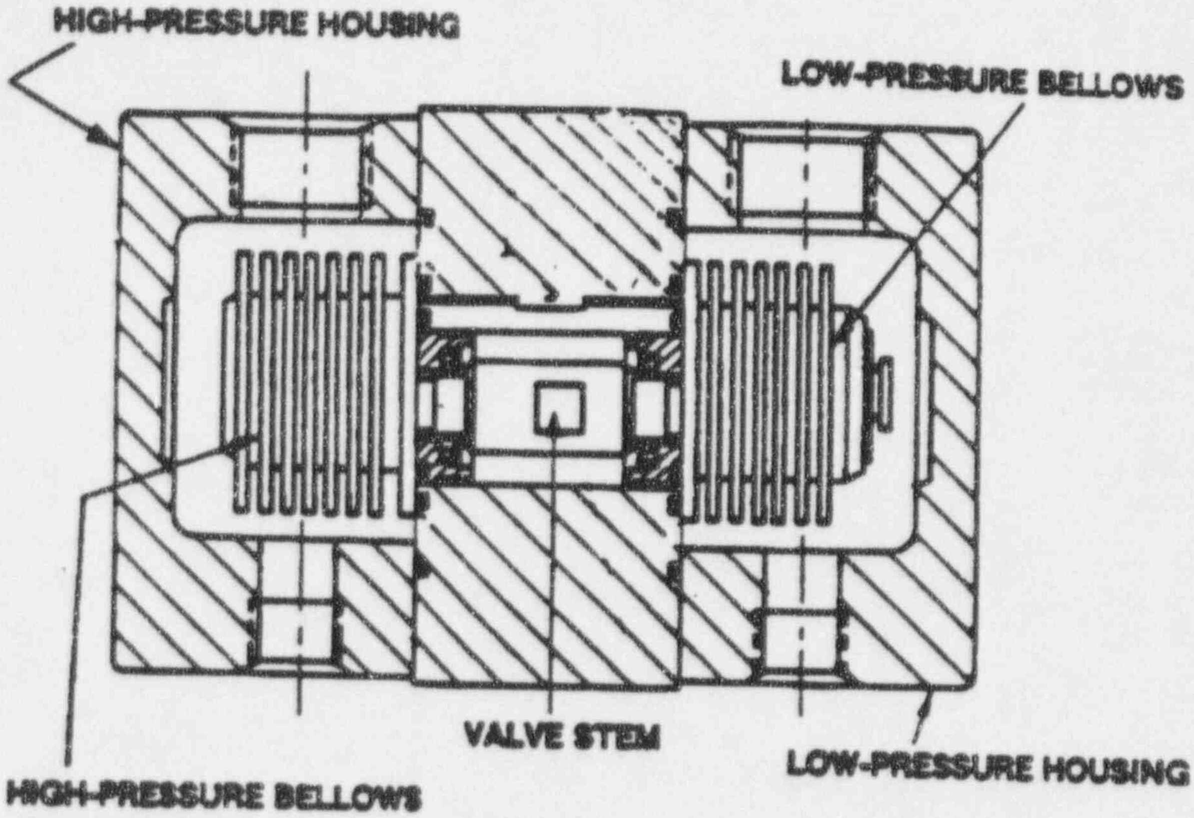

Figure 5.1-1
Barton Model 752 DPU

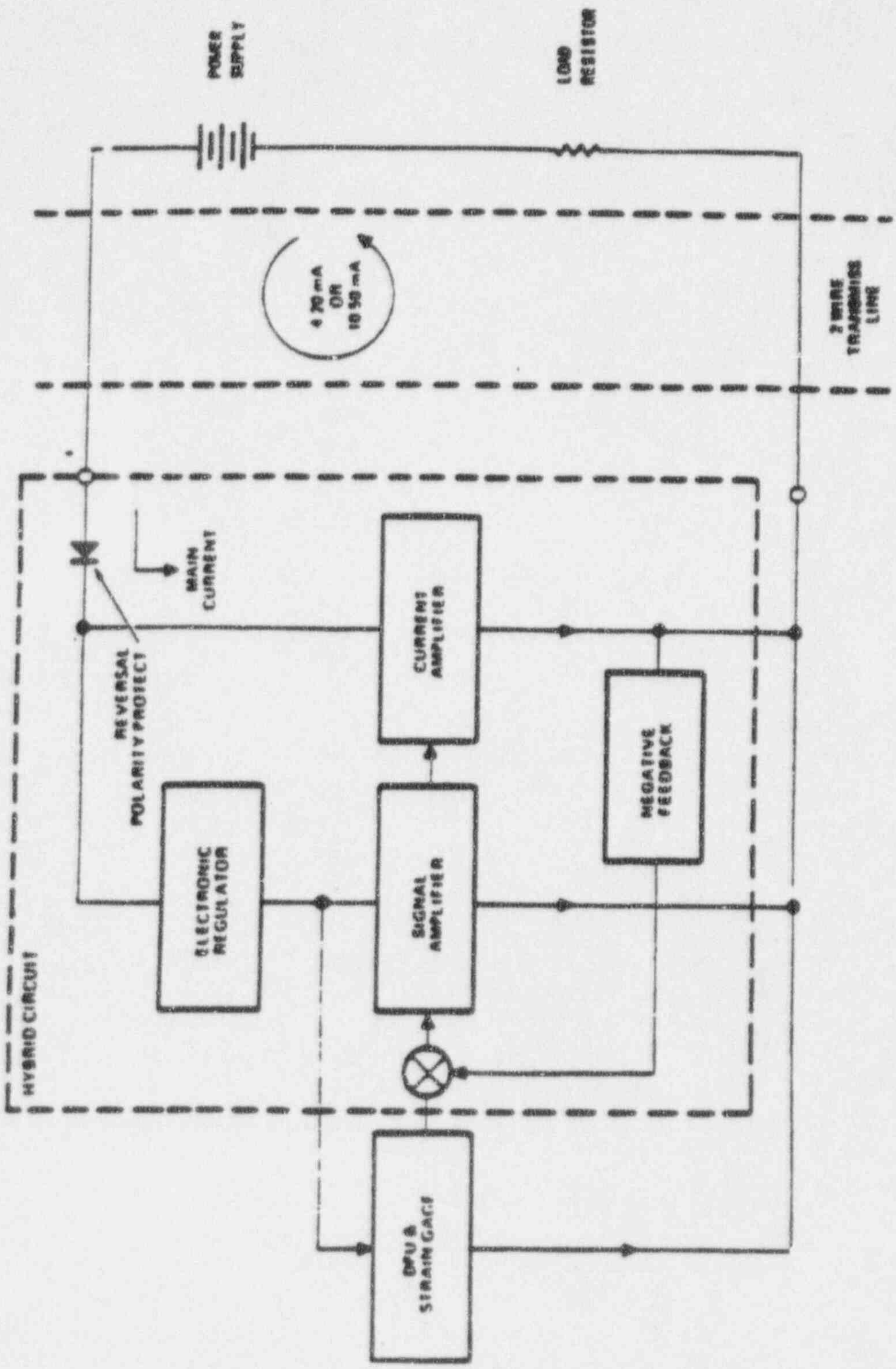

Figure 5.1-2
Barton Model 752 Block Diagram

5.2 BARTON MODEL 332 SIMILARITY ANALYSIS REPORT

5.2.1 Description

The Barton Model 332 differential pressure transmitter combines a Model 224 differential pressure unit (DPU) with a signal processing circuit located within an electronics case.

The model 224 DPU is a dual bellows assembly enclosed within a pressure housing that is attached to the back of the electronics case. The dual bellows assembly consists of two opposing internally connected liquid-filled bellows, a center plate, range springs, over-range valves, and a torque tube assembly as illustrated in Figure 5.2-1. Any pressure change within the housing subjects the bellows to increasing pressure to contract laterally, forcing the fill fluid through the center plate into the bellows being subjected to the least amount of pressure and causes the latter to expand laterally. An example of bellows movement is depicted in Figure 5.2-2. The amount of bellows movement is proportional to the difference in the pressure applied across the bellows unit assembly. As the bellows move laterally, the connecting drive arm follows the motion of the bellows. The drive arm movement is transmitted through the follower arm to the torque tube. The twisting of the torque tube causes the torque tube shaft to rotate through the same angle as the drive arm. Range springs act with the bellows and torque tube to balance the differential pressure applied to the unit.

The torque tube is attached by a flexure wire to a cantilever beam that has two silicon strain gauges mounted on opposite sides. Motion of the free end of the cantilever beam applies tension to one strain gauge and compression to the opposite strain gauge. The two strain gauges are connected to form the active arms of a resistive bridge circuit within the transmitter electronics circuit. The bridge output signal is conditioned and converted to a loop current output signal by the transmitter electronic circuit. The circuit is basically a loop current regulating device, where the loop current (4-20 mA or 10-50 mA) is controlled by the mechanical force or motion over the calibrated pressure range of the transmitter. Within the circuit, the transmitter power supply and load line connect in series. The current from the power supply enters the transmitter, passes through the reverse polarity diode, then divides into two separate paths. The main current flows through the current amplifier and returns to the loop. The remainder of the current passes through the electronic regulator where it again divides to take two separate paths: one to the strain gauge bridge network, the other to the signal amplifier. The bridge output signal is amplified by the signal amplifier which is an integrated circuit operational amplifier. The output voltage of the signal amplifier is the input for the current amplifier circuit which converts this voltage to current. The amount of current is precisely regulated with a feedback network to make it proportional to the bridge current. After passing through these respective stages, the total current flows through the load and back to the power supply.

If the DPU bellows are subjected to a pressure greater than the differential pressure range of the DPU, the bellows will move through their normal range of travel, plus a small additional amount of over-travel, until the valve on the shaft seals against its valve seat. As the valve closes on the seat, it traps the fill fluid in the bellows, protecting the unit from damage or shift in calibration.

5.2.2 Similarity Analysis

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5.2.3 Summary

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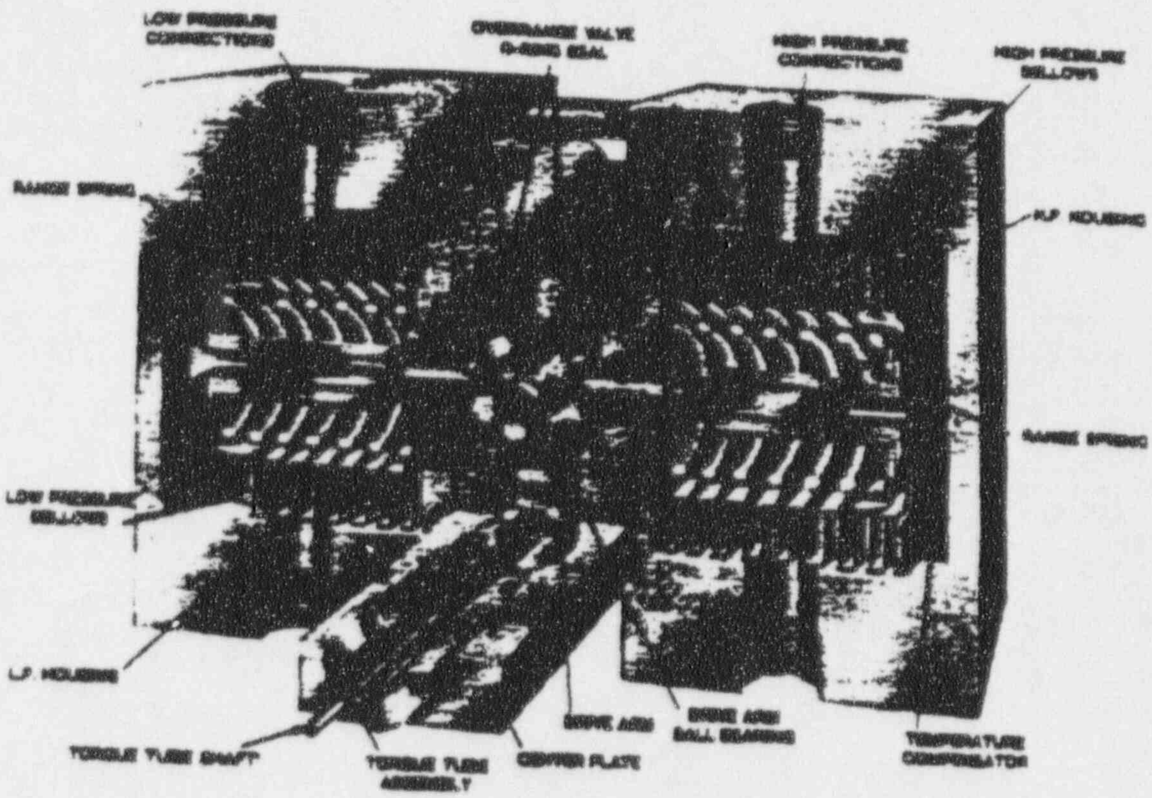


