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Work Performed Under Contract DE-AC09-78ET-35900

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ALLIED-GENERAL NUCLEAR SERVICES
P.O. BOX 847
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STUDIES AND RESEARCH CONCERNING BNFP

PROCESS MONITORING AND PROCESS SURVEILLANCE DEMONSTRATION PROGRAM

Harry R. Kight

November 1979

[redacted]

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
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PREPARED FOR THE
DEPARTMENT OF ENERGY
FUEL CYCLE PROJECT OFFICE
UNDER CONTRACT DE-AC09-78ET-35900

[redacted]

ABSTRACT

Computerized methods of monitoring process functions and alarming off-standard conditions were implemented and demonstrated during the FY 1979 Uranium Run. In addition, prototype applications of instruments for the purpose of tamper indication and surveillance were tested.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

LIST OF EXHIBITS

1.0 INTRODUCTION

A large nuclear fuel reprocessing facility is a very complex system with many possibilities for process upsets and for potential diversion of Special Nuclear Material (SNM). It is with this in mind that the Process Monitoring/Process Surveillance (PM/PS) subsystem of the Barnwell Nuclear Fuel Plant (BNFP) Computerized Nuclear Materials and Accounting System (CNMCAS) was developed.

The PM/PS program, which was developed and tested in FY 1979, consists of two parts. The first part involves a series of specific CNMCAS functions which were developed and tested in the BNFP Separations Facility and the Plutonium Nitrate Storage Area (PNSA). The programs are as follows:

- Parameter Monitoring Alarm Function (PAMALA)
- Quantity Transferred Versus Received Comparison Function (QTVRC)
- Physical Inventory Monitoring Function (PIM)*
- Process Status Function (PSF)*
- Analytical Summary Function (ASF)*
- High Activity Feed (HAF) Flow Rate Function (HAF)*
- Transfer Flow Direction Confirmation Function (TFDC)**
- PNSA Storage Function (SF)**

The purpose of these functions (which are explained in detail in the text of this report) is to provide automated computer monitoring and surveillance of key process variables and to notify the operators if any limiting value is exceeded.

The second part of the PM/PS program was called the Prototype Instrument Test Program. The purpose of this program was to identify and test various instruments as diversion/tamper indicators on out-of-cell lines with direct access to product solutions.

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*Separations Facility only.
**PNSA only.

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2.0 SUMMARY

All of the computerized PM/PS functions performed as intended during testing. A number of software problems were encountered initially; however, with a nominal amount of "debugging," the problems were corrected. Initial checkout of the functions in the PNSA was delayed due to a datum transmission problem; however, program debugging was carried on while the data transmission line was modified and the test programs were successfully completed.

One problem with the PM/PS function programs is that they take up a significant amount of processor time and memory space. Since the various function operations are carried out in the CNMCAS central processor along with the CNMCAS programs, the processor would be seriously overloaded in normal operation.

To alleviate this potential problem, an effort should be made in the future to:

- Rewrite the various programs in a more time- and space-efficient computer language.
- Combine as many of the various functions and programs as possible. Right now there is a lot of duplication (the same data, presented in a different form).
- Reassess the program priorities and rearrange in a more efficient manner. (Temporary data files set up in memory could be accessed by a number of different programs at the same time if priorities and schedules were set properly.)

The prototype instrument tests involved six different types of sensors, including pressure switches, position switches, radiation monitors, thermal flowmeters, conductivity meters, and ultrasonic liquid detectors. Applications of these sensors were on a product pump flush line, a product tank air sparger line, and a product tank instrument dip tube.

With the exception of the radiation monitors, tests indicated that all the instruments were adaptable as diversion/ tamper detectors; however, some were relatively more sensitive than others. The test of the radiation monitors were inconclusive because the test sources were not strong enough. Based on results of the tests, some alternative instrument arrangements should be tried and modifications should be made to some of the existing arrangements. The instruments should also be interfaced with CNMCAS to demonstrate remote surveillance capabilities.

3.0 PROTOTYPE INSTRUMENT TEST

3.1 Purpose

The overall intent of the test installations was to develop a system which will detect any attempted theft/diversion of plutonium product from the associated plutonium product storage tank (35-D-306). A variety of instruments were installed to determine their applicability and relative effectiveness at detecting a potential diversion.

3.2 Instrumentation

3.2.1 Ultrasonic Level Detector with High Alarm (LSH-333) -- National Sonics Model No. 621S-16

This unit uses an ultrasonic signal that can be transmitted through the walls of a pipe or vessel filled with liquid but will not transmit when the vessel is filled with a gas.

Ultrasonic detection is unaffected by variations in temperature, pressure, reflected light, liquid conductivity, or vibration.

3.2.2 Thermal Flowmeter with Low Flow Alarm (FSL-327) -- Celesco -- Model No. MF-10

Detection in the sensor head is achieved by the use of a sensing thermoresistor, a reference thermoresistor, and a heater. The heater is located in the flow stream so that during flow the heat is carried away from both sensors. When the flow stops, convection currents heat one sensor above the temperature of the other. This temperature imbalance causes a voltage change in the bridge circuitry, signaling a flow stoppage.

The sensor head creates an increasing signal as the flow rate decreases. Extremely stable in operation, this unit is virtually unaffected by line voltage fluctuations and wide temperature changes in fluids or ambient conditions.

3.2.3 Radiation Monitor with High Alarm (RISH-396 and RISH-3103) -- Baird Atomic -- Model No. 904-443

This monitor presents visual and audible indications of radioactivity. A front panel red alarm flashes when the preset alarm value is reached. Simultaneously, an optional remote alarm is triggered. The monitor is adjustable from 10% to 100% full scale.

3.2.4 High Conductivity Switch (CSH-395 and CSH-3102) -- Leeds and Northrup -- Model No. 7085-1-101-102-000

This conductivity resistivity controller, designed for use with the 7086 cells, is a low-cost instrument for accurate, continuous monitoring of electrolytic conductivity.

3.2.5 Valve Tamper Device (ZS-3101, ZS-3107, ZS-3105, and ZS-3106) -- Mercoid -- Model No. DA-961

These mercury switches were attached to the handles of ball valves and would set off an alarm whenever a handle was moved.

3.2.6 Low Pressure Switch (PSL-316 and PSL-317) -- Mercoid -- Model No. DA-521-3

This pressure device will detect a pressure increase or decrease which is more than the preset range.

3.2.7 Ball Valves with Valve Position Indicators (ZS-397 and ZS-3100) -- Jamesbury -- Model No. A36-TT

These valves have limit switches which will indicate at a remote location what position the valves are in (opened, closed).

3.2.8 Thermal Flowmeter with Low Flow Alarm (FSL-328) -- Fluid Components, Inc. -- Model No. 12-64-4

This device detects variations in flow velocity by sensing changes in the heat transfer properties of the flowing liquid. The sensing head consists of three thermowelds, which contain a matched pair of resistive temperature sensors (one active and one reference), and a low-powered heating element. The heater is located so that it will always heat the active temperature sensor. This creates a temperature difference between the active and reference sensors which can be converted to flow rate.

3.2.9 Thermal Low Flow Switches (FSL-329) -- Fluid Components, Inc., Model No. FR-70-4

This monitor operates just like the model 12-64-4 except that the FR-70-4 will detect lower flows.

3.3 General Information

3.3.1 Installation

There were three test installations, all of which were connected to process lines going to the No. 3 plutonium product storage tank (35-D-306). The instruments for Test 1 were connected to the density-probe purge line for that tank. For Test 2, they were in the sparger line for that tank, and for Test 3, they were connected to the flush line on the pump for that tank (see Exhibits 3-1, 3-2, and 3-3 for drawings).

3.3.2 Test

An instrument technician was present at each test to adjust the alarm point for each instrument. A portable alarm panel was fabricated

and carried to each test site. All three tests were done using demineralized water, and because of this, the test of the radiation monitors was conducted in the laboratory.

3.4 Test System No. 1 -- Density Probe -- Purge Line

3.4.1 Installation (See Exhibit 3-1)

This system has the instrumentation to detect low pressure, high conductivity, any liquid level, a flow of liquid, high radiation, and the position of two valves. The pressure switch will be set to detect the difference between the normal pressure of purge air and a negative pressure of an attempted diversion. The conductivity, level, and flow instruments are set to detect the difference between the normal contents of the process line (air) and any liquid. The radiation monitor will be set to detect the gamma associated with the plutonium product. The valve position indicators are there to give a warning when someone is opening a valve that is a direct connection between the operations area and the process line.

3.4.2 Test of System No. 1

The density transmitter and tank were isolated from the test installation. A metered water supply was installed on one test connection and the other test connection was used as a drain. Flow of water as low as 0.0001 gpm was tested through the system. This tested the flow sensor, the level sensor, and the conductivity sensor. The pressure switch was tested by isolating it and applying a vacuum through the test connection.

3.4.3 Test Results and Conclusions

- Valve Position Switches

  The devices which were installed on the valves at the two test connections were very effective as indicators of valve position. These switches were sensitive to valve handle movement and always alarmed when the handle was between the completely closed position and the position where the valve actually started to open.

- Level Detector

  The level sensor (LSH-333) was extremely sensitive to liquid in the line. No matter what the flow rate, this sensor would detect it and would not clear until the line was blown clear with air.

- Conductivity Detector

  The conductivity sensor (CE-395) was almost as quick reacting as the level sensor, but because the sensor had to be covered with liquid, it would take a few seconds longer when a very low flow rate was used. (Sensor is housed in a 3/4-inch tee.)

- Pressure Sensor

  The pressure sensor (PSL-316) has a minimum span of 3 psi. This means when the high pressure trip is set at 0 psi, the closest that the low pressure trip can be set is -3 psi. During the actual test of PSL-316, it was determined that with these settings the switch actually tripped at a negative pressure of 3.7 psi and would reset at 0 psi. To remove plutonium product from 35-D-306 (assuming a density of 1.4 grams/milliliter), it would require a vacuum of 4.45 psi or more (see Drawing Exhibit 3-4). Therefore, the PSL would alarm before the necessary vacuum required to remove plutonium product could be applied.