Figure 5.2-1
Barton Model 224 Differential Pressure Unit

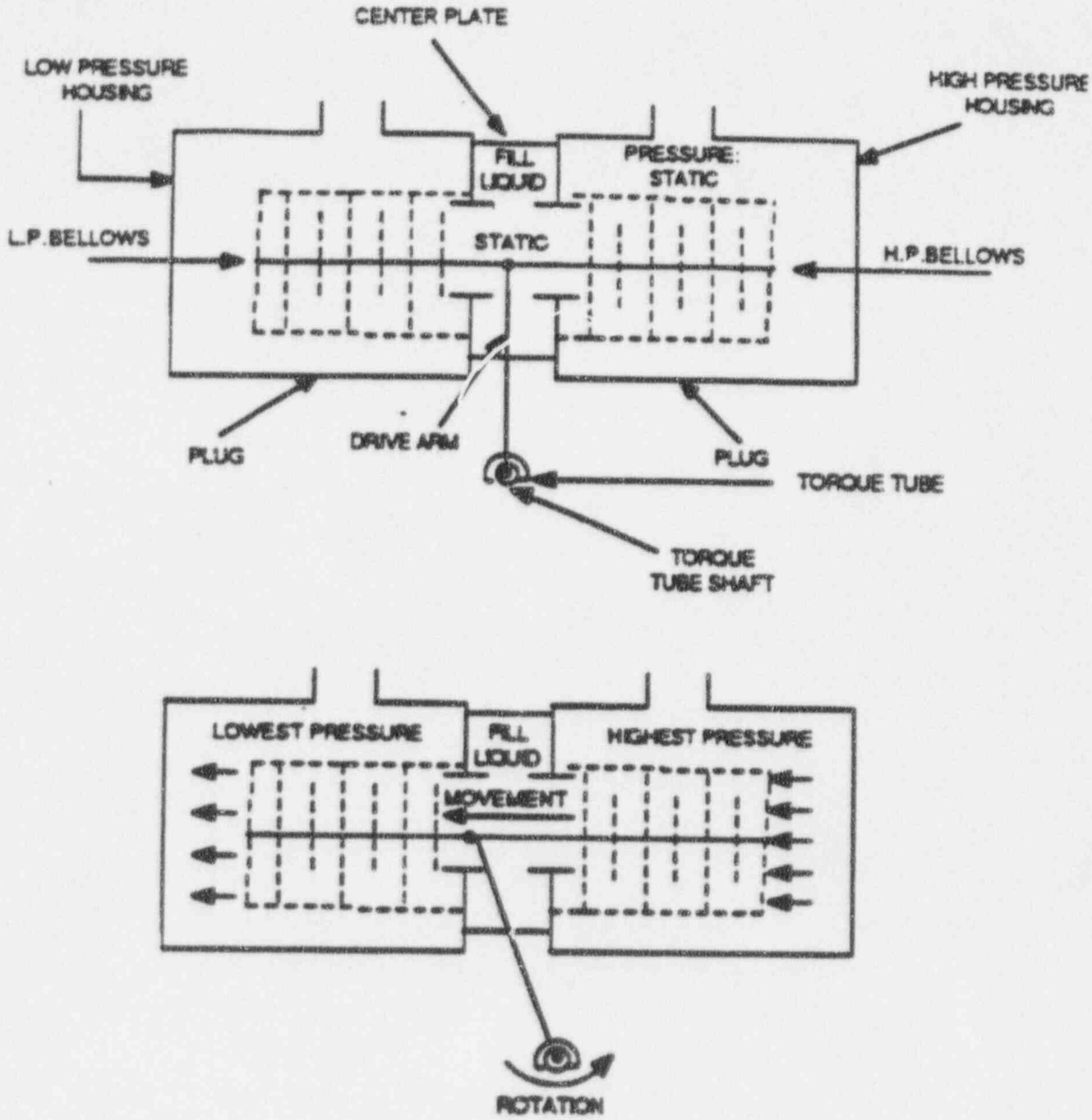
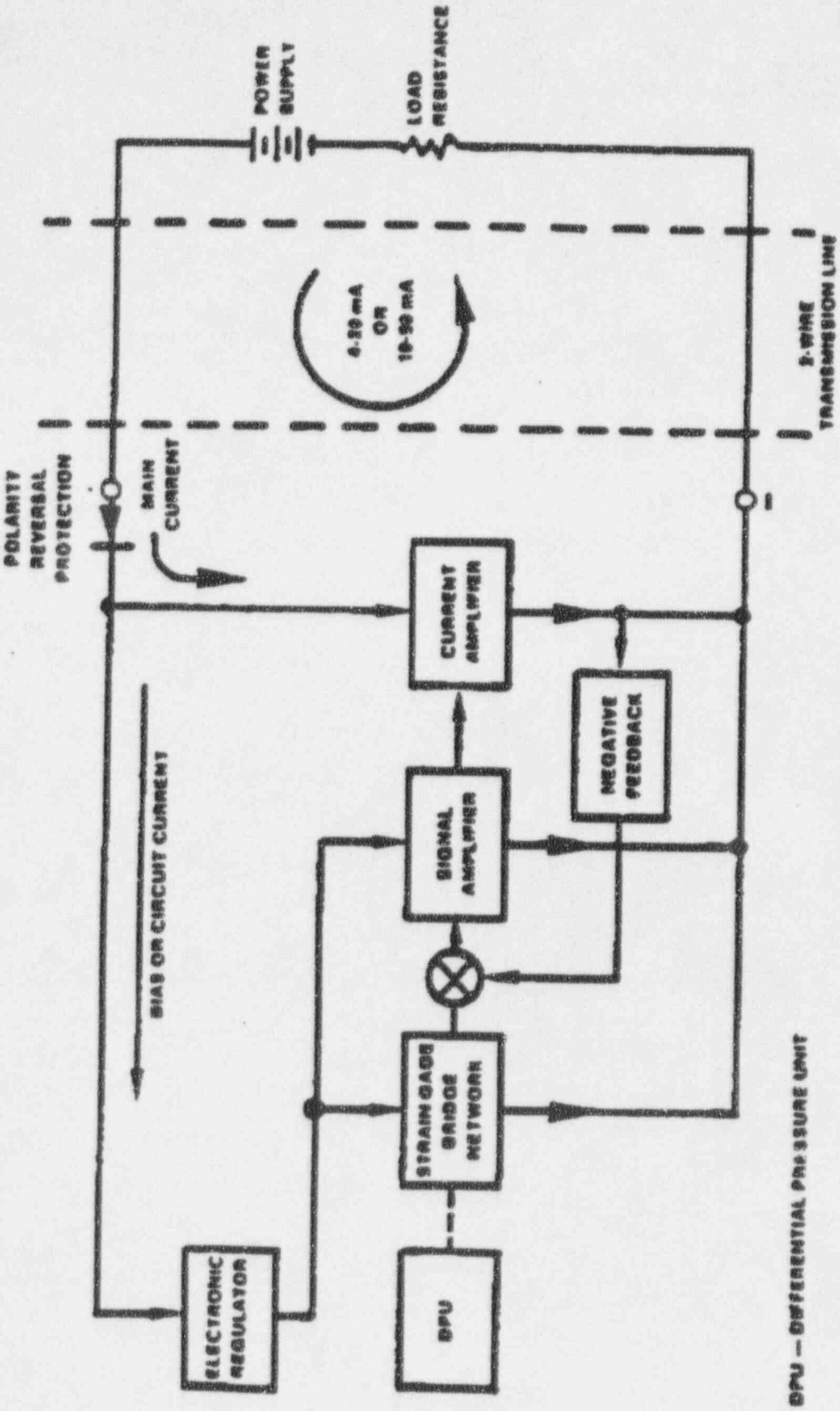


Figure 5.2-2
Barton Model 224 Mechanical Operation


POWER SUPPLY
LOAD RESISTANCE
4-20 mA OR 10-50 mA
2-WIRE TRANSMISSION LINE
POLARITY REVERSAL PROTECTION
MAIN CURRENT
BIAS OR CIRCUIT CURRENT
CURRENT AMPLIFIER
NEGATIVE FEEDBACK
SIGNAL AMPLIFIER
STRAIN GAGE BRIDGE NETWORK
ELECTRONIC REGULATOR
DPU
DPU — DIFFERENTIAL PRESSURE UNIT

5.3 BARTON MODEL 351 SEALED SENSOR ANALYSIS REPORT

5.3.1 Description

The Barton Model 351 sealed sensor is connected by armored capillary to a pressure or differential pressure transmitter or switch to form a complete measurement system. The 351 sensor is designed specifically for use in systems that have unusual fill fluid requirements due to fluid volumes, fluid chemistry or ambient temperature concerns. Typical applications of the 351 sealed sensor system found in PWR plants include the containment pressure and containment sump water level measuring systems. Although all of these systems utilize the model 351 sensor, each application differs by the process medium being measured and the installation required (i.e., length of capillary, elevation of sensors, etc.). Common among all installations are the primary design components of the sealed sensor system. These components are the 351 sensor assembly and the capillary tubing.

The model 351 sensor assembly consists of a single stainless steel bellows housed in a case constructed of either carbon or stainless steel. Process connections are mated to the housing via either an NPT pipe fitting or a forged steel or stainless steel flange. An illustration of the typical model 351 sensor assembly is depicted in figure 5.3-1.

Stainless steel capillary tubing is used to couple the sensor to the transmitter or switch. The capillary is supplied as either 0.25 inch or 0.187 inch outside diameter. Each component of the sealed sensor system is welded, i.e., sensor to capillary, capillary to fill valve (when used), and capillary to transmitter or switch. The internal volume of the sensor bellows, the capillary and the transmitter or switch pressure housing are evacuated and filled with either silicon oil or distilled water. As pressure on the bellows varies due to changes in the process medium, the variations are transmitted hydraulically through the capillary tubing to the transmitter or switch. The system capillary may be bent or looped in accordance with manufacturers instructions with no adverse effects upon system performance.

5.3.2 Analysis

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5.3.3 Summary

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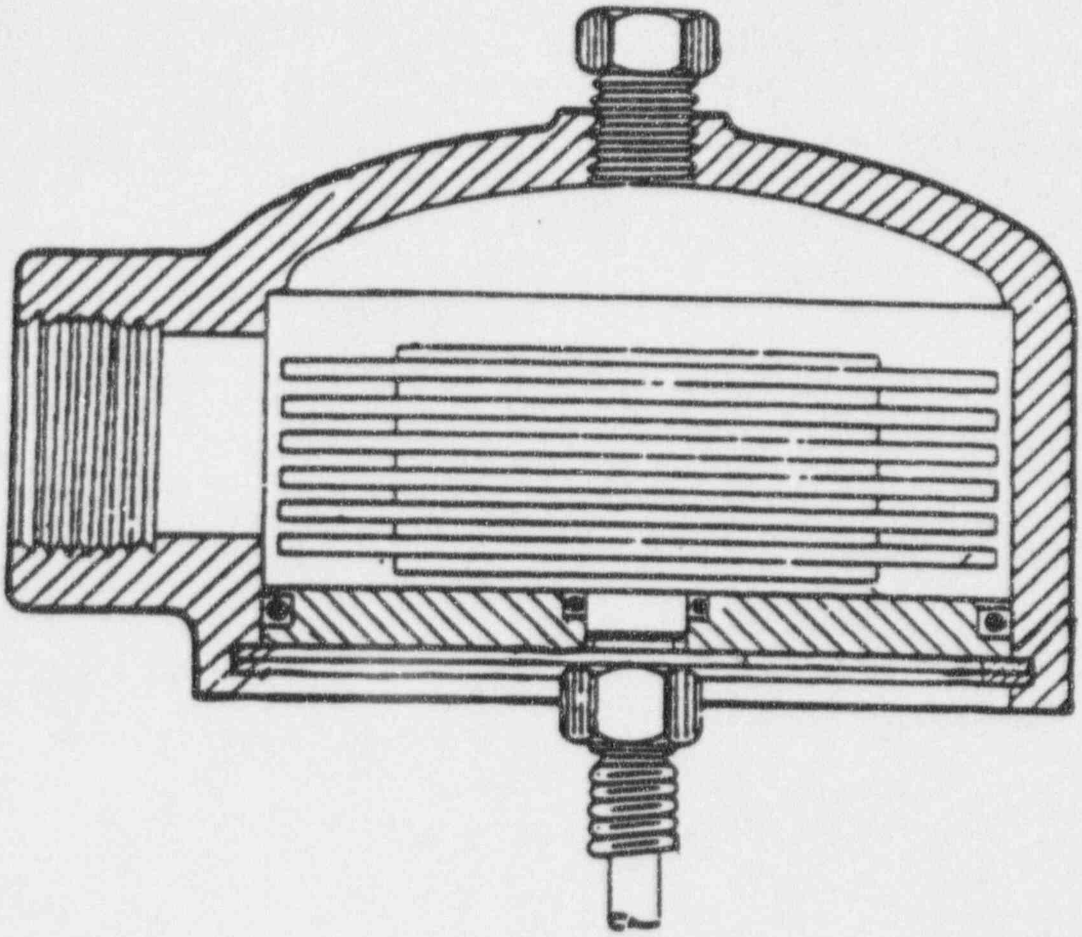

Figure 5.3-1
Typical Barton Model 351 Sensor Assembly

5.4 BARTON MODEL 763A SIMILARITY ANALYSIS REPORT

5.4.1 Description

The Barton Model 763A electronic pressure transmitter combines a gauge pressure transducer assembly with an electronic signal processing circuit contained within a transmitter housing as depicted in the block diagram of Figure 5.4-1.

The mechanical actuating device for the electronic transmitter is a C-type bourdon tube, elliptical in cross section and sealed at one end. The opposite end, which is open, is attached to the pressure source. A flexure (link wire) is attached to the free (sealed) end of the bourdon tube and connected to a metal cantilever beam. Bonded to opposite sides of the beam are (2) silicon piezo-resistive strain gauges. Increased internal pressure applied to the bourdon tube tends to straighten the tube, which in turn bends the cantilever beam proportionally and thus applies tension or compression to the strain gauges. The two strain gauges are connected to form two active arms of a resistive bridge circuit. The bridge output signal is conditioned and converted to loop current output signal by the transmitter's electronic circuit. The circuit is basically a loop current regulating device, where the loop current (4-20 mA or 10-50 mA) is controlled by the mechanical force or motion over the calibrated pressure range of the transmitter. Within the circuit, the transmitter power supply and load line connect in series. The current from the power supply enters the transmitter, passes through the reverse polarity diode, then divides into two separate paths. The main current flows through the current amplifier and returns to the loop. The remainder of the current passes through the electronic regulator where it again divides to take two separate paths: one to the strain gauge bridge network, the other to the signal amplifier. The bridge output signal is amplified by the signal amplifier which is an integrated circuit operational amplifier. The output voltage of the signal amplifier is the input for the current amplifier circuit which converts this voltage to current. The amount of current is precisely regulated with a feedback network to make it proportional to the bridge current. After passing through these respective stages, the total current flows through the load and back to the power supply.

5.4.2 Similarity Analysis

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5.4.3 Summary

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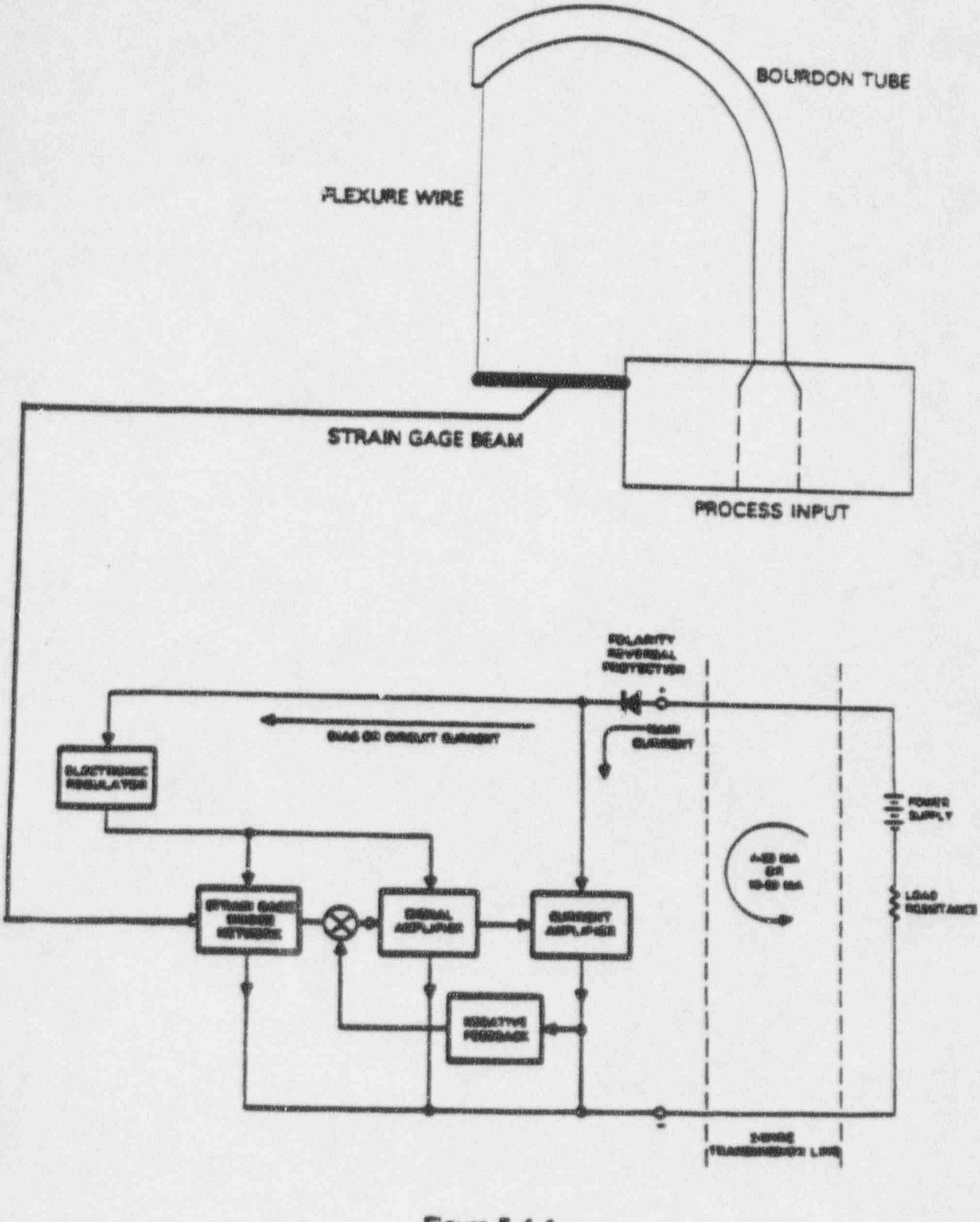

Figure 5.4-1
Barton Model 763A Block Diagram

5.5 FOXBORO MODEL E11GM SIMILARITY ANALYSIS REPORT

5.5.1 Description

The Foxboro Model E11GM is an electronic force-balance instrument that measures gauge pressure and transmits it as a proportional current signal. A block diagram of the transmitter is depicted in Figure 5.5-1. The pressure measured is applied to the inside of a bellows. The outer side of the bellows is vented to atmosphere, thus providing a gauge pressure reference. The pressure measured exerts a force on the bellows which is transmitted to the force bar. The force transmitted from the bellows is balanced by an opposing force from the feedback coil. Both of the forces act through the force bar and the vector flexure assembly. The diaphragm seal and point P act as fulcrums. Movement of the force bar produces a minute movement of the detector armature which changes the current flow in the detector secondary. This current is amplified and then applied simultaneously through the feedback coil and to the remainder of the instrument loop. The force on the feedback coil, generated by the current flow, balances the force on the bellows. The force balance is established by the output (loop) current which is therefore proportional to the pressure applied at the sensor bellows.