3.5 Test System No. 2 -- Storage Tank -- Sparger Line

3.5.1 Installation (See Exhibit 3-2)

This system has instrumentation to detect low pressure and indicate the position of one valve. The pressure switch could have two purposes, depending on how it is set to alarm:

(1) It could be set to detect the difference between no pressure (sparger off) and a negative pressure (vacuum on system) due to an attempted diversion.

(2) It could be set to detect the difference between no pressure (sparger off) and a small pressure (sparger on). This could be tied to the CNMCAS measurement system to monitor the sparge time and ensure that the tank has mixed long enough before the sample is taken.

The valve position indicator is there for the same reason as in Test 1.

3.5.2 Test of System No. 2

Two separate tests were run on the PSL. First, 35-D-306 was filled to 80% of overflow and the sparger was set at full flow to see if it would detect the difference between no pressure and sparging pressure. Then, the diversion function was tested by applying a vacuum through the test connection.

3.5.3 Test Results and Conclusions

- Valve Position Switches

  The results of the test of the valve position indicator in this test were the same as in Test 1. The indicator (ZS-3107) always alarmed before the valve actually began to open.

  (1) PSL Test 1 -- Diversion Detection - The PSL in this test has the same range as PSL-316 (Test 1), but the distance the solution would have to be pulled by a vacuum has increased (see

Exhibit 3-5). In this case, the amount of vacuum required to pull the solution out of the storage tank is 5.25 psi for water and 7.36 psi for a plutonium solution with a density of 1.4 grams/milliliter. For the purpose of detecting an attempted diversion, this PSL (PSL-317) would alarm long before the required vacuum on the system could be obtained.

(2) PSL Test 2 -- Sparge Detection - Because of where PSL-317 is located in the sparge line (downstream of the flow orifice) and because of the 3 psi range, it could not detect the difference between sparging and not sparging (see Drawing 35PA3X1-3, Exhibit 3-1). A differential pressure transmitter set to sense the pressure drop across the flow orifice would be a better detector of sparger flow.

3.6 Test System No. 3 -- Storage Tank -- Pump Flush

3.6.1 Installation (See Exhibit 3-3)

This installation has instrumentation to detect no flow, low flow, flush flow, high conductivity, high radiation, and valve position of two valves. The radiation monitor, conductivity monitor, and the valve position indicators have the same purpose as in Test 1. They will go off during a normal flushing, but the system will be drained afterwards and reset to detect theft/diversions. The two flow switches work together. When neither switch is activated, no flow is indicated. When both are activated, it indicates flush flow; and when FSL-329 only is activated, it indicates low flow or a possible theft/diversion.

3.6.2 Test of System No. 3

The test installation was isolated from the storage tank and a demineralized water hose was attached to one of the flush connections. Another hose was attached to the other test connection as a drain. Flows of water were varied through the test installation to ensure that flush flow, no flow, and reverse flow could be detected. The water also tested the conductivity device.

3.6.3 Test Results and Conclusions

- Valve Position Indicators

  The results of the checkout of the valve position indicators for this test were the same as in Tests 1 and 2.

- Conductivity Detector

  The conductivity sensor (CE-3102) for this test would be more efficient if it were installed in the lower section of the installion near FSL-329. With it in its present position, it did not alarm on low or reverse flow but only on the higher flush flow. If it were

moved to the lower section of the installation, it would detect any liquid that entered the line (high or low flow).

- Flow Switches

The flow switches operated as designed. When there was no flow, the green light on the panel was lit indicating no flow. When a low flow was started through the system, a red light indicated low or reverse flow. However, when a fast flow was used, a blue light on the panel indicated a flush flow. To ensure that there is never a flush flow indication when actually there is a reverse flow, a check valve should be placed near FSL-328 on the pump side. This would prevent a fast flow from coming from the pump through both FSL's and giving a flush flow indication. (See Drawing Exhibit 3-2.)

3.7 Radiation Monitor Test

The test of the radiation monitoring device was done in the laboratory area using the Baird Atomic radiation monitor and GM tube, two sealed sources, a 1/4-inch thick piece of styrafoam, and a 1/8-inch thick piece of stainless steel plate (see detail "A" of Exhibits 3-1 and 3-3). The stainless steel plate is the same thickness as the walls of the 3/4-inch pipe which the monitor will be trying to detect plutonium product through. The styrofoam is a cushion for the GM tube. Calculations were made using the following assumptions:

(1) Fresh plutonium product - no Am-241 or U-237 present,

(2) Plutonium product at 250 grams plutonium/liter,

(3) About a 4-inch section of 3/4-inch stainless steel pipe will be exposed to the GM tube, and

(4) The plutonium product will contain the following percentages of each isotope:

- Pu-238 2.5%
- Pu-239 50.0%
- Pu-240 25.0%
- Pu-241 15.0%
- Pu-242 7.5%.

From these assumptions, a surface dose rate of approximately 14 mrem/hour was calculated. With the projected maximum dose rate of 10 mrem/hour in the piping and instrument gallery, the radiation monitor should be able to detect the presence of plutonium solution in the pipe. Further testing with appropriate gamma sources is planned.

3.8 Recommendation

Further testing and development work should be done on all three of these systems. The test should be conducted when there is uranium solution in the plutonium product storage tank.

The output of the alarms should be tied into the CNMCAS.

On Test 2, a differential pressure transmitter should be hooked up across the flow orifice to detect flow.

The conductivity indicator on Test 3 needs to be moved to a lower line.

A check valve should be installed in the line between FSL-328 and the pump, and the system should be tested again.

Other instruments which could be used to detect a diversion should be identified and tested for applicability.

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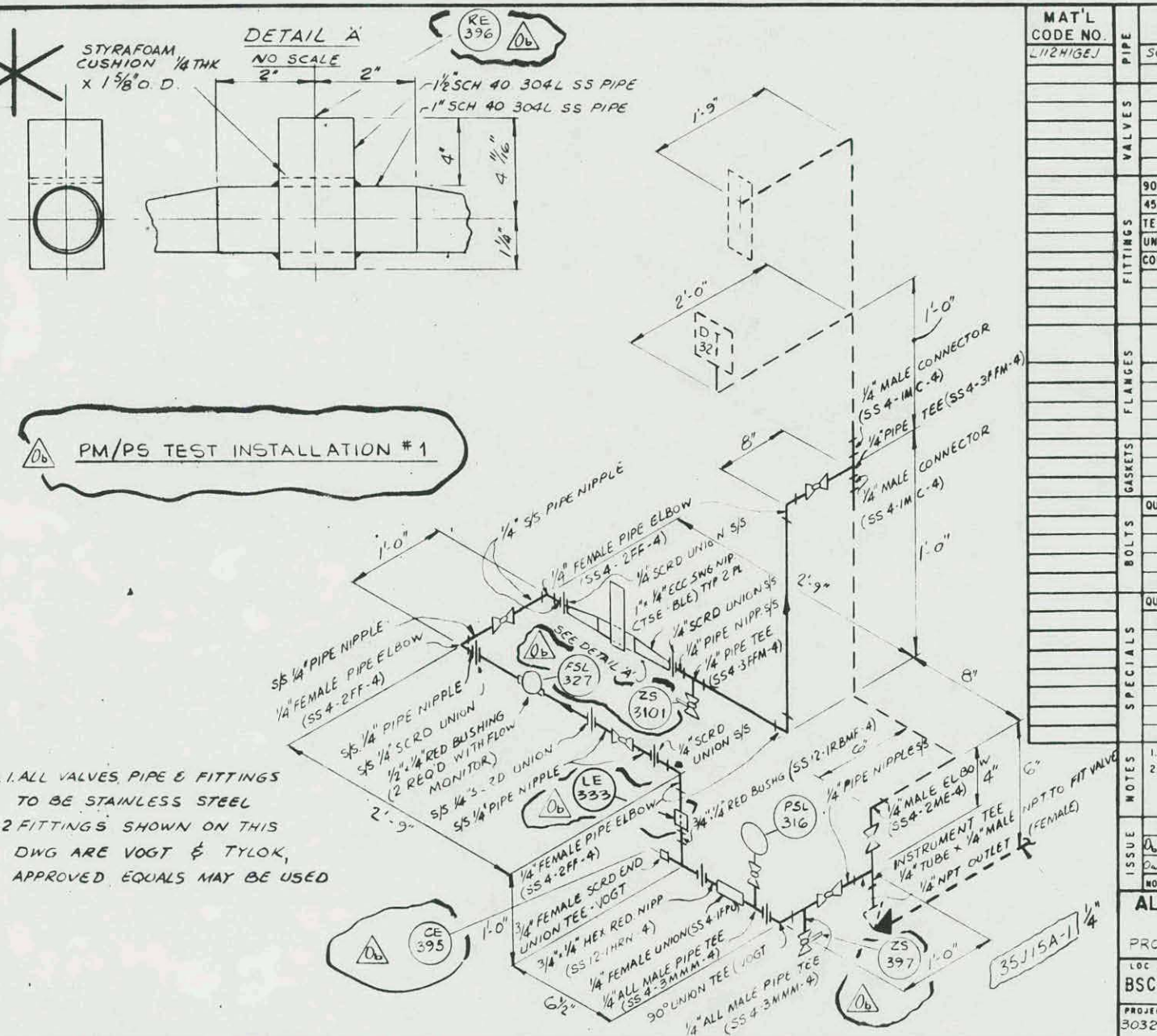


NOTE. 1. ALL VALVES, PIPE & FITTINGS TO BE STAINLESS STEEL
2 FITTINGS SHOWN ON THIS DWG ARE VOGT & TYLOK, APPROVED EQUALS MAY BE USED

MAT'L CODE NO.
L112HIGEJ

	IDENTIFICATION	QUANTITY BY SIZE 1/4"
PIPE	SCH 40S A312 SMLS 304L S/S	5'
VALVES		
FITTINGS	90° ELL	
	45° ELL	
	TEE	
	UNION	
	COUPLING	