5.5.2 Similarity Analysis

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5.5.3 Summary

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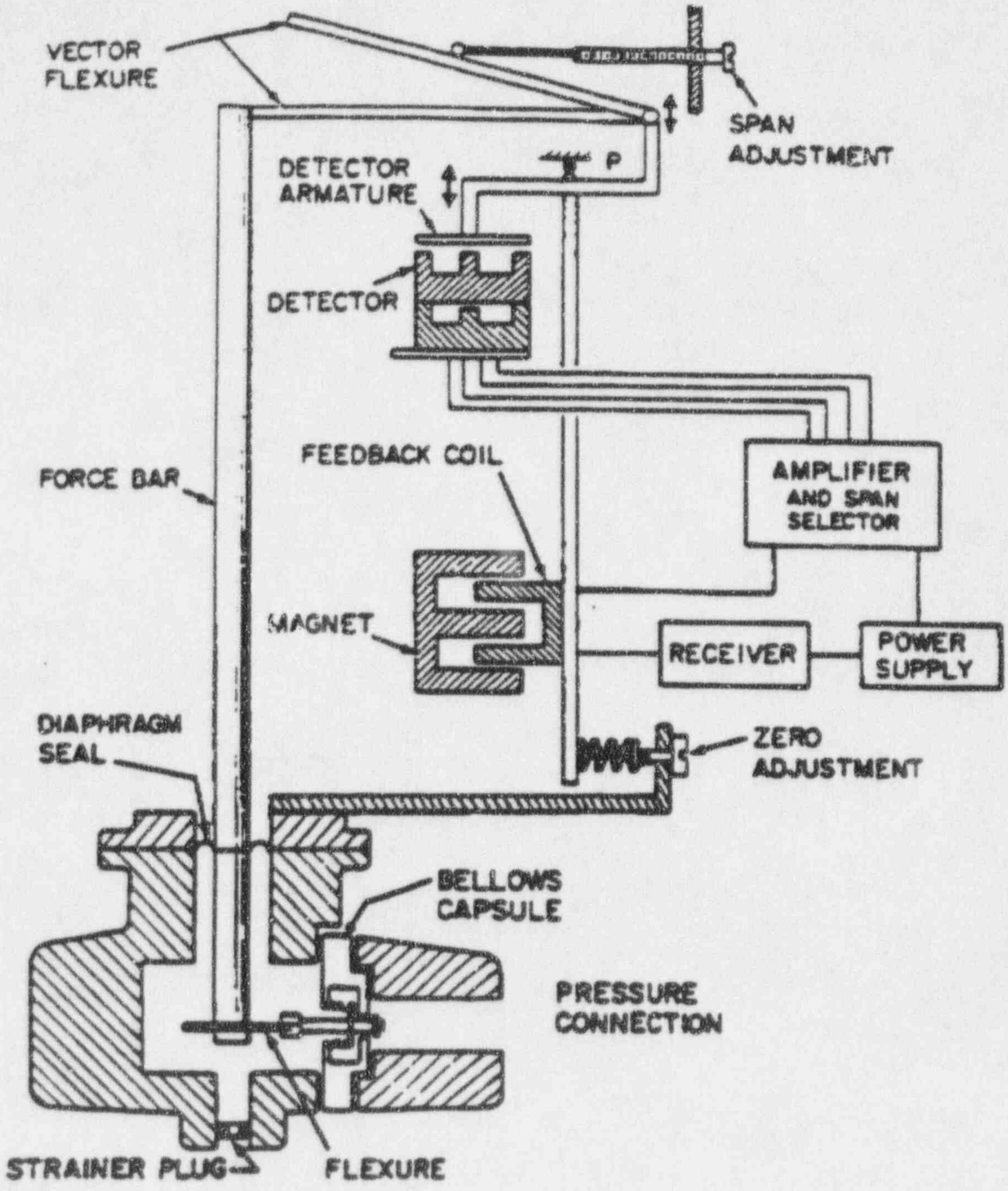

Figure 5.5-1
Foxboro Model E-11GM Block Diagram

5.6 FOXBORO/WEED MODEL N-E11AH SIMILARITY ANALYSIS REPORT

5.6.1 Description

The Foxboro/Weed Model N-E11AH is an electronic force-balance instrument that measures absolute pressure and transmits it as a proportional current signal. A block diagram of the transmitter is depicted in Figure 5.6-1. The pressure measured is applied to the inside of a bellows. The outer side of the bellows is evacuated, thus providing a zero absolute pressure reference. The pressure measured exerts a force on the bellows which is transmitted to the force bar. The force transmitted from the bellows is balanced by an opposing force from the feedback coil. Both of the forces act through the force bar and the vector flexure assembly. The diaphragm seal and point P act as fulcrums. Movement of the force bar produces a minute movement of the detector armature which changes the current flow in the detector secondary. This current is amplified and then applied simultaneously through the feedback coil and to the remainder of the instrument loop. The force on the feedback coil, generated by the current flow, balances the force on the bellows. The force balance is established by the output current which is therefore proportional to the absolute pressure applied at the sensors bellows.

5.6.2 Similarity Analysis

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5.6.3 Summary

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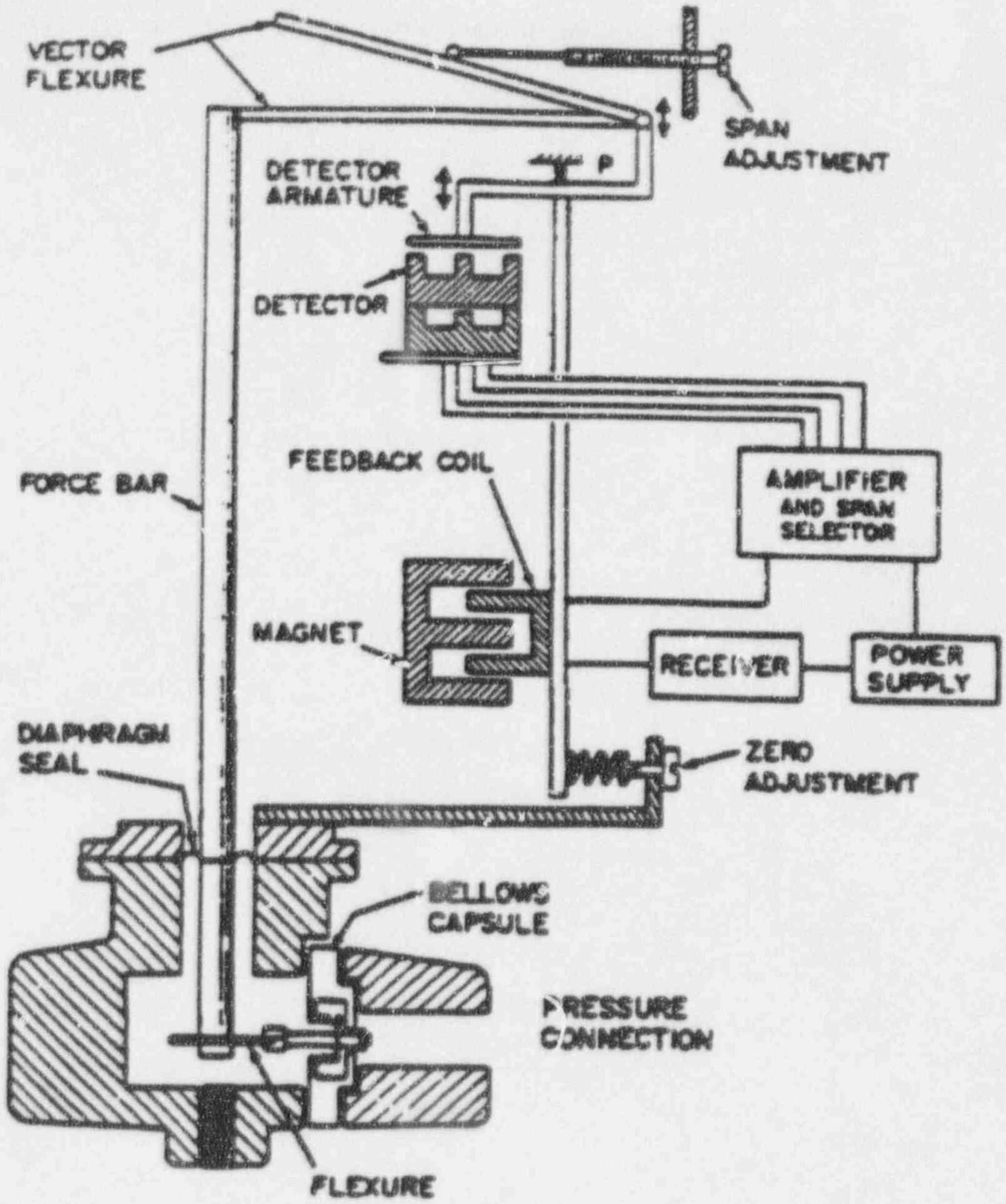


Figure 5.6-1
Foxboro Model N-E11AH Block Diagram

5.7 FOXBORO MODEL E13DH SIMILARITY ANALYSIS REPORT

5.7.1 Description

The Foxboro Model E13DH is an electronic force-balance instrument that measures differential pressure and transmits it as a proportional current signal. A block diagram of the transmitter is depicted in figure 5.7-1. The differential pressure measured is applied to opposite sides of a twin diaphragm capsule. The pressure measured exerts a force on the capsule which is transmitted to the force bar. The force transmitted from the capsule is balanced by an opposing force from the feedback coil. Both of the forces act through the force bar and the vector flexure assembly. The diaphragm seal and point P act as fulcrums. Movement of the force bar produces a minute movement of the detector armature which changes the current flow in the detector secondary. This current is amplified and then applied simultaneously through the feedback coil and to the remainder of the instrument loop. The force on the feedback coil, generated by the current flow, balances the force on the capsule. The force balance is established by the output (loop) current which is therefore proportional to the pressure applied at the sensor capsule.

5.7.2 Similarity Analysis

+a,c

5.7.3 Summary

+a,c

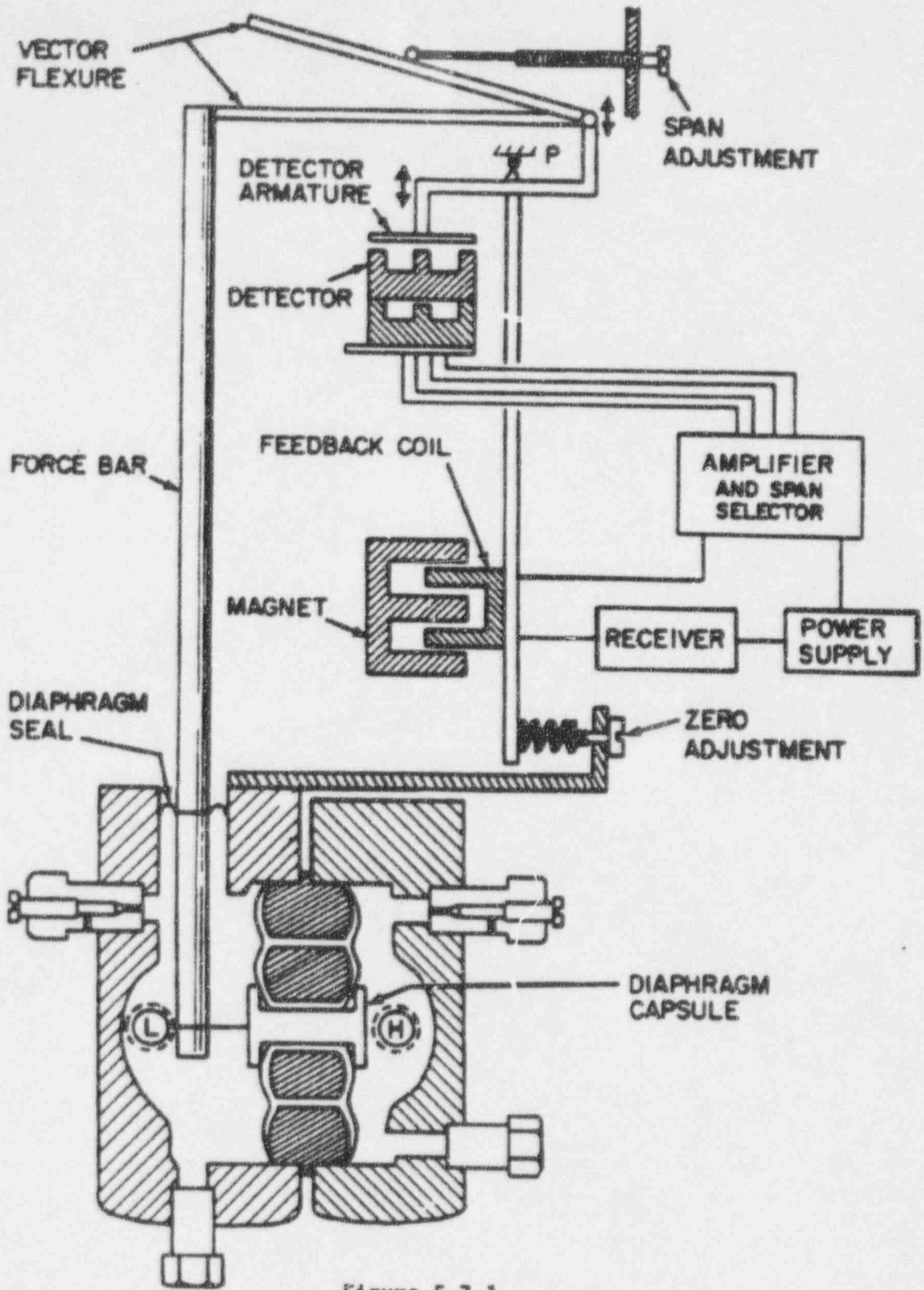


Figure 5.7-1

Foxboro Model E-13 DH Block Diagram

5.8 TOBAR MODEL 32DP2 SIMILARITY ANALYSIS REPORT

5.8.1 Description

The Tobar Model 32DP2 differential pressure transmitter combines a differential pressure transducer assembly with an electronic signal processing circuit contained within a transmitter housing as depicted in the block diagram of Figure 5.7-1.

The mechanical actuating device for the electronic transmitter is the differential pressure capsule containing a flexure on which a bridge network of strain sensitive resistive elements has been deposited. An outline of the model 32DP2 differential pressure capsule is depicted in Figure 5.7-2. The capsule measures the algebraic difference between the two pressures. Process pressure is applied through the pressure flanges to the capsule diaphragms. The diaphragms are positioned according to this algebraic difference. The high- and low-pressure diaphragms are connected by pushrods to the flexure which when flexed provides an electrical output via the strain sensitive resistive elements. The capsule assembly header contains hermetic feed-through leads to carry the strain gauge signals to the electronic signal processing circuit.

The signal processing circuit consists of the transmitter preamplifier and DC current output amplifier circuits. The flexure signal is the input to the temperature-stable operational preamplifier where it is amplified to an acceptable level and forwarded to the output current amplifier. The output current amplifier regulates the output loop current in proportion to the flexure signal which is proportional to the process differential pressure.

If an overpressure is applied, an o-ring within the diaphragm assembly seats against the capsule body. The fill fluid trapped between the diaphragm and capsule body will prevent further movement of the diaphragm. An integral stop shoulder on the pushrods prevents further movement of the flexure.

5.8.2 Similarity Analysis

+a,c

[ ]

+a,c

+a,c

[ ]

5.8.3 Summary

+a,c

[ ]

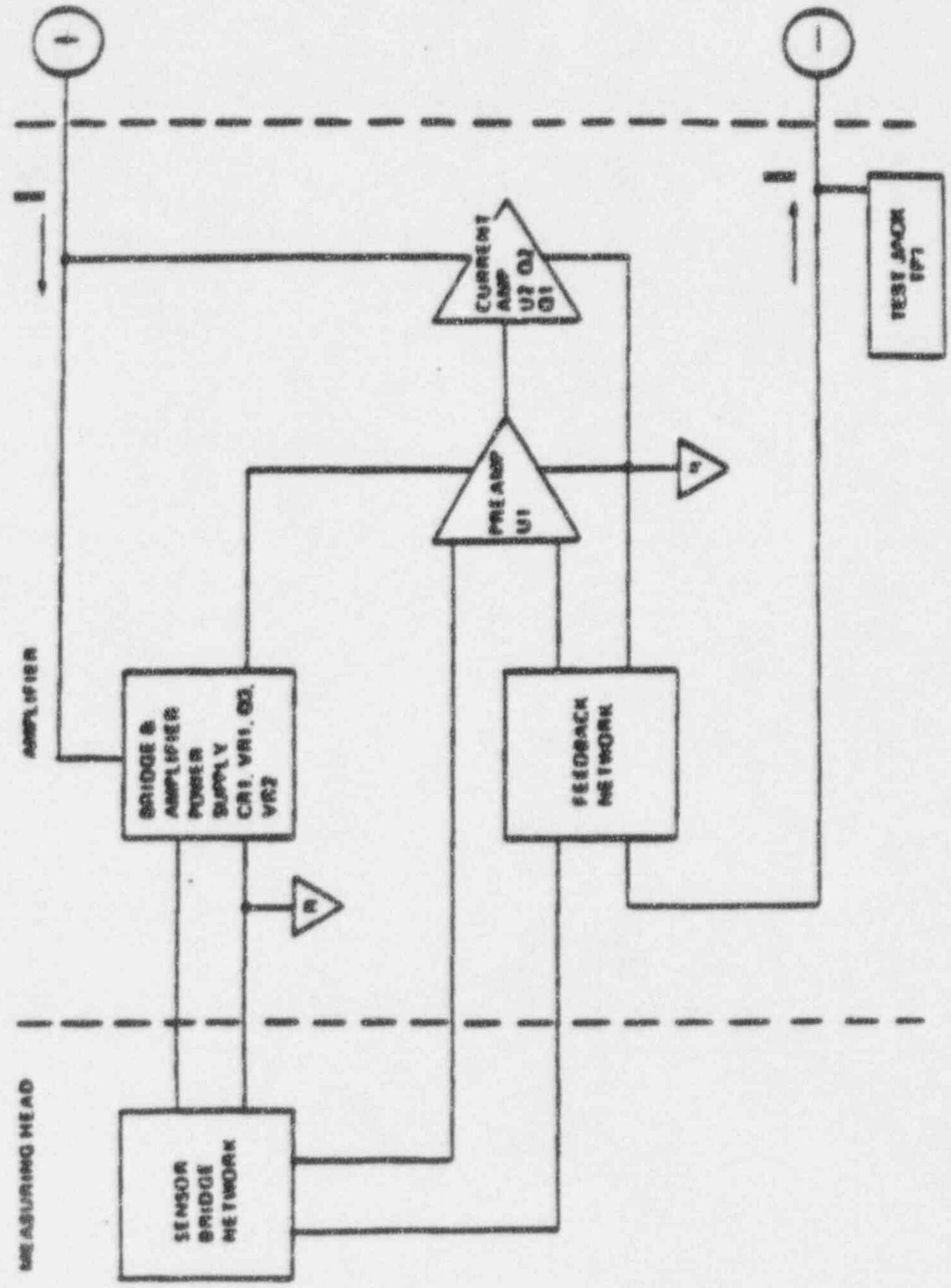


Figure 5.8-1

Tobar Model 32DP2 Amplifier Block Diagram

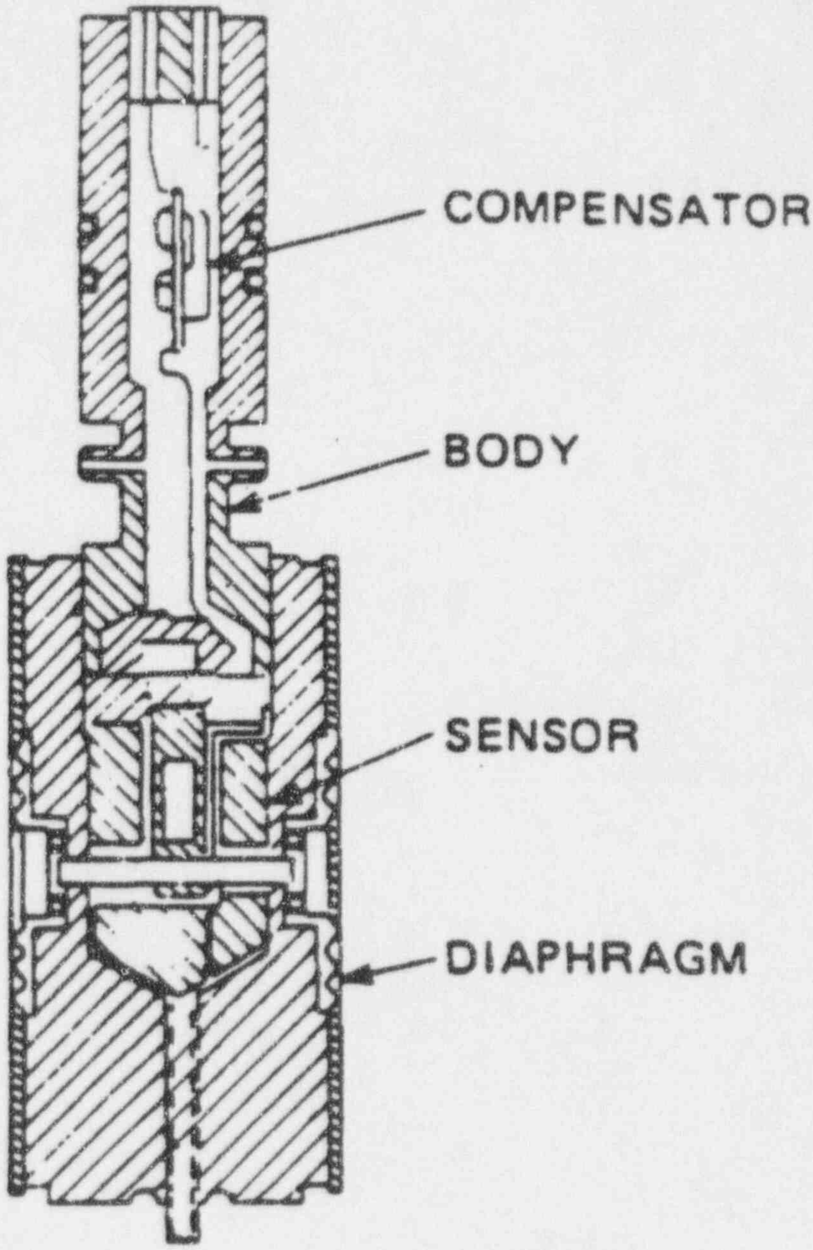


Figure 5.8-2

Tobar Model 32DP2 Capsule Assembly

5.9 TOBAR MODEL 32PA2 SIMILARITY ANALYSIS REPORT

5.9.1 Description

The Tobar Model 32PA2 absolute pressure transmitter combines an absolute pressure transducer assembly with an electronic signal processing circuit contained within a transmitter housing as depicted in the block diagram of Figure 5.8-1.

The mechanical actuating device for the electronic transmitter is a diaphragm capsule containing a flexure on which a bridge network of strain sensitive resistive elements has been deposited. An outline of the model 32PA2 pressure capsule is depicted in Figure 5.8-2. Process pressure is applied through a pressure flange to the capsule diaphragm which is mounted at one end of an evacuated chamber. The evacuated chamber provides the reference for absolute pressure measurement. The diaphragm strain is sensed directly by the capsule flexure which applies tension or compression to the bridge network strain gauges. The capsule assembly header contains hermetic feed-through leads to carry the strain gauge signals to the electronic signal processing circuit.

The signal processing circuit consists of the transmitter preamplifier and DC current output amplifier circuits. The flexure signal is the input to the temperature stable operational preamplifier where it is amplified to an acceptable level and forwarded to the output current amplifier. The output current amplifier regulates the output loop current in proportion to the flexure signal which is proportional to the process differential pressure.

5.9.2 Similarity Analysis

+a,c

+a,c

5.9.3 Summary

+a,c

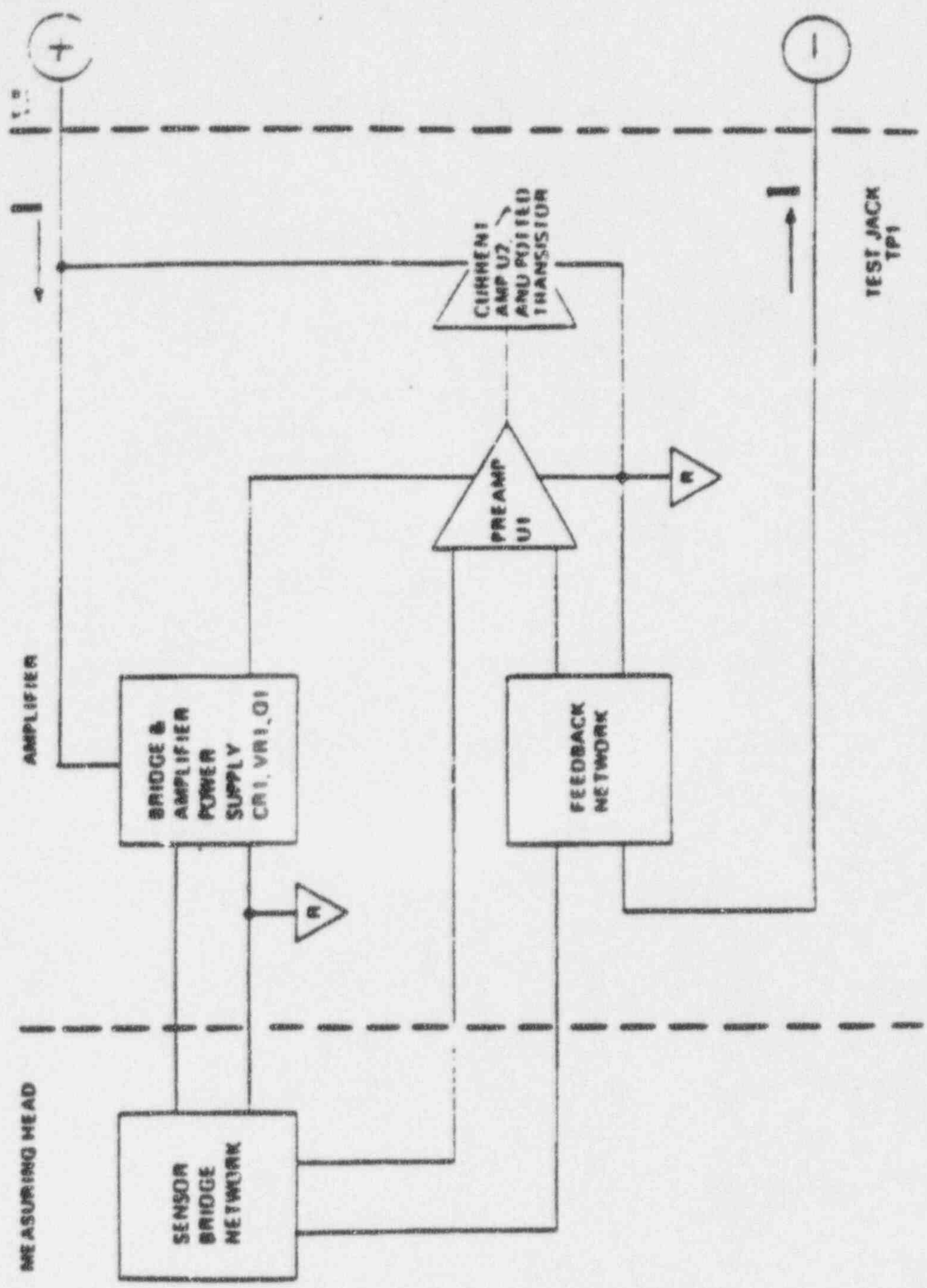


Figure 5.9-1

Tobar Model 32PA2 Amplifier Block Diagram

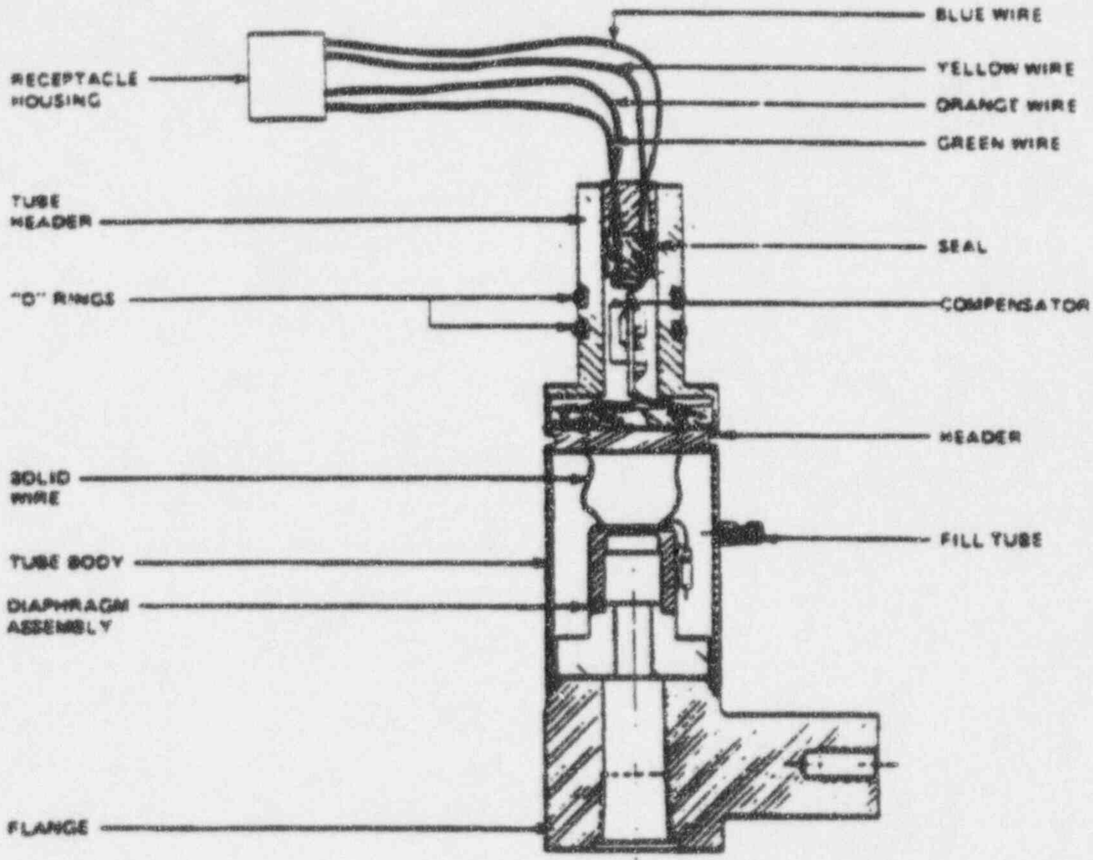


Figure 5.9-2

Tobar Model 32PA2 Capsule Assembly

5.10 VERITRAK MODEL 76DP1 SIMILARITY ANALYSIS REPORT

5.10.1 Description

The Veritrak Model 76DP1 differential pressure transmitter combines a differential pressure transducer assembly with an electronic signal processing circuit contained within a transmitter housing as depicted in the block diagram of Figure 5.9-1.

The mechanical actuating device for the electronic transmitter is the differential pressure capsule containing a flexure on which a bridge network of strain sensitive resistive elements has been deposited. An outline of the model 76DP1 differential pressure capsule is depicted in Figure 5.9-2. The capsule measures the algebraic difference between the two pressures. Process pressure is applied through the pressure flanges to the capsule diaphragms. The diaphragms are positioned according to this algebraic difference. The high- and low-pressure diaphragms are connected by push rods to the flexure which when flexed provides an electrical output via the strain sensitive resistive elements. The capsule assembly header contains hermetic feed-through leads to carry the strain gauge signals to the electronics signal processing circuit.

The signal processing circuit consists of the transmitter preamplifier and DC current output amplifier circuits. The flexure signal is the input to the temperature stable operational preamplifier where it is amplified to an acceptable level and forwarded to the output current amplifier. The output current amplifier regulates the output loop current in proportion to the flexure signal which is proportional to the process differential pressure.

If an overpressure is applied, an o-ring within the diaphragm assembly seats against the capsule body. The fill fluid trapped between the diaphragm and capsule body will prevent further movement of the diaphragm. An integral stop shoulder on the pushrods prevents further movement of the flexure.