	TYPE	RATING AND FACING/ENDS	QUANTITY BY SIZE
FLANGES			
GASKETS			

BOLTS	QUANT.	SIZE	TYPE	BOLTS / JOINT
			-	

SPECIALS	QUANT.	IDENTIFICATION
	6	1/4" BALL VALVES JAMESBURY S/S SCRD ENDS

NOTES
1. REF DWGS: P&ID 3R-A-4 PIPING PLAN
2 MARK EACH PIPE DETAIL WITH FULL LINE NUMBER AT EACH END

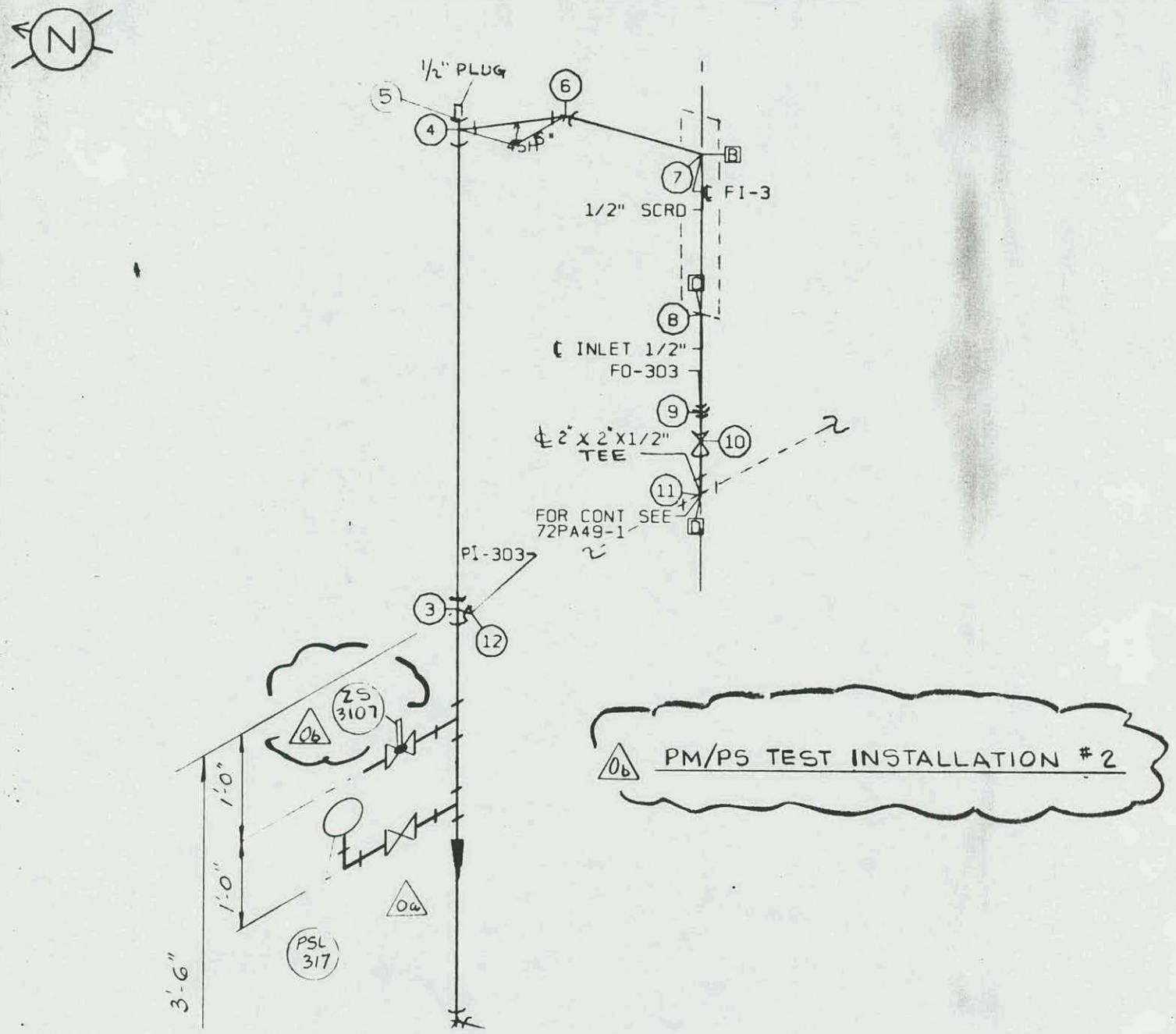
EXHIBIT 3-1

ISSUE NO.	DESCRIPTION	DRN	CHK	APPROVED	DATE
0b	ADDED LE-333 & CHNG TAG NOS. (30322 31466)	RNA	MZ	WM	HRK	1/5/93
0a	ISSUED FOR CONSTRUCTION	TJ	MZ	MLM	9/15/92

ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
PROCESS MONITORING/PROCESS SURVEILLANCE

LOC/PLANT/AREA	DESIGN ENGINEERING DEPARTMENT
BSC-TPIG	AGNS P.O. BOX 847 BARNWELL, S.C. 29812

PROJECT NUMBER	PIPE LINE NUMBER	DRAWING NUMBER	ISSUE
30322 31466		5078-J-5001	0b


N
1/2" PLUG
5
6
4
45°
B
7
FI-3
1/2" SCRD
8
INLET 1/2"
FO-303
9
2" X 2" X 1/2"
TEE
10
11
FOR CONT SEE
72PA49-1
PI-303
3
12
ZS
3107
06
1'-0"
1'-0"
3'-6"
PSL
317
0a
0a
06
PM/PS TEST INSTALLATION #2

LIST OF MATERIAL

CODE	DESCRIPTION / SIZE	SHOP	FIELD
L13GA4COG	PIPE WELDED SCH 80 CS T-C GALV 1/2IN		20
L20BNOBA	GATE VLV 150 LB SCRD BRONZE B±T 1/2IN		2
L30F1AAMG	ELBOW 45 300 LB SCRD MI GALV 1/2IN		1
L30F1ABMG	ELBOW 90 300 LB SCRD MI GALV 1/2IN		1
L31F1ABMG	TEE 300 LB SCRD MI GALV 1/2IN		2
L34NA2JFG	STRT NIPPLE XS TBE CS GALV 1/2X 3 IN		1
L370ABWCG	PLUG BAR STOCK THRD 1/2 (1)		1
L31F1ABMG	1/2" STR TEE 300LB SCRD MI. GALV.		2
L34NA2JFG	STRT. NIPPLE XS TBE GALV. CS. 1/2" x 3"		4
L20BNOBA	1/2"-150LB BR. THRD GATE VALVE		1
L21DNOAC	1/2"-200LB BR. THRD GLOBE VALVE		1
L30SAABC	1/2"-90° ELBOW		1

DIMENSIONAL INFORMATION

FROM	TO	DISTANCE	CUT LENGTH
1	2	8'-5 3/16"	
2	3	3'-6"	
3	4	4'-1"	
4	5	1'-1 1/4"	
4	6	8'-1"	
6	7	14'-7 7/16"	
8	9	9'-15/16"	
9	10	3"	
10	11	5'-9/16"	
3	12	1'-1 1/2"	

CUT LENGTHS FOR ALL SCRD/S.W. AND 1½" & SMLR. B.W. LINES ARE ± 1".

REFERENCE

V=VERTICAL	PT=INSTRU.
H=HORIZONTAL	VT=VENT
M=MITER	DR=DRAIN
THREADED END	
BEVEL FOR WELD	
PLAIN END	
FIELD WELD	
F BY FIELD	
BOLT HOLES TO STRADDLE M/S-F/W & UNLESS NOTED	
INSULATE	
STEAM TRACE	
SHOP FABRICATE	
FIELD FABRICATE	X
HEAVY WALL	
ALLOY	
PRESS	
TEMP	
WGT-EMPTY	24
WGT-FULL	26

ASSEMBLIES

POINT	FITT	CODE	SIZE
12		L20BNOBA	1/2"
12		L34NA2JFG	1/2"X3"