5.10.2 Similarity Analysis

+a,c

[ ]

+a,c

+a,c

[ ]

5.10.3 Summary

+a,c

[ ]

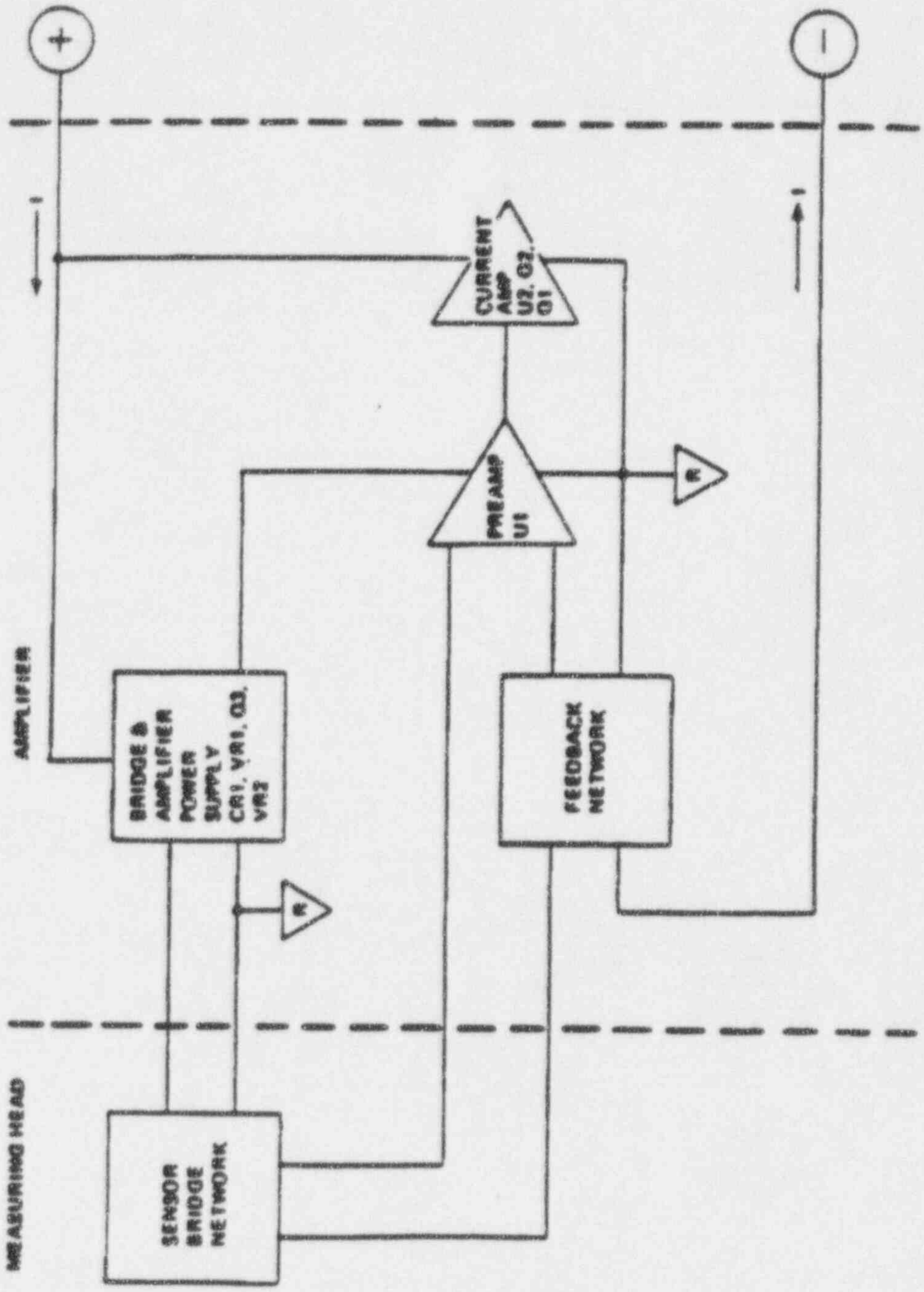


Figure 5.10-1

Veritrac Model 76DP1 Amplifier Block Diagram

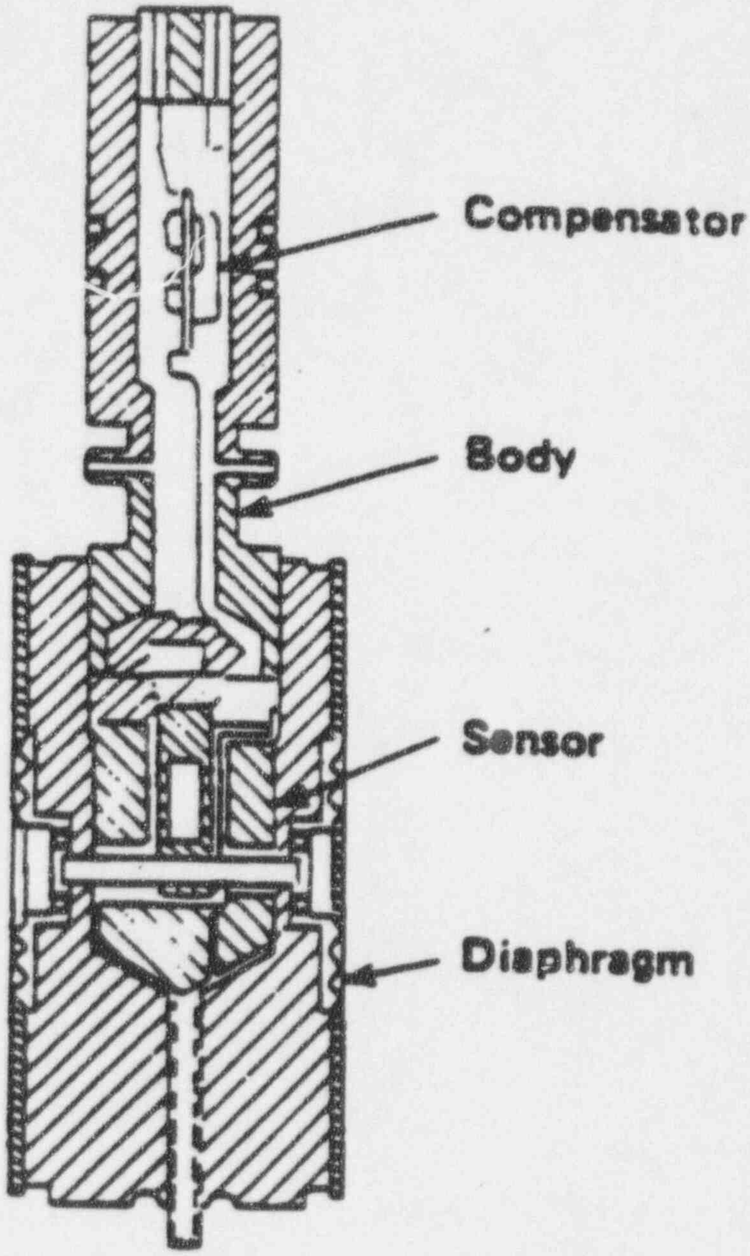


Figure 5.10-2

Veritrac Model 76PA1 Capsule Assembly

5.11 VERITRAK MODEL 76PG1 SIMILARITY ANALYSIS REPORT

5.11.1 Description

The Veritrak Model 76PG1 gauge pressure transmitter combines a pressure transducer assembly with an electronic signal-processing circuit contained within a transmitter housing as depicted in the block diagram of Figure 5.10-1.

The mechanical actuating device for the electronic transmitter is a diaphragm capsule containing a flexure on which a bridge network of strain sensitive resistive elements has been deposited. An outline of the model 76PG1 pressure capsule is depicted in Figure 5.10-2. Process pressure is applied through a pressure flange to the capsule diaphragm. The process pressure strains the capsule sensor against the capsule spring rate. The diaphragm strain is sensed directly by the capsule flexure which applies tension or compression to the bridge network strain gauges. The capsule assembly header contains hermetic feed through leads to carry the strain gauge signals to the electronics signal processing circuit.

The signal processing circuit consists of the transmitter preamplifier and DC current output amplifier circuits. The flexure signal is the input to the temperature-stable operational preamplifier where it is amplified to an acceptable level and forwarded to the output current amplifier. The output current amplifier regulates the output loop current in proportion to the flexure signal which is proportional to the process pressure.

5.11.2 Similarity Analysis

+a,c

+a,c

5.11.3 Summary

+a,c

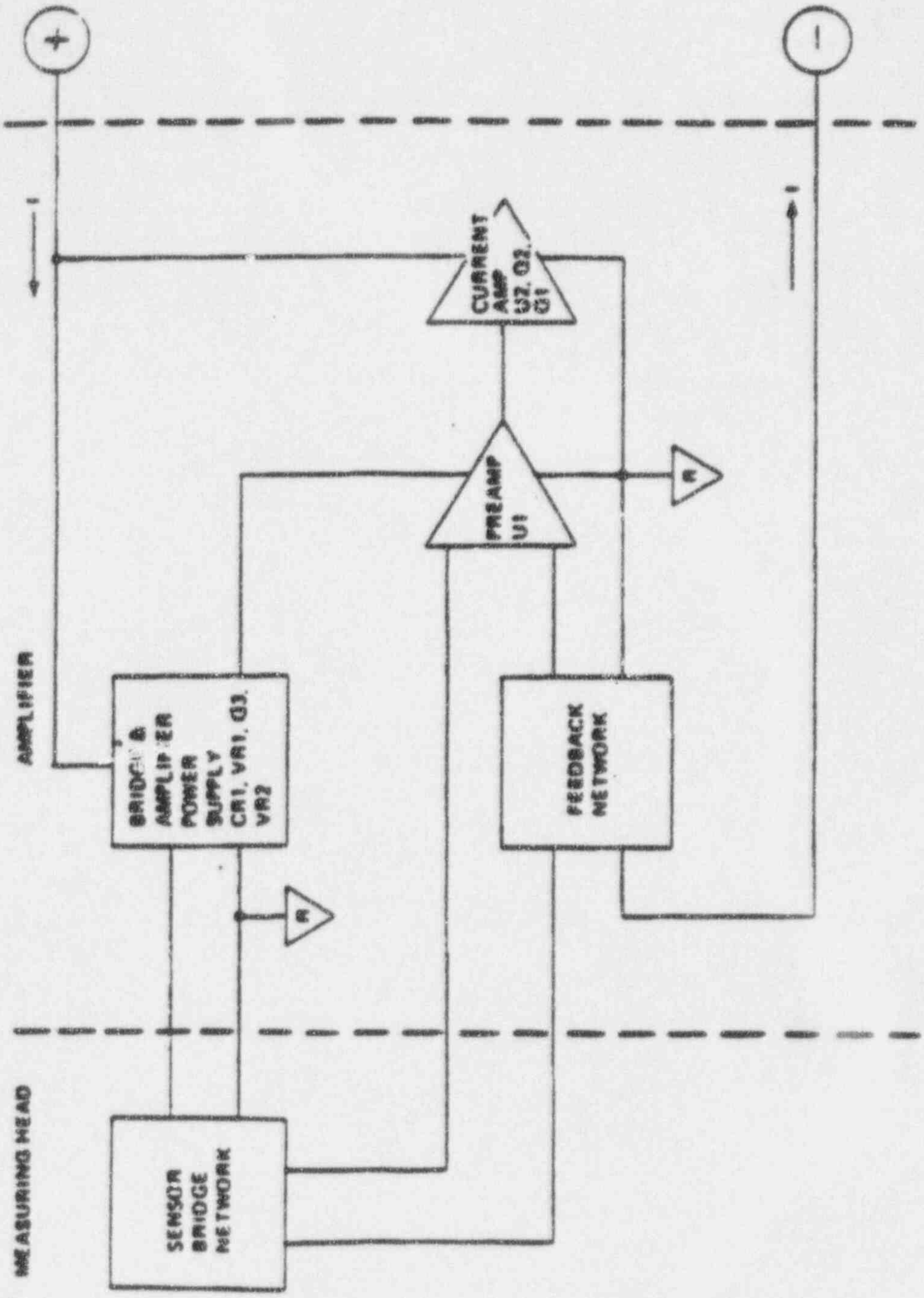


Figure 5.11-1

Veritrac Model 76PG1 Amplifier Block Diagram

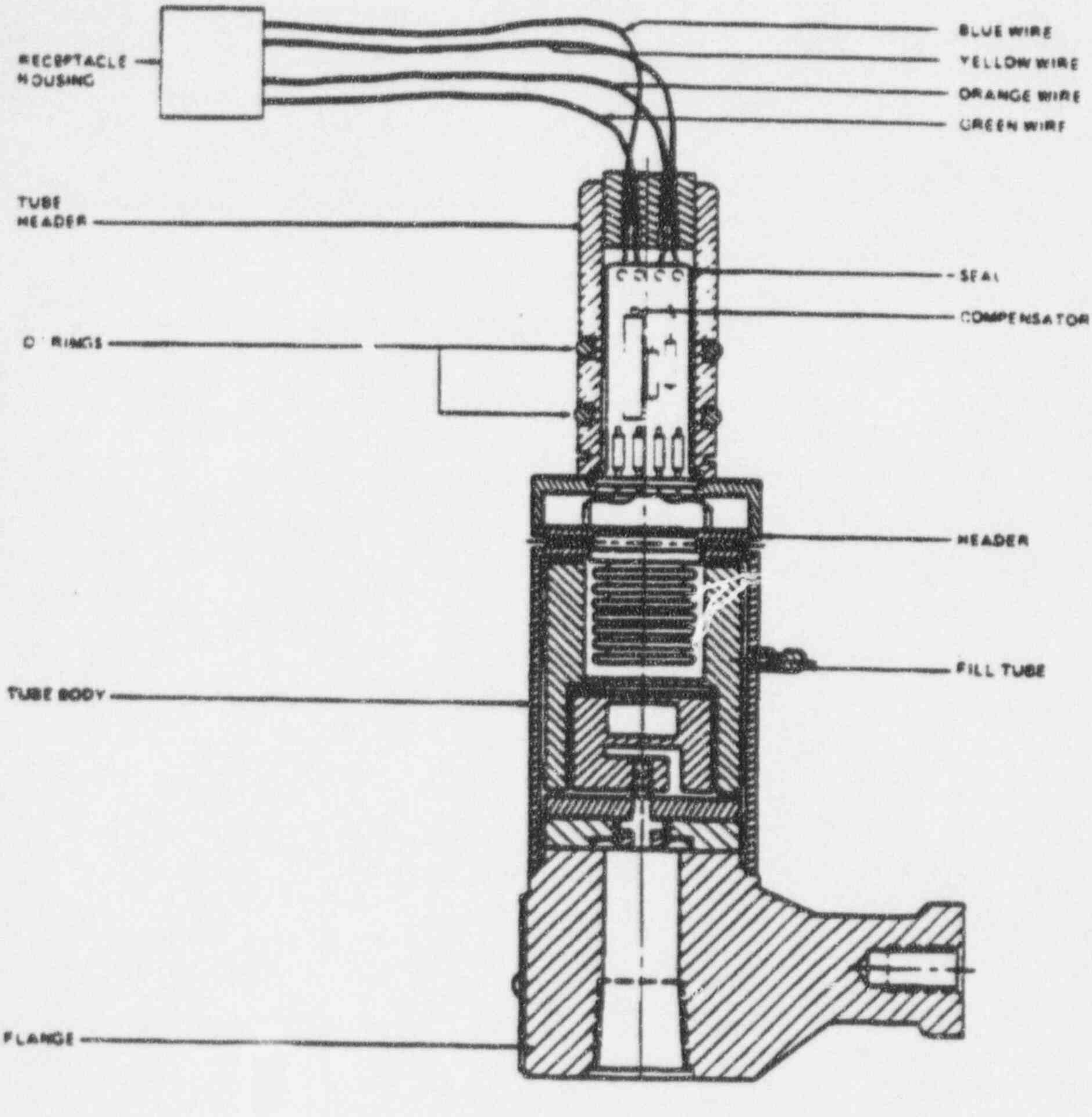


Figure 5.11-2

Veritrac Model 76PG1 Capsule Assembly

5.12 VERITRAK MODEL 76PH2 SIMILARITY ANALYSIS REPORT

5.12.1 Description

The Veritrak Model 76PH2 absolute pressure transmitter combines an absolute pressure transducer assembly with an electronic signal processing circuit contained within a transmitter housing as depicted in the block diagram of Figure 5.11-1.

The mechanical actuating device for the electronic transmitter is a diaphragm capsule containing a flexure on which a bridge network of strain sensitive resistive elements has been deposited. An outline of the model 76PH2 pressure capsule is depicted in Figure 5.11-2. Process pressure is applied through a pressure flange to the capsule diaphragm which is mounted at one end of an evacuated chamber. The evacuated chamber provides the reference for absolute pressure measurement. The diaphragm strain is sensed directly by the capsule flexure which applies tension or compression to the bridge network strain gauges. The capsule assembly header contains hermetic feed-through leads to carry the strain gauge signals to the electronics signal processing circuit.

The signal processing circuit consists of a chopper-stabilized AC strain gauge amplifier which converts the strain gauge signal to a standard 4-20 mA output proportional to the absolute pressure that has been measured. A low-level error signal is generated by the strain gauge bridge and feedback resistive networks and is the input for the chopper circuit. The chopper circuit converts this error to an AC signal which is passed to the dual JFET AC amplifier circuit. The signal is amplified and sent to the demodulator circuit where it is rectified to a DC signal and filtered to provide the drive for the output current buffer stage transistors. The output buffer stage provides a regulated DC current that is proportional to the input pressure of the transmitter. An oscillator is used to provide a synchronous drive for both the chopper and demodulator circuits.