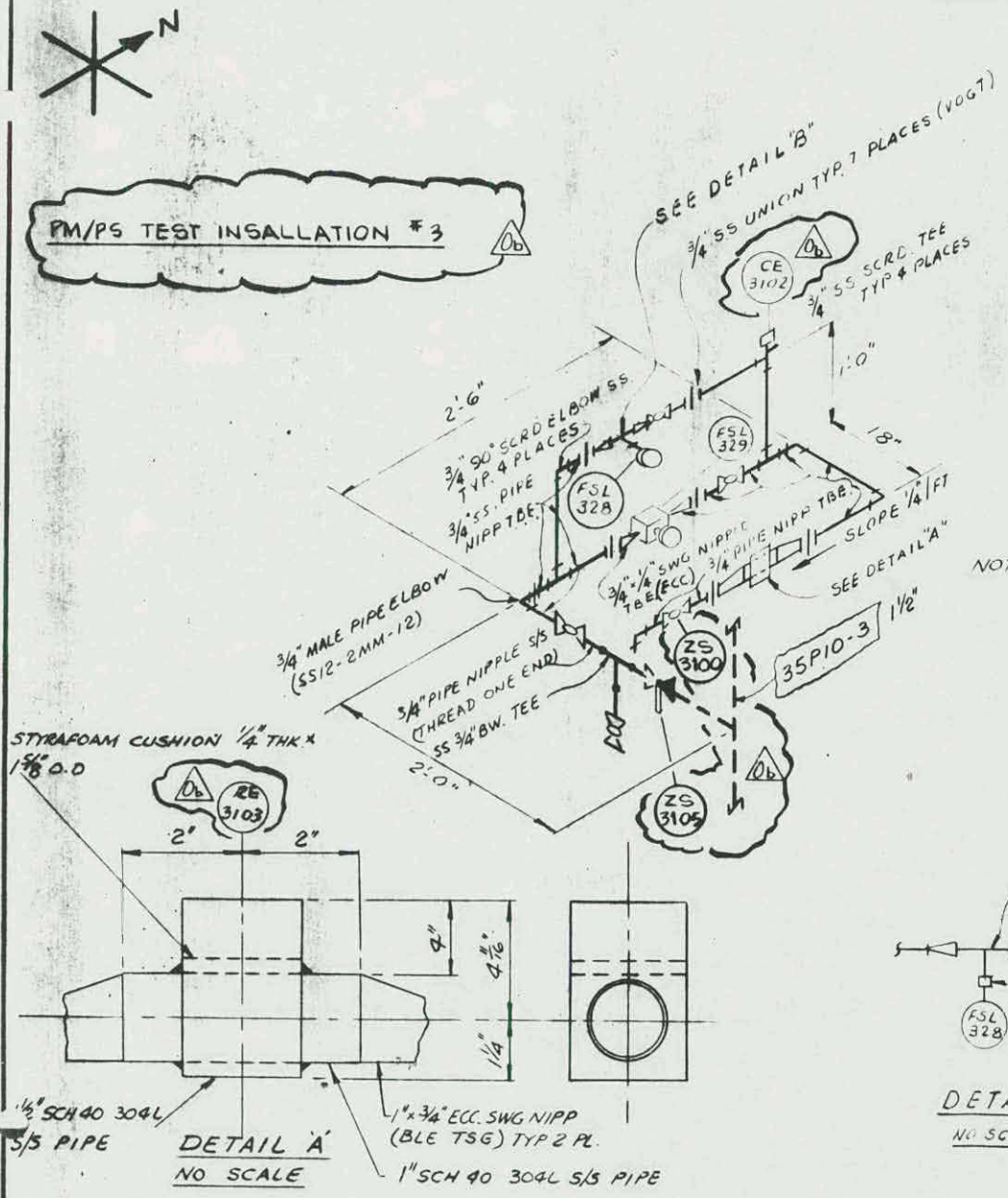
LINE NO	SIZE	CLS
35 PA 3X1	1/2	AB2U

REFERENCE DRAWING	REFERENCE EQUIPMENT
3R-A-4	TPIG

NOTES AND REVISIONS

1. REVISED FOR DEP 30322 31466 (4)

SUPP'T ENG



MAT'L CODE NO.		IDENTIFICATION	QUANTITY BY SIZE 3/4"
L112NIGEJ	PIPE	SCH. 40 A312 SMLS 304L S/S	2'-6"
	VALVES		
	FITTINGS	90° ELL	5
		45° ELL	
		TEE	3
		UNION	6
		COUPLING	1

	TYPE	RATING AND FACING/ENDS	QUANTITY BY SIZE
FLANGES			
GASKETS			

	QUANT.	SIZE	TYPE	BOLTS / JOINT
BOLTS				

	QUANT.	IDENTIFICATION
SPECIALS	5	3/4" BALL VALVES JAMESBURY S/S SCRD ENDS

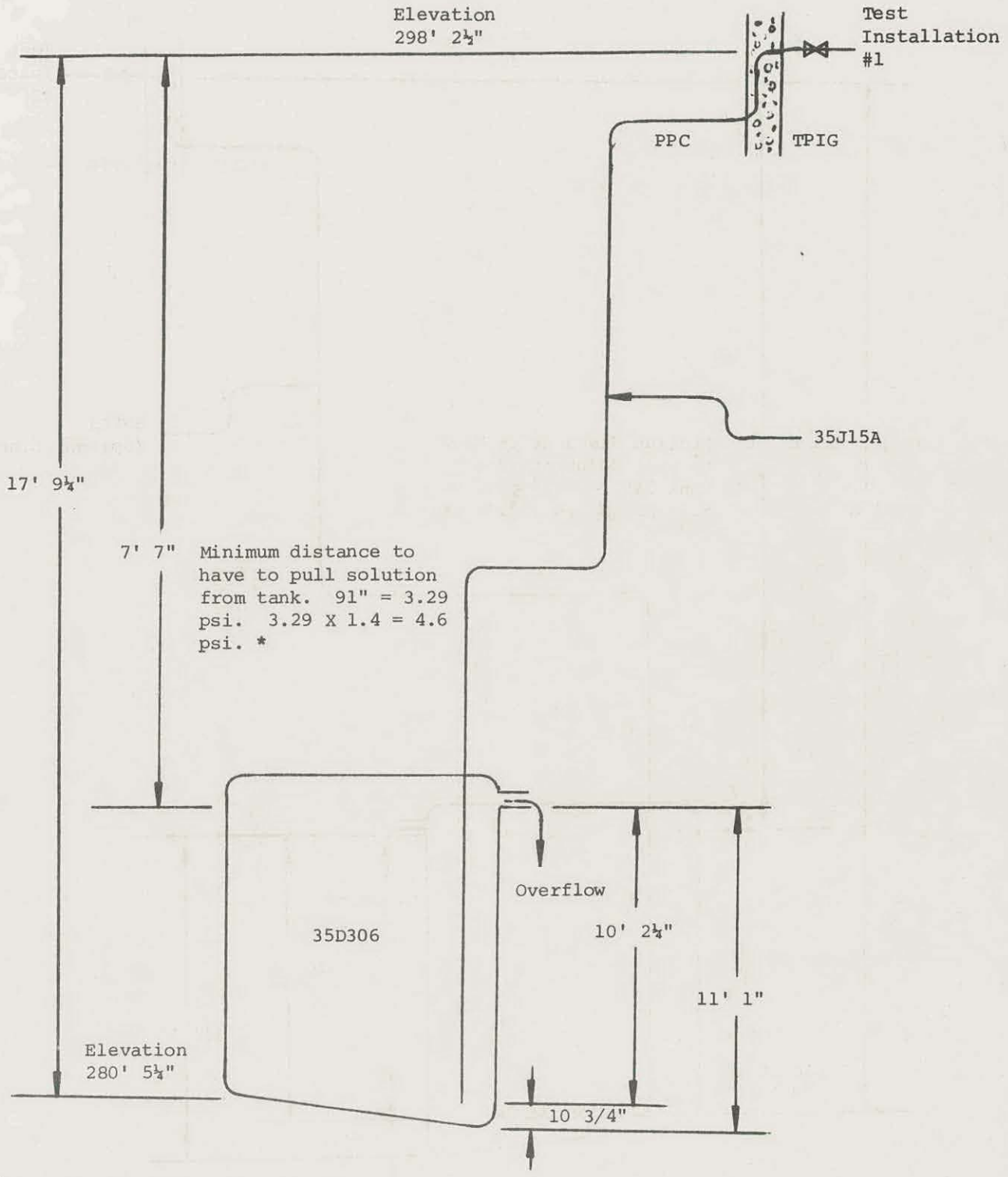
NOTES
1. REF. DWGS: P&ID 3R-A-4 PIPING PLAN
2. MARK EACH PIPE DETAIL WITH FULL LINE NUMBER AT EACH END

EXHIBIT 3-3

ISSUE NO.	DESCRIPTION	DRN.	CHK	APPROVED	DATE
Oa	ADDED ZS-3100, CHNG. TAG NOS. (30322 31466)	KNA		JHM	HRK 1/18/91
Ob	ISSUED FOR CONSTRUCTION	T.J.	TB	HRK	WLM 10/4/90

ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
PROCESS MONITORING/PROCESS SURVEILLANCE

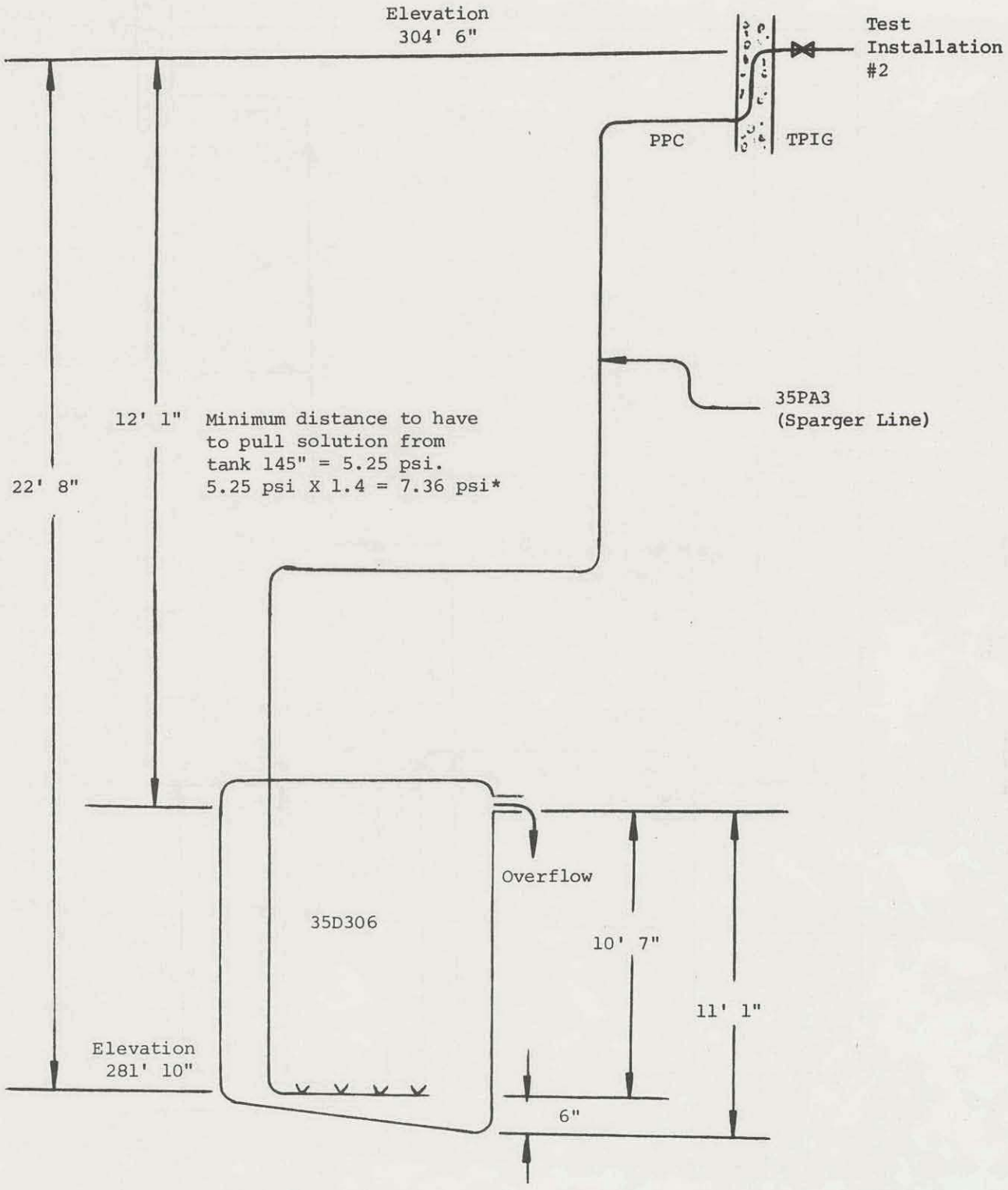
LOC / PLANT / AREA	DESIGN ENGINEERING DEPARTMENT		
BSC-PPC PUMP NICHE	AGNS	P.O. BOX 847 BARNWELL, S.C. 29812	
PROJECT NUMBER 30322 31466	PIPE LINE NUMBER	DRAWING NUMBER 507B-J-5002	ISSUE Ob



*1.4 g/ml = Density of Pu Products
4.6 psi required to pull solution out of 35D306 through 35J15A.

PRESSURE SENSOR (PSL-316) TEST

EXHIBIT 3-4



*1.4 g/ml = density of Pu Product

PRESSURE SENSOR (PSL-317) TEST

EXHIBIT 3-5

4.0 PARAMETER MONITORING AND ALARM PROGRAM (PAMALA)

4.1 Description

This program takes the readings gathered by the Real-Time Peripheral (RTP)* system and compares them to a predetermined set of limits (high and low). If a parameter is outside the limits, the instrument identification number, measured reading, limit values, time, and date are displayed on a color CRT as an Alarm. This process is repeated every few minutes, depending on processor load.

4.2 Test

4.2.1 Separations Facility Test

A test of the PAMALA program was conducted in the Separations Facility during the FY 1979 run and in the PNSA after the uranium run was completed.

The following PAMALA program functions were tested in the Separations Facility during the third campaign of the FY 1979 uranium run.

(1) Display of Alarms - The alarms are accumulated in memory and are displayed on a color CRT. The ability of the PAMALA program to display more than one page of alarms was tested. It displayed up to four pages of alarms with no problems.

(2) Dump of Alarms to DEC Writer - The PAM program has the ability to print all the displayed alarms to the RTP DEC writer. This function will give a hard copy of all active alarms, including those on the second, third, and fourth page of display (see Exhibit 4-1).

(3) Dump of Alarms to Floppy Disk - The alarms that are displayed can be stored on a floppy disk. This function was tested and found to work satisfactorily.

(4) Dump of Stored Alarms to DEC Writer - The alarms that have been stored on floppy disks can be printed at the RTP DEC writer. This function also performed as designed.

(5) Disable/Enable of Alarms - This function was used during the third campaign. It allowed Operations personnel to disable alarms that were out-of-limits because of maintenance or testing of the transmitter. The function performed as designed.

---

*Real-Time Peripheral (RTP) also called Remote Data Acquisition System (RDAS) - See Section 4.6 in document, AGNS-35900-2.2-22 for full explanation.

4.2.2 PNSL Tests

When the PAMALA program was started, the PNSL instruments were tied into the system. Almost all of these instruments were reading out of limits due to problems experienced with data transmission from the PNSL. These alarms from the PNSL were so numerous that it was difficult to pick out the valid Separations' alarms. Since it had been planned to check out the PNSL area after the uranium run, it was decided to temporarily disconnect its instrumentation from the RTP collection system. This eliminated the problem of too many alarms.

The data transmission problems were not solved until mid-September, leaving time enough to perform only Quantity Transferred Versus Received Comparison (QTVRC), Transfer Flow Direction Confirmation (TFDC), and Storage Function (SF) programs with the PNSL instrument data directly. The PNSL PAMALA program was checked out from the RTP using a data simulator to enter manual data. Finally, late in September, channel checks were performed to confirm satisfactory data receipt at the RTP system. Further testing will be scheduled in FY 1980 to confirm that the PNSL PAMALA program is operational.

4.3 Evaluation

The PAMALA program was a successful first step in the development of a CNMCAS process monitoring system. This program performed its function exactly as it was designed with only minor problems.

The alarm message that is used in the present form of the PAMALA program contains the following:

(1) Time
(2) Date
(3) Instrument Number
(4) Low Limit
(5) High Limit
(6) Measured Value.

The low limit is printed in blue; the high limit is printed in red; and the measured value is printed in red if it is above the limit and blue if it is below the limit.

In order to more easily identify the vessel and system with which a particular alarm is associated, the vessel name and number should be included in the display.

4.4 Recommendations

Based on test results, the following revisions to the PAMALA program are recommended:

- In order to more rapidly survey the operation of the entire process, it would be helpful to combine this PAMALA information with the

information gathered by the Process Status Function and the Analytical Summary Program.

- Use of a combined graphic display of PAMALA, PSF, and AS data, by process systems, appears to be an excellent way to transmit the data. The program could be designed to cycle through the systems (i.e., codecontamination, second uranium, second plutonium, etc.) automatically with a manual override to lock a specific system on the screen if desired. A schematic of the system could be displayed with parameters shown at their process locations.

- The program should be expanded to permit multiple alarm levels to be applied to a given reading. Responses to various alarm levels would be different in terms of timing, degree of corrective action applied, etc.

- An alarm evaluation and suggested response(s) should be added to the program. This would necessarily have to be an on-going effort because of the variety of possible causes for a given alarm.

- The capability to promptly update the RTP data base file when an instrument range is changed should be provided. This would also be useful for making limit adjustments on readings that may change from process campaign to process campaign.

- The capability to review and flag out-of-limit values for analytical results would be another useful addition to PAMALA.

- An operations input for each PAMALA alarm should be included to provide documentation of the response to each alarm. At present, there is no explanation as to how, when, or who cleared an alarm.

EXHIBIT 4-1

PRINTOUT OF PAMALA ALARMS

TIME	DATE	INSTR. #	LOW LIMIT	HIGH LIMIT	MEAS. VALUE
22:45:27	11- 7-79	FR-205	13.00	******	12.552
22:45:41	11- 7-79	LR-239	7.30	73.00	2.824
22:45:48	11- 7-79	LR-302	10.00	180.00	3.600
22:45:54	11- 7-79	LR-303	10.00	180.00	7.044
22:46:11	11- 7-79	LR-402	10.00	110.00	112.387
22:46:41	11- 7-79	LI-515	******	49.00	53.948
22:46:48	11- 7-79	LR-426	21.00	61.00	61.851
22:46:54	11- 7-79	LI-466	78.00	84.00	84.294
22:47: 0	11- 7-79	LI-464	4.00	******	- 2.409
22:47: 7	11- 7-79	LR-430	50.00	90.00	96.266
22:47:13	11- 7-79	LR-411	32.00	46.00	47.648

5.0 QUANTITY TRANSFERRED VERSUS RECEIVED COMPARISON

5.1 Purpose

5.1.1 QTVRCS (Separations) Subprogram

The purpose of this program is to compare the quantity that is transferred from the uranium product sample tank to the quantity received in the accountability tank and alarm the operator of the situation that requires investigation.

5.1.2 QTVRCP (Plutonium Nitrate Storage Area -- PNSA) Subprogram

The purpose of the Quantity Transferred Versus Received Comparison - PNSA (QTVRCP) Program is to compare the quantity of solution transferred with the quantity of solution received and alarm the control room operator of a situation that requires investigation. The sending/receiving vessel combination is such that the transfer may be from the Plutonium Product Cell (PPC) area to the PNSA or may be within the PNSA. Consideration is also given to the fact that the sending or receiving vessel may be a module (combination of six tanks) as opposed to a single tank.

5.2 Description

5.2.1 QTVRCS (Separations) Subprogram

The Quantity Transferred Versus Received Comparison (Separations) Subprogram is integrated with the measurement programs for the uranium product sample tank and the accountability tank.

When the uranium product sample tank's measurement program completes the after-transfer measurement, the quantity of solution transferred is calculated and is saved in the accountability tank's temporary file.* When the accountability tank's measurement program is reactivated by the operator (after the transfer into the tank is completed), the measurement program gets the before-sample data, calculates the quantity of solution received, and saves this value in the accountability tank's temporary file. The QTVRCS subprogram is now activated (by the accountability tank's measurement program). The QTVRCS subprogram accesses the accountability tank's temporary file and compares the quantity transferred with the quantity received. If the difference is greater than the specified limit, the comparison is flagged. After the QTVRCS subprogram prints a report to the operator, it returns control to the accountability tank's measurement program.

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*This file is set up by the measurement program as an interim data storage area.

5.2.2 QTVRCP (PNSA) Subprogram

The QTVRCP (PNSA) subprogram consists of a general measurement routine similar to the measurement programs for input/output points. This measurement routine allows for data collection and temporary data storage. This routine guides the operator through before-sampling, after-sampling, and after-transfer measurements for the source vessel and through before-receipt, before-sampling, and after-sampling measurements for the receiving vessel. The subprogram calculates the quantity transferred and the quantity received and compares the two values. If the difference is greater than the specified limit, an out-of-limits message is printed to the operator. A summary report is also printed to the operator (see Exhibit 5-1).

5.3 Tests

5.3.1 Separations Test

During the Subruns 2 and 3 of the FY 1979 Uranium Run, transfers made between the uranium product sample tank and the accountability tank were checked with the QTVRCS program.