5.12.2 Similarity Analysis

+a,c

+a,c

5.12.3 Summary

+a,c

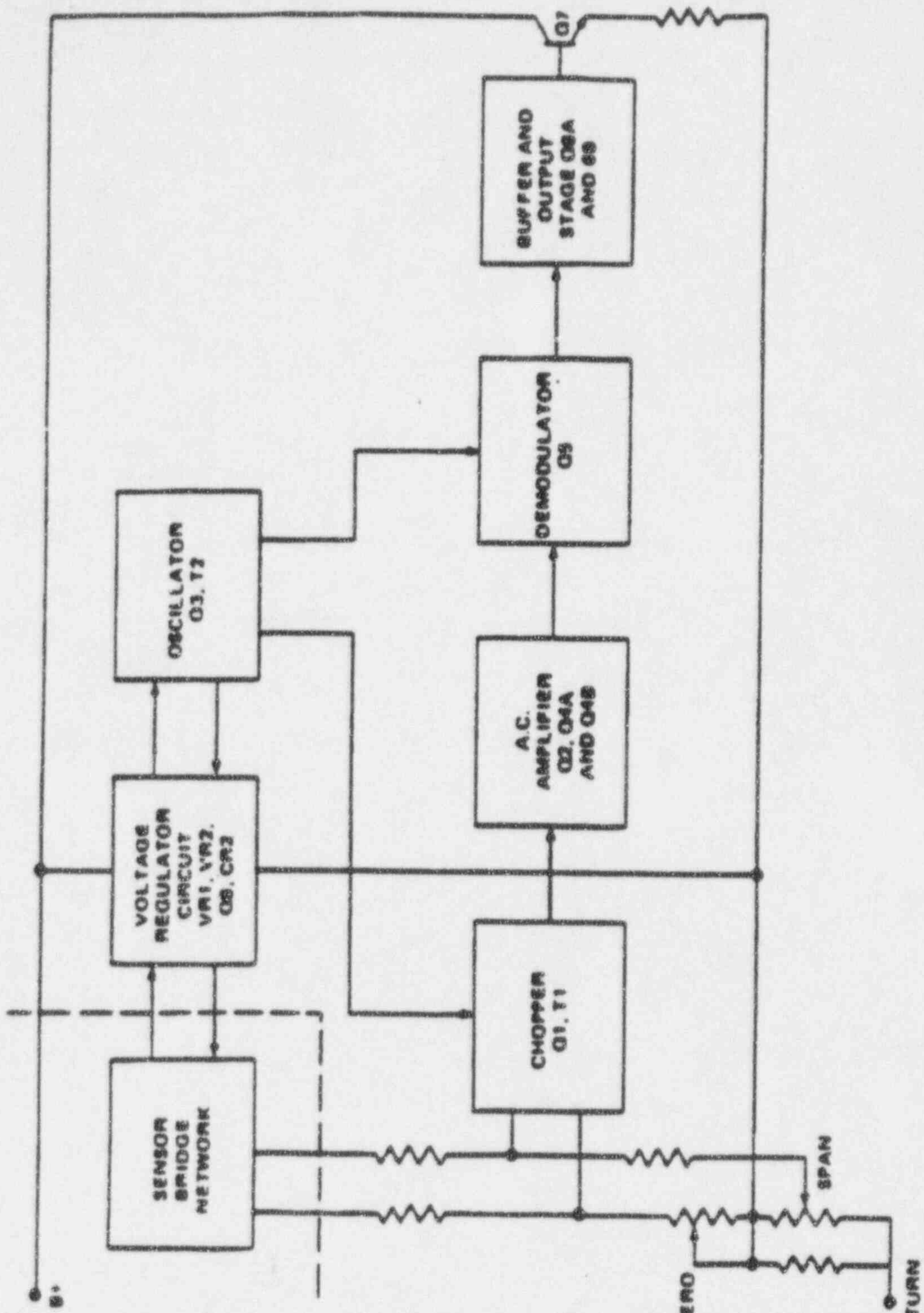


Figure 5.12-1

Veritrac Model 76PH2 AC Amplifier Block Diagram

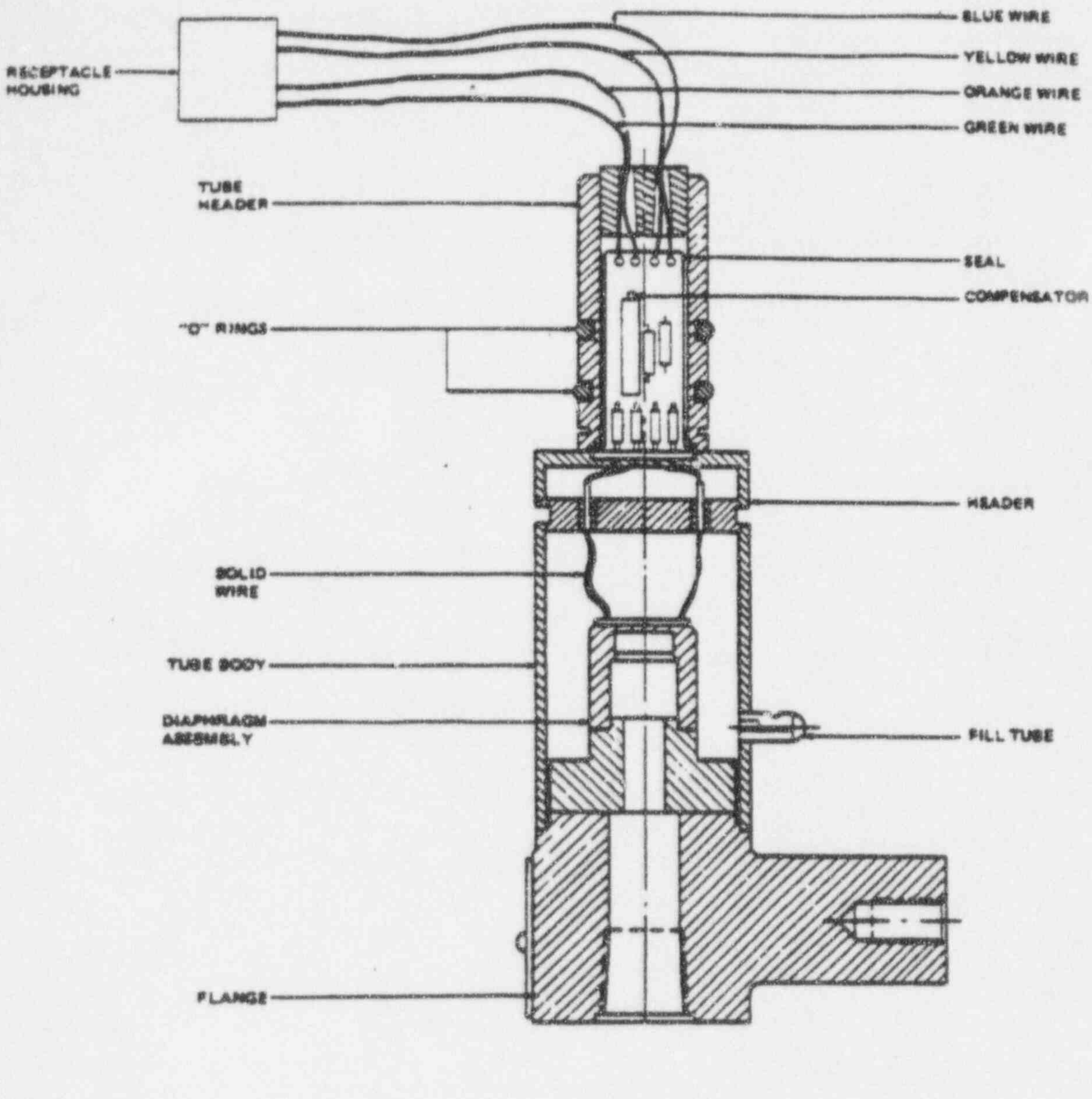


Figure 5.12-2

Veritrac Model 76PH2 Capsule Assembly

6.0 Safety Benefits

Reduction in the amount of response time testing requirements results in improvement in plant safety by:

- Increasing the availability of equipment. The response time tests typically require that instruments be removed from service in order to perform the test. The time period can range several hours to several days depending on the type of test. By eliminating or reducing unnecessary testing, the plant safety is improved.

- Decreasing the possibility of unwanted engineered safety features actuations. Some of the testing requires that equipment be placed in the trip condition. Improper return to service or other malfunctions that occur while testing may lead to plant trips or inadvertent actuation of equipment. By eliminating or reducing unnecessary testing, the plant safety is improved.

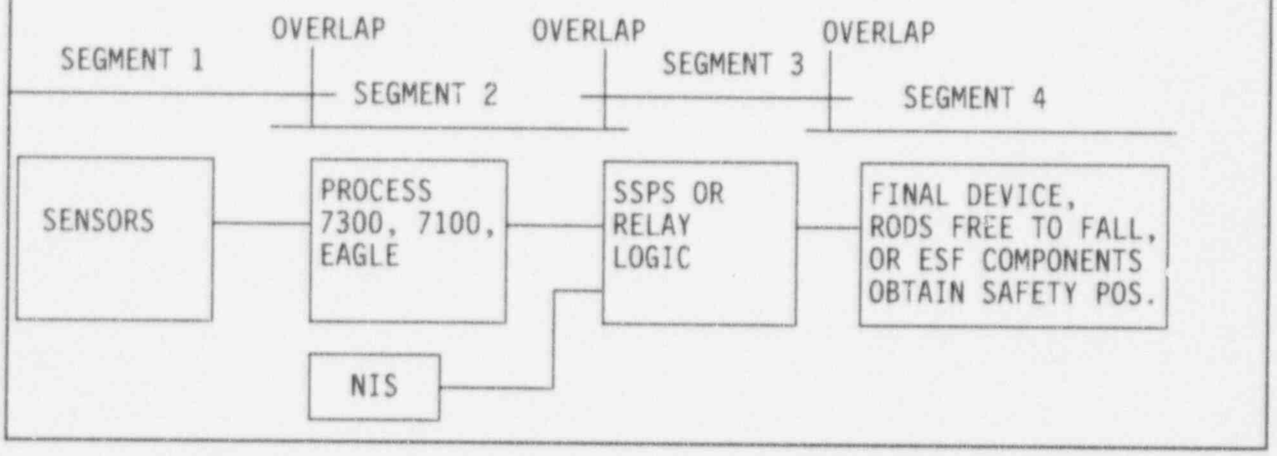
- Decreasing radiation exposure. Sensors are typically located in radiation areas to minimize the sensing line lengths. Eliminating unnecessary testing on these sensors reduces exposures consistent with the guidelines of ALARA.

7.0 Cost Benefits

The EPRI report data indicated that RTT was both resource and exposure (ALARA) intensive. The process noise method of RTT for pressure sensors is often performed by an outside vendor (AMS or Westinghouse) and can cost $30K - $45K per unit per outage for a 4 loop plant (based on recent bids at Zion and Braidwood Stations). The hydraulic ramp generator test method of RTT, an alternate method to process noise and the usual method for those pressure transmitters with no process noise, can take up to 24 hours per transmitter to perform (based on procedures used at Braidwood Station). An individual utility cost saving would depend on the test method(s) and plant procedures used and whether or not an outside vendor is used for some or all of the work.

The overall response time of a channel is generally obtained by combining the times from the Segments shown below:

FIGURE 1



The manpower required to do response time testing on Segments 1, 2, and 3 shown above is estimated by the WOG to be between 900 and 2000 manhours.

Both the BWR Owners Group and EPRI estimated that the manpower required to do this response time testing could range between 1500 and 2600 manhours.

Using a conservative estimate, shown below, one can see a significant utility cost savings.

Manhours	900	(per 18 month cycle)
Cost/hr	$24.00	(includes benefits)
Success Rate*	75%	

900 hrs x $24.00/hr x 75% = $16,200.00

* Percent of total hours for RTT surveillance requirements eliminated

8.0 Safety Assessment For Increased Response Times Beyond Current Technical Specification Limits

The WOG programs outlined in Section 1.0 demonstrate the capability of the calibration surveillance to detect failures that would affect response time on sensors, signal conditioning, and logic equipment. Typical allowances include 400 milliseconds for differential pressure sensors, 200 milliseconds for pressure sensors, and 100 milliseconds each for the signal conditioning and logic. For most applications significant information exists in the form of test data from manufacturers and from the industry that pressure and differential pressure sensors have response times that could be a factor of ten below these allowances. In addition, FMEAs (with test verification) have been performed on the signal conditioning and logic portions of the Westinghouse instrumentation and have shown with reasonable assurance that response times of the signal conditioning will not increase above the 200 milliseconds allowance. Summing of the above more conservative response times results in total response times well within the values allowed in the Technical Specifications.

However, as added assurance, a maximum incredible response time for each reactor trip function was calculated by increasing the sensor, signal conditioning, and logic each by a factor of five and applying the root mean square method since the degradation of response time of each portion of the system would be independent. The results of the root mean square method show that containment pressure measurement response time matches the Technical Specification and for level and flow functions, which utilize differential pressure transmitters, the highest response time calculated was 2.4 seconds. In all cases, even without applying the root mean square method, the response time obtained for functions with pressure transmitters was still below the Technical Specification value.

Engineered Safety Features response times, where the required response time corresponds to the diesel start time, are excluded from surveillance by NRC Generic Letter 93-05. Since LOCA and steamline break analyses utilize pressure and containment pressure measurements as primary functions and the SGTR analyses is conservatively performed assuming no delay, the only potential impact to the safety analyses results involves transients that credit level and flow measurements as primary reactor trips or ESF functions with response times less than the diesel start time.

- Low reactor coolant flow reactor trip is credited in the partial loss of flow analysis and the locked rotor event. With the margins assumed, the response time would increase from 1.0 to 2.4 seconds.
    - The partial loss of flow event is bounded by the complete loss of flow analysis in terms of consequences and would continue to be bounded even with the projected time response increase. This more limiting event satisfies condition II criteria of no fuel failure.

8.0 Safety Assessment For Increased Response Times Beyond Current Technical Specification Limits (continued)

- The locked rotor event is classified as a condition IV event that allows fuel failure to occur. With the projected increased response time, better estimate assumptions (e.g. consistent power shape in the transient reactivity feedback and DNBR analysis, actual moderator temperature coefficient) would yield similar results. The peak reactor coolant system pressure is expected to increase less than 2.0% and the maximum clad temperature and $ZR-H_2O$ reaction criteria would not be exceeded.

- High steam generator water level ESF functions are credited in the feedwater malfunction event. With the margins assumed including a .25 second turbine stop valve closure time, the response time would still be below the Technical Specification value.

- Lo-lo steam generator water level reactor trip is used in the loss of normal feedwater/station blackout event, the feedline break even, the loss of load/turbine trip event, and the determination of mass/energy release outside containment. With the margins assumed, the response time would increase from 2.0 to 2.4 seconds. This trip function is not required for protection for a DNB condition, so no fuel failure would be expected due to the projected increase in response time. The effect of the increased response time on the DNB transient, pressurizer overfill, reactor coolant system subcooling, and the results of the mass/energy release outside containment would be negligible.

9.0 Program Methodology

Each sensor that has been identified as a candidate for elimination of periodic response time testing requirements is listed in Table 9-1. The response time to be allocated in place of response times obtained through actual measurement during the period of verification may be obtained from: (1) historical records based on acceptable response time tests (hydraulic, noise, or power interrupt tests), (2) inplace, onsite, or offsite (e.g. vendor) test measurements, or (3) utilizing vendor engineering specifications. There is no specific recommendation, although the value will be increasingly more conservative progressing through these methods. Available values have been incorporated into the table. An explanation for use of Table 9-1 is provided below.

1. Determine the type of sensor being used for each reactor trip or engineered safety features function that requires periodic response time verification per the plant Technical Specifications.

2. Verify that these sensors are included in Table 9-1.

3. Obtain the sensor response time from Table 9-1. If the sensor response time is not provided in the Table, then neither the manufacturer nor Westinghouse currently provide this information. Fill in the Baseline column using the most conservative data obtained from either previous plant insitu response time testing or, if replacing the transmitter, the response time obtained through testing.

4. Ensure that the plant test procedures are written such that the sensor response time is accounted for separately from the rest of the protection channel. (If this is not the case, incorrect overall times may be obtained because Table 9-1 values only account for the sensor portion of the protection channel.)