5.3.2 PNSA Test

A test of the QTVRCP program was conducted after the integrated uranium run. Ruskas* were hooked to the level and density transmitters of PNSA tanks 36-D-312A and 36-D-314A and PPC tank 35-D-304. The program was set up to read these Ruskas as well as the Taylor* instruments. Manual readings were also recorded from the Ruska and Taylor instruments. By using these six Ruskas, the following vessels were represented:

(1) 35-D-304 -- PPC Plutonium Product Storage Tank
(2) 36-D-312A -- PNSA Plutonium Product Storage Tank
(3) 36-D-314A -- PNSA Plutonium Product Storage Tank
(4) Module 5 -- PNSA Plutonium Product Storage Module**
(5) Module 7 -- PNSA Plutonium Product Storage Module**

The QTVRCP program was tested on each of the following transfers:

(1) From a PPC plutonium product storage tank to a PNSA plutonium storage tank
35-D-304 → 36-D-312A

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*A Ruska is a DDR-6000 precision differential pressure gauge. A Taylor instrument is the brand name of the process instruments used in the Separations Facility.

**The drain valves for all six vessels in a module are opened and the level and density transmitters on the "A" tank are used to represent the whole module (MOD 5 = 36-D-312A, MOD 7 = 36-D-314A).

(2) From a PPC plutonium product storage tank to a PNSA plutonium storage module
35-D-304 → MOD 5

(3) Between two PNSA plutonium storage tanks
36-D-312A → 36-D-314A
36-D-314A → 36-D-312A

(4) From a PNSA plutonium product storage tank to a PNSA plutonium storage module
36-D-312A → MOD 7
36-D-314A → MOD 5

(5) Between two PNSA plutonium storage modules
MOD 5 → MOD 7
MOD 7 → MOD 5

5.4 Evaluation

The QTVRCP program is very similar to the measurement programs used for normal input/output measurements. These measurement programs have been under development for two years and have very few bugs left in them. Because of this, very few problems were encountered with the QTVRCP program.

One minor problem with the QTVRCP (PNSA) program is that the operator inputs the measurement point for the source and destination vessels at the beginning of each transfer. If a mistake is made here and the wrong measurement point number is entered, then measurement data is collected on the wrong vessel. A double check of the numbers should be incorporated into the program.

The QTVRCS program carried out its function for the whole FY 1979 campaign with no problems or changes.

5.5 Recommendations

- Have the Transfer Flow Direction Confirmation (TFDC) program run as a subprogram of the QTVRC program. (See Section 9.0 for a full description of TFDC.)

- Set up QTVRCP so that the last step will automatically enter the destination vessel in the list of tanks being monitored by the PNSA storage function program. (See Section 10.0 for a full description of SF.)

- Another program which will probably be required is a Product Transfer Authorization Program. Transfer of SNM would require an input from operations, requesting permission to transfer a stated quantity of material from point A to point B. This, in turn, would be approved with an input from NMC (and possibly others). The QTVRC program could be revised to check the transfer and receiving points before proceeding.

EXHIBIT 5-1

SUMMARY OF TRANSFER FROM QTVRCP

FROM 03060 - 19 PU NIT STR MODULE #7 TO 03058 - 25 PU NIT STR MODULE #5

22-Sep-79 07:35 AM

SOURCE VESSEL	BEFORE SAMPLE	AFTER SAMPLE	AFTER TRANSFER	DESTINATION VESSEL	BEFORE RECEIPT	BEFORE SAMPLE	AFTER SAMPLE
LJR-3602-13(IN H2O)	107.64	107.64	75.71	LJR-3602-1(IN H2O)	158.09	191.81	191.84
LJR-3602-13R(CM H2O)	108.20	108.20	76.11	LJR-3602-1R(CM H2O)	155.15	187.21	187.23
DJR-3602-13	29.076	29.076	29.077	DJR-3602-1	29.078	29.079	29.080
DJR-3602-13R(CM H2O)	83.117	83.101	51.389	DJR-3602-1R(CM H2O)	131.170	163.088	163.122
TJR-3602-13(DEG C)	32.0	32.0	32.1	TJR-3602-1(DEG C)	25.2	25.2	25.1
LJR-3602-13(CM H2O)	107.64	107.64	75.71	LJR-3602-1(CM H2O)	158.09	191.81	191.84
LJR-3602-13R(CM H2O)	108.20	108.20	76.11	LJR-3602-1R(CM H2O)	155.15	187.21	187.23
DJR-3602-13(G/ML)	1.153	1.153	1.153	DJR-3602-1(G/ML)	1.143	1.143	1.143
DJR-3602-13R(G/ML)	.995	.995	.980	DJR-3602-1R(G/ML)	.943	.948	.947
TJR-3602-13(DEG C)	32.0	32.0	32.1	TJR-3602-1(DEG C)	25.2	25.2	25.1
VOLUME (LITERS)	1974.900	1973.850	1388.360	VOLUME (LITERS)	3010.910	3629.790	3629.790
SOLUTION (KG)	1964.370	1964.240	1361.090	SOLUTION (KG)	2837.970	3441.190	3441.600
VOLUME TRANSFERRED	585.486 LITERS			VOLUME RECEIVED	618.881 LITERS		
SOLUTION TRANSFERRED	603.151 KG			SOLUTION RECEIVED	603.218 KG		
LEVEL COMPARISON	.566	.562	.398	LEVEL COMPARISON	-2.944	-4.604	-4.612
DENSITY COMPARISON	-.158	-.158	-.173	DENSITY COMPARISON	-.200	-.195	-.196
BS TO AS COMPARISON	.123			BR TO BS COMPARISON	-603.218		
BS TO AT COMPARISON	603.274			BR TO AS COMPARISON	-603.624		
AS TO AT COMPARISON	603.151			BS TO AS COMPARISON	-.407		

TRANSFERRED VERSUS RECEIVED DIFFERENCE = -.0667725 KG
(AS-AT TO BR-BS)

ACCEPTABLE RANGE = .5 KG

6.0 PHYSICAL INVENTORY MONITORING

6.1 Description

One of the problems associated with the performance of a physical inventory in a reprocessing plant is the verification that nothing has been added to or removed from a vessel once the official inventory measurements and samples have been taken. The purpose of the PIM program is to perform this verification function, upon request, as each vessel is inventoried. If the liquid level of solution in the vessel changes by more than a preset amount prior to completion of the inventory, it is flagged.

6.2 Test

The PIM program was tested during the inventory of the third campaign. The operation of PIM consists of selecting one of six options for the program to perform. The following is a list of these options:

- LIS -- List Active Data Base
- ADD -- Add New Vessel to Active Data Base
- DIS -- Disable RTP Measurement For a Vessel
- RTP -- Collect RTP Measurement Data
- SUM -- Print Summary of all Points
- DEL -- Delete PIM Data Base.

A test of each option was conducted.

The "DIS" option was added during the conduct of these tests. It was discovered that, after entering a vessel into the program, there was no way to remove it if it became necessary to reinventory that vessel. With the DIS option, it is possible.

To test the overall performance of the program, an auto valve was opened slightly, allowing 12 M HNO_3 to leak into a vessel that was being monitored with the PIM program. The program was arbitrarily set to alarm if the current reading changed from the original reading by more than seven inches of water. The program alarmed when the limit was exceeded. The valve was closed and the reading stabilized (see Exhibit 6-1).

To be an applicable monitoring tool, the alarm setting must be reduced considerably. Based on the fact that the level in the other vessels varied by less than 0.20 inches of water during the test (see Exhibit 6-2), an acceptable lower limit of approximately 0.25 inches could be applied.

6.3 Evaluation

Even though this was the first attempt at designing a PIM program, it does a thorough job of monitoring the inventoried vessels and alarming the operator of abnormal conditions. There were some minor problems, but they do not affect the basic design.

Even though the process level instrumentation used in the PIM program may not be the most accurate available, it has been shown to be very consistent. This will permit narrowing the "acceptable level change" within the program to where the program can detect very small increases or decreases in level.

6.4 Recommendations

Based on the experience gained during this test, the following changes are recommended to improve this program:

- The "RTP" option, which collects measurement data on all the vessels in the PIM data base, only runs when requested by the operator. In order to truly monitor the inventoried vessels, the RTP readings should be taken on a regular basis without operator assistance.

- This program should be set up to work automatically in conjunction with the Physical Inventory Program which has not been implemented yet. (The Physical Inventory Program will calculate the volume, kilograms uranium, kilograms solution for all the vessels which have been measured and isolated for inventory.)

- Enough measurement data on each vessel should be collected and evaluated so that a minimum "acceptable level change" can be set for each vessel.

- When they occur, alarms should be transmitted to the Safeguards Control Center (SCC) for recording and monitoring of the response.

EXHIBIT 6-1

PRINTOUT FROM PIM TEST

02040 DISS ACID SURG TK LR-607 ACCEPTABLE LEVEL CHANGE = 7

DATE	TIME	LEVEL	LEVEL CHANGE	FLAG
17- 7-79	8: 3	43.89		
17- 7-79	9:29	44.24	-.35	
17- 7-79	12:54	44.48	-.59	
17- 7-79	15:44	44.90	-1.01	
17- 7-79	18:40	45.18	-1.29	
17- 7-79	23: 4	46.51	-2.62	
17- 7-79	23:43	46.35	-2.46	
18- 7-79	8: 1	48.57	-4.68	
18- 7-79	8:44	48.72	-4.82	
18- 7-79	9:26	48.88	-4.99	
18- 7-79	13: 7	49.51	-5.62	
18- 7-79	15: 3	49.72	-5.83	
18- 7-79	15:58	49.84	-5.95	
18- 7-79	20:46	51.25	-7.36	****
19- 7-79	8:47	52.40	-8.51	****
19- 7-79	10:46	53.15	-9.26	****
19- 7-79	12:24	52.98	-9.09	****
19- 7-79	15:11	53.12	-9.23	****
19- 7-79	19:26	52.42	-8.53	****
19- 7-79	22: 4	52.25	-8.36	****
22- 7-79	17:24	52.18	-8.29	****
22- 7-79	23:47	52.16	-8.27	****
23- 7-79	6:39	52.14	-8.25	****
23- 7-79	17:16	52.25	-8.36	****
24- 7-79	7:51	52.61	-8.72	****
24- 7-79	9:12	52.58	-8.69	****