5. Incorporate the sensor response time acceptance criteria in the plant procedures.

6. Obtain the response time for the remainder of the reactor trip or engineered safety features function.

7. Add the sensor response time to the response time for the remainder of the protection channel and verify that the total is less than the value for that function given in the plant Technical Specifications or FSAR.

Table 9-1
Sensor Response Times

Manufacturer	Model Number	Description	Response Time		
			Baseline (1)	Manufacturer Supplied	Westinghouse E Spec
BARTON	288	Differential Pressure Indicating Switch			
BARTON	289	Differential Pressure Indicating Switch			
BARTON	332	Differential Pressure Transmitter			
BARTON	351	Sealed Sensor			1 sec
BARTON	752	Differential Pressure Transmitter		30 msec	400 msec
BARTON	763	Gauge Pressure Transmitter		180 msec	200 msec
BARTON	763A	Gauge Pressure Transmitter		180 msec	200 msec
BARTON	764	Differential Pressure Transmitter		180 msec	400 msec
FOXBORO	E11GM	Gauge Pressure Transmitter			
FOXBORO/WEED	N-E11AH	Absolute Pressure Transmitter			
FOXBORO/WEED	N-E11DM	Differential Pressure Transmitter			
FOXBORO/WEED	N-E11GH	Gauge Pressure Transmitter			
FOXBORO/WEED	N-E11GM	Gauge Pressure Transmitter			
FOXBORO	E13DH	Differential Pressure Transmitter			
FOXBORO/WEED	N-E13DH	Differential Pressure Transmitter			
FOXBORO/WEED	N-E13DM	Differential Pressure Transmitter			

(1) Utilize the most conservative value for response time obtained from either previous plant insitu response time testing or, if replacing the transmitter, the response time obtained through testing.

	Response Time

Table 9-1
Sensor Response Times

Manufacturer	Model Number	Description	Baseline (1)	Manufacturer Supplied	Westinghouse E Spec
ROSEMOUNT	1151	Pressure Transmitter			
ROSEMOUNT	1152	Pressure Transmitter			
ROSEMOUNT	1153	Pressure Transmitter			
ROSEMOUNT	1154	Pressure Transmitter			
ROSEMOUNT	1151	Differential Pressure Transmitter			
ROSEMOUNT	1152	Differential Pressure Transmitter			
ROSEMOUNT	1153	Differential Pressure Transmitter			
ROSEMOUNT	1154	Differential Pressure Transmitter			
TOBAR	32DP1	Differential Pressure Transmitter			400 msec
TOBAR	32DP2	Differential Pressure Transmitter			400 msec
TOBAR	32PA1	Absolute Pressure Transmitter			200 msec
TOBAR	32PA2	Absolute Pressure Transmitter			200 msec
TOBAR	32PG1	Gauge Pressure Transmitter			200 msec
VERITRAK	76DP1	Differential Pressure Transmitter			400 msec
VERITRAK	76PG1	Gauge Pressure Transmitter			200 msec
VERITRAK	76PH2	Absolute Pressure Transmitter			200 msec

(1) Utilize the most conservative value for response time obtained from either previous plant insitu response time testing or, if replacing the transmitter, the response time obtained through testing.

10.0 Technical Specifications

Appendix A contains a markup of the recommended Technical Specifications to be used when eliminating the requirements for actual measurement of response times on Reactor Trip and Engineered Safety Features Systems. This change does not represent a significant hazard to the public as evaluated in accordance with the requirements of 10 CFR 50.92. See Appendix B.

11.0 CONCLUSIONS

EPRI Report NP-7243 Revision 1, "Investigation of Response Time Testing Requirements" shows that response time testing is redundant to other routine tests because component failures that impact sensor response time will be detectable by other tests. By utilizing the FMEA results and the recommendations of the EPRI Report, justification is established for eliminating periodic response time testing surveillance requirements for the pressure and differential pressure sensors covered by that report. Justification for eliminating additional sensors has been documented by this WCAP by showing similarity to those sensors included in the EPRI report. Where similarity could not be shown, FMEA or testing demonstrated that the time response would not be significantly effected by degradation of components or that such changes would be detectable by normal calibration procedures. All sensors that have been justified by the above methods appear in Table 9-1.

12.0 REFERENCES

1. EPRI NP-7243, May 1991, "Investigation of Response Time Testing Requirements". Revision 1 pages for the report were issued on March 18, 1994.

2. EPRI TR-103436, Volume 2, "Instrument Calibration and Monitoring Program - Failure Modes and Effects Analysis".

3. WCAP 14036, Nov. 1994, "Elimination of Periodic Protection Channel Response Time Tests".

APPENDIX A

Docket No. 50-445
August 14, 1987

3/4.3.1 REACTOR TRIP SYSTEM INSTRUMENTATION

LIMITING CONDITION FOR OPERATION

3.3.1 As a minimum, the Reactor Trip System instrumentation channels and interlocks of Table 3.3-1 shall be OPERABLE with RESPONSE TIMES as shown in Table 3.3-2.

APPLICABILITY: As shown in Table 3.3-1.

ACTION:

As shown in Table 3.3-1.

SURVEILLANCE REQUIREMENTS

4.3.1.1 Each Reactor Trip System instrumentation channel and interlock and the automatic trip logic shall be demonstrated OPERABLE by the performance of the Reactor Trip System Instrumentation Surveillance Requirements specified in Table 4.3-1.

4.3.1.2 The REACTOR TRIP SYSTEM RESPONSE TIME of each Reactor trip function shall be ~~demonstrated~~ to be within its limit at least once per 18 months. Each ~~test~~ shall include at least one train such that both trains are ~~tested~~ at least once per 36 months and one channel per function such that all channels are ~~tested~~ at least once every N times 18 months where N is the total number of redundant channels in a specific Reactor trip function as shown in the "Total No. of Channels" column of Table 3.3-1.

verification   verified   verified

MUHP-3040 Revision 1
WCAP-13787 Revision 2 8/01/95

INSTRUMENTATION

Docket No. 50-445
August 14, 1987

SURVEILLANCE REQUIREMENTS

4.3.2.1 Each ESFAS instrumentation channel and interlock and the automatic actuation logic and relays shall be demonstrated OPERABLE by performance of the ESFAS Instrumentation Surveillance Requirements specified in Table 4.3-2.

4.3.2.2 The ENGINEERED SAFETY FEATURES RESPONSE TIME of each ESFAS function shall be ~~demonstrated~~ to be within the limit at least once per 18 months. ~~Each test~~ shall include at least one train such that both trains are ~~tested~~ at least once per 36 months and one channel per function such that all channels are ~~tested~~ at least once per N times 18 months where N is the total number of redundant channels in a specific ESFAS function as shown in the "Total No. of Channels" column of Table 3.3-3.

verification   verified   verified

APPENDIX A

REACTOR TRIP SYSTEM and ENGINEERED SAFETY FEATURES ACTUATION SYSTEM INSTRUMENTATION (Continued)

the sensor from its calibration point or the value specified in Table 3.3-4, in percent span, from the analysis assumptions. Use of Equation 3.3-1 allows for a sensor draft factor, an increased rack drift factor, and provides a threshold value for REPORTABLE EVENTS.

The methodology to derive the Trip Setpoints is based upon combining all of the uncertainties in the channels. Inherent to the determination of the Trip Setpoints are the magnitudes of these channel uncertainties. Sensor and rack instrumentation utilized in these channels are expected to be capable of operating within the allowances of these uncertainty magnitudes. Rack drift in excess of the Allowable Value exhibits the behavior that the rack has not met its allowance. Being that there is a small statistical chance that this will happen, an infrequent excessive drift is expected. Rack or sensor drift, in excess of the allowance that is more than occasional, may be indicative of more serious problems and should warrant further investigation.

Insert A

The measurement of response time at the specified frequencies provides assurance that the Reactor trip and the Engineered Safety Features actuation associated with each channel is completed within the time limit assumed in the safety analyses. No credit was taken in the analyses for those channels with response times indicated as not applicable. Response time may be demonstrated by any series of sequential, overlapping, or total channel test measurements provided that such tests demonstrate the total channel response time as defined. Sensor response time verification may be demonstrated by either: (1) in place, onsite, or offsite test measurements, or (2) utilizing replacement sensors with certified response time.

The Engineered Safety Features Actuation System senses selected plant parameters and determines whether or not predetermined limits are being exceeded. If they are, the signals are combined into logic matrices sensitive to combinations indicative of various accidents events, and transients. Once the required logic combination is completed, the system sends actuation signals to those Engineered Safety Features components whose aggregate function best serves the requirements of the condition. As an example, the following actions may be initiated by the Engineered Safety Features Actuation System to mitigate the consequences of a steam line break or loss-of-coolant accident: (1) Safety Injection pumps start and automatic valves position, (2) Reactor trip, (3) feed water isolation, (4) startup of the emergency diesel generators, (5) containment spray pumps start and automatic valves position (6) containment isolation, (7) steam line isolation, (8) turbine trip, (9) auxiliary feedwater pumps start and automatic valves position, (10) containment cooling fans start and automatic valves position, (11) essential service water pumps start and automatic valves position, and (12) Control Room Isolation and Ventilation Systems start.

APPENDIX A

INSERT A

The verification of response time at the specified frequencies provides assurance that the reactor trip and the engineered safety features actuation associated with each channel is completed within the time limit assumed in the safety analyses. No credit was taken in the analyses for those channels with response times indicated as not applicable. Response time may be verified by actual tests in any series of sequential, overlapping or total channel measurements, or by summation of allocated sensor response times with actual tests on the remainder of the channel in any series of sequential or overlapping measurements. Allocations for sensor response times may be obtained from: (1) historical records based on acceptable response time tests (hydraulic, noise, or power interrupt tests), (2) inplace, onsite, or offsite (e.g. vendor) test measurements, or (3) utilizing vendor engineering specifications. WCAP-13632 Revision 1, "Elimination of Pressure Sensor Response Time Testing Requirements" provides the basis and methodology for using allocated sensor response times in the overall verification of the Technical Specifications channel response time. The allocations for sensor response times must be verified prior to placing the sensor in operational service and re-verified following maintenance that may adversely affect response time. In general, electrical repair work does not impact response time provided the parts used for repair are of the same type and value. One example where time response could be affected is replacing the sensing assembly of a transmitter.

APPENDIX B

WESTINGHOUSE NUCLEAR SAFETY DEPARTMENT
SIGNIFICANT HAZARDS CONSIDERATION ANALYSIS

1) NUCLEAR PLANT(S):______________________________

2) SUBJECT: Response Time Testing Deletion - Pressure Sensor

3) TECHNICAL SPECIFICATIONS CHANGED: 4.3.1.2 and 4.3.2.2 "Instrumentation-Surveillance Requirements, B 3/4.3.1 and B 3/4.3.2 "Reactor Trip and Engineered Safety Features Actuation System Instrumentation"

4) A written analysis of the significant hazards consideration, in accordance with the three factor test of 10CFR50.92, of a proposed license amendment to implement the subject change has been prepared and is attached. On the basis of the analysis, the checklist below has been completed.

Will operation of the plant in accordance with the proposed amendment:

4.1) Yes___ No_X_ Involve a significant increase in the probability or consequences of an accident previously evaluated;

4.2) Yes___ No_X_ Create the possibility of a new or different kind of accident from any accident previously evaluated;

4.3) Yes___ No_X_ Involve a significant reduction in margin of safety.

5) Reference Documents:

1. WCAP-13632 Revision 2, "Elimination of Pressure Sensor Response Time Testing Requirements", Aug. 1995

2. (List of Applicable Sensors)

6) Comments: None

Prepared by (Nuclear Safety): ______________________________
Date:________________

Verified by (Nuclear Safety): ______________________________
Date:________________

Coordinated with Engineer(s): ______________________________
Date:________________

Nuclear Safety Group Manager: ______________________________
Date:________________

PLANT NAME
PRESSURE SENSOR RESPONSE TIME TESTING DELETION
SIGNIFICANT HAZARDS CONSIDERATION ANALYSIS

INTRODUCTION

In 1975 response time testing (RTT) requirements were included in the Westinghouse Standard Technical Specifications and were required for all plants licensed after that date.

The Standard Technical Specifications contain definitions for both Reactor Trip System and Engineered Safety Features Actuation System response times. The response time definitions are:

> "The REACTOR TRIP SYSTEM RESPONSE TIME shall be the time interval from when the monitored parameter exceeds its trip setpoint at the channel sensor until loss of stationary gripper coil voltage."
>
> "The ENGINEERED SAFETY FEATURES RESPONSE TIME shall be that time interval from when the monitored parameter exceeds its ESF actuation setpoint at the channel sensor until the ESF equipment is capable of performing its safety function (i.e., the valves travel to their required positions, pump discharge pressures reach their required values, etc.). Times shall include diesel generator starting and sequence loading delays where applicable."

The Bases section states that the response time may be measured by any series of sequential, overlapping, or total steps such that the entire response time is measured. This approach is also consistent with ISA Standard 67.06. Given this guidance and the complexity of testing an entire instrument channel from the sensor to the final device, plant surveillance procedures typically test a channel in two or more steps. One individual step in most plant test methodologies is the instrument sensor. Separate procedures using specialized test equipment and/or outside vendors are typically used solely for testing the sensors.

The first RTT guidelines were established by the Institute of Electrical and Electronic Engineers in ANSI/IEEE Standard 338-1975, "Criteria for the Periodic Testing of Class 1E Power and Protection Systems". In 1977 this Standard was revised and accepted by the NRC with NRC Regulatory Guide 1.118, "Periodic Testing of Electric Power and Protection Systems", Revision 1. Following Revision 2 of the Regulatory Guide 1.118, the Instrument Society of America approved Standard ISA S67.06, "Response Time Testing of Nuclear Safety-Related Instrument Channels in Nuclear Power Plants" August 29, 1986.

This significant hazards consideration analysis applies to the proposed deletion of periodic time testing requirements for certain pressure and differential pressure

transmitters and switches from the Technical Specifications.

DESCRIPTION OF THE AMENDMENT REQUEST

As required by 10 CFR 50.91 (a)(1), an analysis is provided to demonstrate that the proposed license amendment to delete the requirement for certain pressure and differential pressure sensor response time testing involves no significant hazards consideration. The proposed amendment, described in Reference 1, would modify Surveillance Requirements 4.3.1.2 and 4.3.2.2 Technical Specifications 3/4.3.1, "Reactor Trip System Instrumentation" and 3/4.3.2, "Engineered Safety Feature Actuation System Instrumentation" and B 3/4.3.1 and B 3/4.3.2 "Reactor Trip and Engineered Safety Features Actuation System Instrumentation" to indicate that the total response time will be determined based on the results of Reference 1 for pressure sensors.

EVALUATION

The primary purpose of this evaluation is to determine if the deletion of periodic response time testing could be justified for specific pressure, level, and flow functions that utilize pressure and differential pressure sensors. IEEE Standard 338-1977 defines a basis for eliminating RTT. Section 6.3.4 states:

> "response time testing of all safety-related equipment, per se, is not required if, in lieu of response time testing, the response time of the safety system equipment is verified by functional testing, calibration check, or other tests, or both."

WCAP-13632 Rev. 2 (Reference 1) provides the technical justification for deletion of periodic response time testing of selected pressure sensing instruments. The program described in the WCAP utilizes the methods contained in EPRI Report NP-7243 Rev. 1, " Investigation of Response Time Testing Requirements" for justifying elimination of response time testing surveillance requirements on certain pressure and differential pressure sensors. The EPRI report justifies the elimination of response time testing based on Failure Modes and Effects Analysis (FMEA) that show that component degradation that impacts pressure sensor response time can be detected in other routine tests such as calibration tests. The report concludes that sensor RTT is redundant to other technical specification surveillance requirements such as sensor calibrations. The EPRI report only applies to those specific sensors included in the FMEA.

To address other sensors installed in Westinghouse designed plants, the WCAP contains a similarity analysis to sensors in the EPRI report or a FMEA to provide justification for elimination of response time testing requirements for those other sensors. The specific sensors installed (Reference 2) at (Plant Name) are listed below.

- Steam Generator Water Level (Manufacturer / Model)
- Pressurizer Pressure (Manufacturer / Model)
- Steamline Pressure (Manufacturer / Model)
- Containment Pressure (Manufacturer / Model)
- Reactor Coolant Flow (Manufacturer / Model)

The basis for eliminating periodic response time testing for each sensor is discussed in the WCAP and/or the EPRI report. These reports provide justification that any sensor failure that significantly degrades response time will be detectable during surveillance testing such as calibration and channel checks.