EXHIBIT 6-2

PRINTOUT OF NORMAL PIM DATA

02045 2 DISS LR-102 ACCEPTABLE LEVEL CHANGE = 7

DATE	TIME	LEVEL	LEVEL CHANGE	FLAG
16- 7-79	16:28	25.69		
16- 7-79	17:54	25.65	.04	
16- 7-79	18:53	25.69	NA	
16- 7-79	18:59	25.65	.04	
16- 7-79	21:25	25.69	NA	
16- 7-79	22:29	25.80	-.11	
17- 7-79	7:58	25.69	NA	
17- 7-79	8: 3	25.65	.04	
17- 7-79	9:29	25.72	-.04	
17- 7-79	12:54	25.62	.07	
17- 7-79	15:44	25.65	.04	
17- 7-79	18:40	25.62	.07	
17- 7-79	23: 4	25.62	.07	
17- 7-79	23:43	25.62	.07	
18- 7-79	8: 1	25.62	.07	
18- 7-79	8:44	25.58	.11	
18- 7-79	9:26	25.64	.05	
18- 7-79	13: 7	25.64	.05	
18- 7-79	15: 3	25.60	.09	
18- 7-79	15:58	25.57	.12	
18- 7-79	20:46	25.62	.07	
19- 7-79	8:47	25.63	.06	
19- 7-79	10:46	25.65	.04	
19- 7-79	12:24	25.69	NA	
19- 7-79	15:11	25.62	.07	
19- 7-79	19:26	25.62	.07	
19- 7-79	22: 4	25.62	.07	
22- 7-79	17:24	25.52	.16	
22- 7-79	23:47	25.55	.14	
23- 7-79	6:39	25.58	.11	
23- 7-79	17:16	25.55	.14	
24- 7-79	7:51	25.55	.14	
24- 7-79	9:12	25.57	.12	
24- 7-79	22:44	25.55	.14	
25- 7-79	7:34	25.58	.11	
27- 7-79	5:54	25.52	.16	

7.0 PROCESS STATUS FUNCTION

7.1 Description

The purpose of the Process Status Function (PSF) is to replace manual operations data collection with computerized data collection, storage, and retrieval.

The PSF program has divided the process into 17 sections and the operator can request that data be collected for any or all of the following sections:

- 0 - Terminate
- 1 - Feed Preparation
- 2 - Co-decontamination and Partitioning
- 3 - Second Uranium Cycle
- 4 - Uranium Product Concentration and Storage
- 5 - Second Plutonium Cycle
- 6 - Third Plutonium Cycle
- 7 - Plutonium Product Concentration and Storage
- 8 - VOG/DOG
- 9 - HAW Concentrator
- 10 - General Purpose Concentrator
- 11 - LAW Concentrator
- 12 - Service Concentrator
- 13 - Acid Fractionator and Overhead Vaporizer
- 14 - 1S System
- 15 - No. 1 Solvent System
- 16 - No. 2 Solvent System
- 17 - Chemical Tanks.

The operator selects a section of the process on which data needs to be taken. The PSF program sends a request for the required readings to the RTP data collection system. When the data has been collected by RTP, it is transmitted to the PSF program. The PSF program prints the data on the operator terminal in the format shown in Exhibits 7-2 and 7-3.

7.2 Test

The PSF program performs two simple functions. It collects data on selected PSF vessels and provides a printed summary of the data. Both of these functions were tested during the integrated uranium run and a printout of all 17 sections was obtained.

7.3 Evaluation

This program satisfactorily performs the function of gathering operational data on certain vessels, putting the data with the proper vessel, and combining the number of vesssls into a process section. It then allows the operator to choose which process section he would like to have printed out.

After the operator has chosen a section of the process for data collection, the readings are collected. The problem is that whether or not the operator chooses one or all of the sections, the program collects data for every vessel in all 17 sections. It then gives a printout of the ones choosen.

The printout of each section contains time, date, measurement point number, instrument identification, range, and reading. The vessel name is also given with the measurement number in some cases. The vessel name is very helpful to the operator in using the information provided by this printout.

7.4 Recommendations

As a result of the tests run on the PSF program, it is believed that the following changes would improve the operation and usefulness of the program:

- Set up the program to take only readings on the process section that has been requested. This would greatly reduce the time involved in running this program.

- Update the tank I.D. file to include the vessel name or flow name for every measurement point. This would improve the flexibility of the files.

- As indicated in the first item of Section 4.4, this function could be combined with the Parameter Monitoring and Alarm Program and the Analytical Summary Program.

EXHIBIT 7-1

PROCESS STATUS FUNCTION (FEED PREPARATION)

FEED PREPARATION 17-Sep-79 01:19 PM PAGE 1

	TIME	13:05	12:41	18:24	18:40	02:35	19:21	19:00	18:13	12:53	11:10
	DATE	9/17	9/17	7/10	7/09	7/09	7/03	7/03	7/03	6/27	6/26
	02001 FD SURG TK										
LR-121	0-62.5 INCHES	26.9	26.9	11.6	11.9	12.0	12.9	13.0	13.0	13.8	14.7
DR-164	14.5 INCHES	10.5	10.6	9.1	9.1	9.1	9.1	9.1	9.1	10.0	10.2
	02003 ACCT TK										
LR-125	25.8-129 INCHES	4.3	4.3	55.6	20.0	70.7	173.6	173.6	173.7	16.5	19.5
DR-166	14.95 INCHES	9.1	9.1	15.0	14.9	14.9	14.5	14.5	14.5	14.6	14.1
	02002 DISS FLSH ACCUM TK										
LR-128	0-136.3 INCHES	3.3	3.3	20.9	20.5	20.8	20.5	20.5	20.6	18.4	18.7
DR-167	15.4 INCHES	9.0	9.0	10.5	10.4	10.4	10.4	10.4	10.4	10.4	10.4
	02005 1 FD ADJ TK										
LR-129	114-142.5 INCHES	156.0	155.8	167.5	163.4	101.4	149.8	149.9	149.9	143.5	101.1
DR-168	14.5 INCHES	10.2	10.2	13.1	14.6	14.4	11.8	11.9	11.8	14.4	11.8
	02006 2 FD ADJ TK										
LR-130	114-171 INCHES	51.3	51.4	165.8	35.8	34.9	168.0	168.0	167.9	111.7	151.6
DR-169	14.5 INCHES	10.0	10.0	14.7	14.7	14.5	14.1	14.1	14.1	14.1	13.9
	02127										
LI-131	0-17.2 INCHES	47.8	47.4	13.6	14.6	13.4	14.6	14.5	19.5	20.1	15.3

EXHIBIT 7-2

PROCESS STATUS FUNCTION (CO-DECONTAMINATION AND PARTITIONING

CO-DECON AND PARTITIONING 17-Sep-79 01:20 PM PAGE 1

		TIME	13:05	12:41	18:24	18:40	02:35	19:21	19:00	18:13	12:53	11:10
		DATE	9/17	9/17	7/10	7/09	7/09	7/03	7/03	7/03	6/27	6/26
	02052											
LR-201	0-181 INCHES		24.9	24.9	20.2	68.1	93.0	52.5	55.6	63.3	133.2	120.1
DR-201	14.41 INCHES		13.5	12.8	14.4	14.3	14.2	12.3	12.4	12.3	13.5	12.7
	02075											
FR-241	741 LPH		0.1	0.1	16.1	37.8	35.2	28.0	28.9	29.1	20.6	19.6
	02066											
LI-203	84.8 INCHES		7.6	7.6	83.4	85.4	84.0	88.2	88.6	88.0	85.1	84.6
DR-206	11.95 INCHES		6.1	6.1	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	02134 HAP											
FR-242	13.56 INCHES		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	02076											
DR-207	18.42 INCHES		7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2	7.3
	02136 HSP											
TJR-206-5	30 DEG C		28.8	28.7	36.8	36.0	40.3	35.8	36.0	36.6	37.6	38.0
	02103 HSS											
WR-208	400-464 INCHES		296.4	296.4	454.0	468.1	454.9	438.8	437.3	437.1	456.6	447.1
LR-205	19.07 INCHES		14.9	14.9	21.0	21.0	20.6	20.0	20.4	20.0	20.1	19.8
DR-209	8.92 INCHES		6.6	6.6	9.2	9.5	9.3	8.6	8.6	8.6	9.2	9.2
LI-206	21.2 INCHES		0.0	-0.0	21.8	22.8	22.5	20.9	20.9	20.6	21.4	22.2
	02032 1 BU REC TK											
LI-209	13.42-43.92 INCHES		41.2	41.2	11.3	22.2	19.9	23.8	22.5	24.3	15.4	23.3

EXHIBIT 7-2 (CONTINUED)

CO-DECON AND PARTITIONING 17-Sep-79 01:20 PM PAGE 2

		TIME	13:05	12:41	18:24	18:40	02:35	19:21	19:00	18:13	12:53	11:10
		DATE	9/17	9/17	7/10	7/09	7/09	7/03	7/03	7/03	6/27	6/26
	02106											
WR-215	123.75 INCHES		5.5	5.5	124.5	123.0	122.8	123.3	124.8	123.3	127.2	126.3
DR-220	8.96 INCHES		5.1	5.2	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
LR-212	9.95 INCHES		3.9	3.9	5.2	5.4	5.3	5.2	5.2	5.3	5.8	5.8
	02079											
FR-205	439 LPH		-0.0	-0.0	19.4	18.0	16.2	18.4	15.9	17.3	17.7	18.1
	02104											
WR-224	460 INCHES		304.3	304.3	490.7	500.8	498.3	429.0	437.4	438.9	488.4	475.9
DR-223	9.04 INCHES		6.7	6.7	8.8	8.9	8.9	8.1	8.2	8.1	8.8	8.9
LR-216	18.7 INCHES		13.1	13.1	19.9	19.8	19.9	17.0	16.9	16.9	19.3	19.2
	02105											
WR-227	391.25 INCHES		259.8	259.8	378.2	384.4	377.0	392.4	394.2	393.4	374.2	375.5
LR-219	18.42 INCHES		13.3	13.3	18.2	17.7	18.0	18.3	17.7	18.0	18.1	17.5
DR-226	8.05 INCHES		5.5	5.5	7.2	7.0	7.0	7.1	7.2	7.2	7.1	7.1
	02067											
LI-221	90 INCHES		18.5	13.7	-15.5	-19.6	-0.4	-13.0	-16.3	-14.3	-21.6	-24.7
DR-230	10.75 INCHES		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

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8.0 ANALYTICAL SUMMARY PROGRAM

8.1 Description

CNMCAS receives analytical results from the Lab Data System (LDS) and stores them by measurement point. When the Analytical Summary Program (ASP) is run, it will ask the operator which measurement point he needs analytical results for. The operator enters the measurement point number and the ASP provides a printout of the last 50 analytical results (see Exhibit 8-1). The printout contains the following:

- Heading: (1) Measurement Point Number
  (2) Tank I.D.
  (3) Date and Time of this Request
- Table: (1) Batch Number - where applicable
  (2) Log Number - identification number of this particular sample
  (3) Date - date sample was pulled
  (4) Time - time sample was pulled
  (5) Density - in grams/volume
  (6) Temp - temperature of the sample °C
  (7) Acid - HNO_3 molarity
  (8) Uranium Concentration Units -- Method - results are given in grams/liter and milligram/gram, then the method of analysis is given.
  (9) Dilution Factor - the amount the sample was diluted before analysis was performed.