Based on these results, the (Plant Name) Technical Specifications are being revised to indicate that the system response time shall be verified utilizing a sensor response time justified by the methodology described in WCAP-13632 Revision 2. Allocations for sensor response times may be obtained from: (1) historical records based on acceptable response time tests (hydraulic, noise, or power interrupt tests), (2) inplace, onsite, or offsite (e.g. vendor) test measurements, or (3) utilizing vendor engineering specifications.

ANALYSIS

Conformance of the proposed amendment to the standards for a determination of no significant hazards as defined in 10 CFR 50.92 is shown in the following:

1) The proposed license amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.

   This change to the Technical Specifications does not result in a condition where the design, material, and construction standards that were applicable prior to the change are altered. The same RTS and ESFAS instrumentation is being used; the time response allocations/modeling assumptions in the Chapter 15 analyses are still the same; only the method of verifying time response is changed. The proposed change will not modify any system interface and could not increase the likelihood of an accident since these events are independent of this change. The proposed activity will not change, degrade or prevent actions or alter any assumptions previously made in evaluating the radiological consequences of an accident described in the SAR. Therefore, the proposed amendment does not result in any increase in the probability or consequences of an accident previously evaluated.

2) The proposed license amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.

APPENDIX B

This change does not alter the performance of the pressure and differential pressure transmitters and switches used in the plant protection systems. All sensors will still have response time verified by test before placing the sensor in operational service and after any maintenance that could affect response time. Changing the method of periodically verifying instrument response for certain sensors (assuring equipment operability) from time response testing to calibration and channel checks will not create any new accident initiators or scenarios. Periodic surveillance of these instruments will detect significant degradation in the sensor response characteristic. Implementation of the proposed amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3) The proposed license amendment does not involve a significant reduction in margin of safety.

This change does not affect the total system response time assumed in the safety analysis. The periodic system response time verification method for selected pressure and differential pressure sensors is modified to allow use of actual test data or engineering data. The method of verification still provides assurance that the total system response is within that defined in the safety analysis, since calibration tests will detect any degradation which might significantly affect sensor response time. Based on the above, it is concluded that the proposed license amendment request does not result in a reduction in margin with respect to plant safety.

CONCLUSION

Based on the preceding analysis, it is concluded that elimination of periodic sensor response time testing is acceptable and the proposed license amendment does not involve a Significant Hazards Consideration Finding as defined in 10 CFR 50.92.

APPENDIX C

RCS/I&CSE(95)3-422

Westinghouse Electric Corporation

Energy Systems

Nuclear Services Division

Box 855
Pittsburgh Pennsylvania 15230-0855

July 26, 1995

Mr. Larry Witt
Weed Instruments, Inc.
707 Jeffrey Way
Round Rock, Texas 78664

Dear Mr. Witt:

Westinghouse has been authorized by the utility members of the Westinghouse Owners Group to expand the results of an EPRI Sensor Response Time Testing Study (Research Project 2409-5) to include certain vendor/model sensors not covered therein. One of the primary objectives of the Westinghouse program is to provide justification for deleting Technical Specification requirements for response time testing (RTT) on these pressure and differential pressure sensors.

A survey was made of Westinghouse Owners Group plants to provide information identifying those pressure and differential pressure units that are currently in operation and require RTT by plant Technical Specifications but which have not been previously evaluated in the EPRI Study. The following Weed sensor was identified in that survey:

Foxboro Model E13DH Differential Pressure Transmitter

Similarity analyses were utilized to compare the design of the principal components, and the functionally of each instrument identified above with a similar instrument that was evaluated in the EPRI Study. Where similarities to an instrument evaluated in the EPRI Study could not be drawn, other techniques including failure modes and effects analysis (FMEA), testing, and historical approaches were utilized to provide the necessary justification for response time deletion. In either case, Weed's Engineering assisted in the evaluation and development of the final conclusions reached.

Attached is a draft copy of the similarity analysis report that has been prepared for the instrument identified above. Please review this document for accuracy and completeness. The report will be included in a Westinghouse WCAP which will be issued to both the NRC and the member utilities of the Westinghouse Owners Group. Please acknowledge your completed review by signing and dating this letter and returning a copy to the undersigned. A copy of any comments should be attached.

RCS/I&CSS(95)0-488 Page 2

Your prompt attention to this matter will be greatly appreciated. A response is needed by 7/28/95. If you have any questions or require further information please contact the undersigned at (412) 829-3847.

Thank you in advance for your cooperation.

Sincerely,

WESTINGHOUSE ELECTRIC CORPORATION

J. L. Zielinski
Nuclear Services Division
Replacement Component Services
NSSS Components Engineering

Attachment: Foxboro Model E-13DH Similarity Analysis Report

Reviewed By (with comments) Larry Witt Date 7/26/95

Reviewed By (no comments) Date

COMMENTS: The referended material is technically adequate in the respect to time response.

APPENDIX C

RCS/NSSSCE(93)1-089

Westinghouse Electric Corporation

Energy Systems

Nuclear Services Division

Box 355
Pittsburgh Pennsylvania 15230 0355

February 25, 1993

Mr. Larry Witt
Weed Instruments, Inc.
707 Jeffrey Way
Round Rock, Texas 78664

Dear Mr. Witt:

Westinghouse has been authorized by the ut...ty members of the Westinghouse Owners Group to expand the results of an EPRI Sensor Response Time Testing Study (Research Project 2409-5) to include certain vendor/model sensors not covered therein. One of the primary objectives of the Westinghouse program is to provide justification for deleting Technical Specification requirements for response time testing (RTT) on these pressure and differential pressure sensors.

A survey was made of Westinghouse Owners Group plants to provide information identifying those pressure and differential pressure units that are currently in operation and require RTT by plant Technical Specifications but which have not been previously evaluated in the EPRI Study. The following Foxboro sensor was identified in that survey:

Foxboro Model E11GM Gauge Pressure Transmitter

Similarity analyses were utilized to compare the design of the principal components, and the functionally of each instrument identified above with a similar instrument that was evaluated in the EPRI Study. Where similarities to an instrument evaluated in the EPRI Study could not be drawn, other techniques including failure modes and effects analysis (FMEA), testing, and historical approaches were utilized to provide the necessary justification for response time deletion. In either case, Foxboro/Weed's Engineering assisted in the evaluation and development of the final conclusions reached.

RCS/NSSSCE(93)1-089
February 25, 1993
Page 2

Attached is a draft copy of the similarity analysis report that has been prepared for the instrument identified above. Please review this document for accuracy and completeness. The report will be included in a Westinghouse WCAP which will be issued to both the NRC and the member utilities of the Westinghouse Owners Group. Please acknowledge your completed review by signing and dating this letter and returning a copy to the undersigned. A copy of any comments should be attached.

Your prompt attention to this matter will be greatly appreciated. A response is needed by 3/1/93. If you have any questions or require further information please contact the undersigned at (412) 829-3547.

Thank you in advance for your cooperation.

Sincerely,

WESTINGHOUSE ELECTRIC CORPORATION

J L Zielinski

J. L. Zielinski
Nuclear Services Division
Replacement Component Services
NSSS Components Engineering

Attachment: Foxboro Model E11GM Similarity Analysis Report

Reviewed By
(with comments)

Date

Reviewed By Larry Witt
(no comments) Assistant Program Manager
Weed Instrument

Date 3-1-93

ITT

ITT Fluid Technology Corporation

Barton

900 South Turnbull Canyon Road
P.O. Box 1882
City of Industry, CA 91749-1882
Telephone: (818) 961-2547
Telex 67-7475

February 25, 1993

Mr. Jeff Zielinski
Westinghouse Electric Corporation
P.O. Box 855
Pittsburgh, PA 15230-0855

Dear Mr. Zielinski:

I have reviewed the similarity analysis reports that you sent to me on February 19, 1993. I have comments on only one of these reports, on the Barton Model 332 Differential Pressure Transmitter Similarity Analysis Report.

On the third page of the report, in the fourth paragraph of the section titled "Similarity Analysis", You state that the model 764 transmitter uses a flexure wire to connect the strain gauge to the bellows valve shaft. The model 764 does not have a flexure wire. There is a ball bearing on the tip of the strain gauge, which is positioned in the opening of the bellows valve stem. The valve stem deflects the strain gauge via the ball bearing. This paragraph should be re-written to address the differences in the models 764 and 332 strain gauge assemblies and method of transmitting motion to the strain gauge.

A copy of your original letter requesting our review is enclosed.

Sincerely,

Brian Dearden
Staff Engineer
Nuclear Products

cc: M. Larson
BD022593.L01

RCS/NSSSCE(93)1-073

APPENDIX C

Westinghouse Electric Corporation

Energy Systems

Nuclear Services Division

Box 855
Pittsburgh Pennsylvania 15230-0855

February 19, 1993

Mr. Brian Dearden
ITT Barton
900 South Turnbull Canyon Road
City of Industry, California 91749

Dear Mr. Dearden:

Westinghouse has been authorized by the utility members of the Westinghouse Owners Group to expand the results of an EPRI Sensor Response Time Testing Study (Research Project 2409-5) to include certain vendor/model sensors not covered therein. One of the primary objectives of the Westinghouse program is to provide justification for deleting Technical Specification requirements for response time testing (RTT) on these pressure and differential pressure sensors.

A survey was made of Westinghouse Owners Group plants to provide information identifying those pressure and differential pressure units that are currently in operation and require RTT by plant Technical Specifications but which have not been previously evaluated in the EPRI Study. The following is a list of Barton sensors identified from that survey:

Barton Model 752	Differential Pressure Transmitter
Barton Model 332	Differential Pressure Transmitter
Barton Model 763A	Gauge Pressure Transmitter
Barton Model 351	Sealed Sensor System
Barton Model 581-4	Differential Pressure Switch

Similarity analyses were utilized to compare the design of the principal components, and the functionally of each instrument identified above with a similar instrument that was evaluated in the EPRI Study. Where similarities to an instrument evaluated in the EPRI Study could not be drawn, other techniques including failure modes and effects analysis (FMEA), testing, and historical approaches were utilized to provide the necessary justification for response time deletion. In either case, Barton's Engineering assisted in the evaluation and development of the final conclusions reached.

RCS/NSSSCE(93)1-073
February 19, 1993
Page 2

Attached are draft copies of the similarity analyses reports that have been prepared for the instruments identified above. Please review these documents for accuracy and completeness. These reports will be included in a Westinghouse WCAP that will be issued to both the NRC and the member utilities of the Westinghouse Owners Group. Please acknowledge your completed review by signing and dating this letter and returning a copy to the undersigned. A copy of any comments should be attached.

Your prompt attention to this matter will be greatly appreciated. A response is needed by 2/24/93. If you have any questions or require further information please contact the undersigned at (412) 829-3547.

Thank you in advance for your cooperation.

Sincerely,

WESTINGHOUSE ELECTRIC CORPORATION

J. L. Zielinski
Nuclear Services Division
Replacement Component Services
NSSS Components Engineering

Attachments: Barton Model 752 Similarity Analysis Report
Barton Model 332 Similarity Analysis Report
Barton Model 581-4 Similarity Analysis Report
Barton Model 763A Similarity Analysis Report
Barton Model 351 Similarity Analysis Report

Reviewed By ____________ Date 2/25/93
(with comments)

Reviewed By ____________ Date ____________
(no comments)

APPENDIX C

Westinghouse Electric Corporation
Energy Systems
Nuclear Services Division
Box 855
Pittsburgh Pennsylvania 15230-0855

February 19, 1993

Ms. Vicki Bourn
Manager
Sales & Marketing Administration
Camille Bauer, Inc.
7425 S. Hart Avenue
Tempe Arizona 85283

Dear Ms. Bourn:

Westinghouse has been authorized by the utility members of the Westinghouse Owners Group to expand the results of an EPRI Sensor Response Time Testing Study (Research Project 2409-5) to include certain vendor/model sensors not covered therein. One of the primary objectives of the Westinghouse program is to provide justification for deleting Technical Specification requirements for response time testing (RTT) on these pressure and differential pressure sensors.

A survey was made of Westinghouse Owners Group plants to provide information identifying those pressure and differential pressure units that are currently in operation and require RTT by plant Technical Specifications but which have not been previously evaluated in the EPRI Study. The following is a list of Tobar/Veritrak sensors identified from that survey:

Tobar Model 32DP2	Differential Pressure Transmitter
Tobar Model 32PA2	Absolute Pressure Transmitter
Veritrak Model 76DP1	Differential Pressure Transmitter
Veritrak Model 76PG1	Gauge Pressure Transmitter
Veritrak Model 76PH2	Absolute Pressure Transmitter

Similarity analyses were utilized to compare the design of the principal components, and the functionally of each instrument identified above with a similar instrument that was evaluated in the EPRI Study. Where similarities to an instrument evaluated in the EPRI Study could not be drawn, other techniques including failure modes and effects analysis (FMEA), testing, and historical approaches were utilized to provide the necessary justification for response time deletion. In either case, Camille Bauer's Engineering assisted in the evaluation and development of the final conclusions reached.

APPENDIX C

Attached are draft copies of the similarity analyses reports that have been prepared for the instruments identified above. Please review these documents for accuracy and completeness. Also included is a copy of Camille Bauer's letter to EPRI dated 11/19/92. The reports and letter will be included in a Westinghouse WCAP that will be issued to both the NRC and the member utilities of the Westinghouse Owners Group. Please acknowledge your completed review by signing and dating this letter and returning a copy to the undersigned. A copy of any comments should be attached.

Your prompt attention to this matter will be greatly appreciated. A response is needed by 2/24/93. If you have any questions or require further information please contact the undersigned at (412) 829-3547.

Thank you in advance for your cooperation.

Sincerely,

WESTINGHOUSE ELECTRIC CORPORATION

J. L. Zielinski
Nuclear Services Division
Replacement Component Services
NSSS Components Engineering

Attachments: Tobar Model 32DP2 Similarity Analysis Report
Tobar Model 32PA2 Similarity Analysis Report
Veritrak Model 76DP1 Similarity Analysis Report
Veritrak Model 76PG1 Similarity Analysis Report
Veritrak Model 76PH2 Similarity Analysis Report
Camille Bauer's letter to EPRI (11/19/92)

Reviewed By (with comments) J.H. Murphy   Date 2/23/93

Reviewed By (no comments)   Date

APPENDIX C

RCS/NSSSCE(93)1-072

Westinghouse Electric Corporation

Energy Systems

Nuclear Services Division

Box 855
Pittsburgh Pennsylvania 15230 0855

February 25, 1993

Mr. Larry Witt
Weed Instruments, Inc.
707 Jeffrey Way
Round Rock, Texas 78664

Dear Mr. Witt:

Westinghouse has been authorized by the utility members of the Westinghouse Owners Group to expand the results of an EPRI Sensor Response Time Testing Study (Research Project 2409-5) to include certain vendor/model sensors not covered therein. One of the primary objectives of the Westinghouse program is to provide justification for deleting Technical Specification requirements for response time testing (RTT) on these pressure and differential pressure sensors.

A survey was made of Westinghouse Owners Group plants to provide information identifying those pressure and differential pressure units that are currently in operation and require RTT by plant Technical Specifications but which have not been previously evaluated in the EPRI Study. The following Weed sensor was identified in that survey:

Weed Model N-E11AH Absolute Pressure Transmitter

Similarity analyses were utilized to compare the design of the principal components, and the functionally of each instrument identified above with a similar instrument that was evaluated in the EPRI Study. Where similarities to an instrument evaluated in the EPRI Study could not be drawn, other techniques including failure modes and effects analysis (FMEA), testing, and historical approaches were utilized to provide the necessary justification for response time deletion. In either case, Weed's Engineering assisted in the evaluation and development of the final conclusions reached.

RCS/NSSSCE(93)1-072
February 25, 1993
Page 2

Attached is a draft copy of the similarity analysis report that has been prepared for the instrument identified above. Please review this document for accuracy and completeness. The report will be included in a Westinghouse WCAP which will be issued to both the NRC and the member utilities of the Westinghouse Owners Group. Please acknowledge your completed review by signing and dating this letter and returning a copy to the undersigned. A copy of any comments should be attached.

Your prompt attention to this matter will be greatly appreciated. A response is needed by 3/1/93. If you have any questions or require further information please contact the undersigned at (412) 829-3547.

Thank you in advance for your cooperation.

Sincerely,

WESTINGHOUSE ELECTRIC CORPORATION

J L Zielinski

J. L. Zielinski
Nuclear Services Division
Replacement Component Services
NSSS Components Engineering

Attachment: Weed Model N-E11AH Similarity Analysis Report

Reviewed By (with comments) — Date

Reviewed By (no comments) Larry Witt, Assistant Program Manager, Weed Instrument — Date 3-1-93