8.2 Test

The only function ASP has to perform is to retrieve data from a CNMCAS file and provide a printout. The testing and development of this function was carried out during all three campaigns of the integrated uranium run.

Verification of the ASP was carried out to ensure that the analytical results were being put into the CNMCAS file and that the ASP was retrieving and printing them correctly. As a cross-check of the ASP, its printout was compared to the final analytical results issued by the Analytical Services Department.

A great deal of the testing that was done to improve ASP reliability was done on the communications link between LDS and CNMCAS. The ASP output relies completely on the information that is supplied from the CNMCAS data base via the LDS communications program.

8.3 Evaluation

The analytical summary program provides a quick and easily read printout of the 50 most recent results for most measurement points. This is a big improvement over the manual logbook system.

The ASP proved to be a reliable program as long as the LDS-CNMCAS communications link was working. Although most of the problems in the link were worked out, it still seems to be the weak point in the collection and reporting of analytical results by CNMCAS.

The ASP printout provides analytical results for acid, density, and uranium. This was a good start in the development of reporting analytical results, but the next step should be to store and report a wider variety of analysis.

Because this was the first step in the development of the ASP, analytical data for all measurement points was not collected. An important part of the next step should be to include all measurement points in the collection and reporting of data.

8.4 Recommendations

The next step in the development of the ASP should include these items:

- Update the "TANK I.D." file (see Appendix B, Page B-12) to include all measurement points and sample points.
- Expand the types of analysis reported by ASP to include N_2H_4, % organic, disengaging time, % TBP, etc.
- Develop a better link between LDS and CNMCAS. In particular, reprogram the LDS to use the same computer language operating system as the CNMCAS.
- As indicated in the first item of Section 4.4, this function could be combined with the Parameter Monitoring and Alarm Program and the Analytical Summary Program.

EXHIBIT 8-1

ANALYTICAL SUMMARY PRINTOUT

02003 ACCT TK

09-Oct-79 09:51 AM

BATCH NUMBER	LOG NUMBER	DATE	TIME	DENSITY	TEMP	ACID	U CONCENTRATION UNITS - METHOD #1 PRIMARY		#2 PRIMARY		#1 BACKUP		#2 BACKUP		DILUTION FACTOR
315	31251	7/16	13:48	1.0215	25.0	0.8	0.0	G/L-F	0.0	G/L-F					80.0000
314	31230	7/16	3:25	1.0172	25.1	0.6	0.1	G/L-F	0.1	G/L-F					80.0000
313	31223	7/15	20:13	1.0199	25.0	0.7	0.1	G/L-F	0.2	G/L-F					X 200
312	31060	7/12	12:54	0.0000	0.0	0.0	75.4	MG/G-VP	72.5	?-					0.0000
311	31045	7/11	6:16	0.0000	0.0	0.0									0.0000
310	30855	7/10	22:11	1.5258	25.0	0.5	251.7	?-	250.9	MG/G-VP					0.0000
309	30818	7/10	16:13	1.5290	24.9	0.6	251.3	?-	250.2	MG/G-VP					0.0000
308	30771	7/10	5:49	1.5306	25.0	0.7	249.9	?-	248.5	MG/G-VP					0.0000
307	30743	7/ 9	23:31	1.5112	25.0	0.6	245.1	?-	244.1	MG/G-VP					0.0000
307	0	0/ 0	0: 0	0.0000	0.0	0.0									0.0000
306	30707	7/ 9	15:11	1.5146	25.0	0.6	247.0	?-	245.6	MG/G-VP					0.0000
305	30686	7/ 9	8:35	1.5133	25.0	0.6	246.4	?-	246.3	MG/G-VP					0.0000
304	30653	7/ 9	0:59	1.5101	24.9	0.6	245.3	?-	244.9	MG/G-VP					0.0000
303	30611	7/ 8	19:48	1.5116	24.9	0.6	245.7	?-	245.4	MG/G-VP					0.0000
302	30579	7/ 8	9:50	1.4916	25.0	0.7	236.7	?-	235.0	MG/G-VP					0.0000
301	30538	7/ 8	0:33	1.4705	25.0	0.8	228.3	?-	229.4	MG/G-VP					0.0000
300	30518	7/ 7	18:37	1.4666	25.0	0.6	229.9	?-	229.9	MG/G-VP					0.0000
299	30484	7/ 7	10:35	1.4756	25.0	0.5	233.8	?-	232.3	MG/G-VP					0.0000
298	30452	7/ 7	4: 9	1.4710	25.1	0.6	231.8	?-	229.5	MG/G-VP					0.0000
297	30422	7/ 6	23:19	1.4642	25.2	1.3	218.0	?-	222.3	MG/G-VP	221.5	MG/G-VP			0.0000
296	30353	7/ 6	9:58	1.4511	25.0	0.6	224.6	?-	224.7	MG/G-VP					0.0000
295	30322	7/ 6	0:24	1.4580	25.0	0.6	226.2	?-	227.6	MG/G-VP					0.0000
294	30296	7/ 5	19: 0	1.4619	25.0	0.8	225.0	?-	225.4	MG/G-VP					0.0000
293	30221	7/ 5	3:17	1.4704	25.0	0.7	230.1	?-	229.6	MG/G-VP					0.0000
292	30090	7/ 3	4:35	1.4724	25.0	0.8	227.4	MG/G-VP							0.0000
291	30053	7/ 2	21: 0	1.4629	25.1	0.6	228.2	MG/G-VP							0.0000
290	30011	7/ 2	12:11	1.4546	25.0	0.5	225.7	MG/G-VP							0.0000
289	29971	7/ 2	3:51	1.4814	25.0	0.4	236.1	MG/G-VP							0.0000
288	29941	7/ 1	23: 1	1.4848	25.0	0.5	237.0	MG/G-VP							0.0000
287	29897	7/ 1	14:26	1.4917	25.0	0.7	236.8	MG/G-VP							0.0000
286	29861	7/ 1	5:34	1.4893	25.0	1.0	231.5	MG/G-VP							0.0000
285	29825	6/30	22:32	1.4709	25.0	1.0	223.8	MG/G-VP							0.0000
284	29792	6/30	14:47	1.4661	25.0	1.0	222.1	MG/G-VP							0.0000
283	29758	6/30	7:27	1.4661	25.0	1.1	220.3	MG/G-VP							0.0000
282	29735	6/30	0:28	1.4615	25.2	1.4	215.7	?-	215.2	MG/G-VP					0.0000
281	29668	6/29	9:12	1.4468	25.1	1.2	212.2	?-	211.7	MG/G-VP					0.0000
280	29614	6/29	0:56	1.4521	25.0	1.8	206.4	?-	205.1	MG/G-VP					0.0000
279	29537	6/28	5:54	1.4944	25.0	1.1	231.8	?-	231.6	MG/G-VP					0.0000
278	29513	6/27	21:28	1.5071	25.0	1.0	237.5	?-	236.9	MG/G-VP					0.0000
277	29425	6/27	9:20	1.4856	25.0	0.9	231.7	MG/G-VP							0.0000
276	29392	6/27	2:43	1.4762	25.0	1.0	226.0	MG/G-VP							0.0000
275	29326	6/26	14: 7	1.4584	25.0	1.6	210.4	MG/G-VP							0.0000
274	29066	6/22	14:47	0.0000	0.0	0.0									0.0000
273	29058	0/ 0	0: 0	1.4692	25.0	1.7	214.3	MG/G-VP							0.0000
272	29058	6/22	8:41	0.0000	0.0	0.0									0.0000
271	28948	6/19	2: 6	1.4667	25.0	1.7	213.1	?-	213.6	MG/G-VP					0.0000
270	28830	6/16	17:16	0.0000	0.0	0.0	238.1	?-	237.3	MG/G-VP					0.0000
269	28819	6/16	10:59	1.4956	24.9	1.1	232.5	?-	232.8	MG/G-VP					0.0000
268	28735	6/15	13:29	1.5124	25.0	1.1	238.4	MG/G-VP	238.0	?-					0.0000
267	28659	6/14	22:25	1.5126	25.0	1.0	240.6	MG/G-VP	239.7	?-					0.0000

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9.0 TRANSFER FLOW DIRECTION CONFIRMATION

9.1 Description

The purpose of the Transfer Flow Direction Confirmation (TFDC) Program is to monitor a transfer route and alarm the operator of situations where the solution flow is misdirected (completely or partially). This function requires a dedicated terminal.

When activated by the operator, the TFDC Program prompts the operator for the source and destination vessel identification. The program accesses the TFDC(1) File to determine which alternate destination vessels must be monitored, and gets RTP level measurement data for the source vessel, destination vessel, and all alternate destination vessels. The program then monitors the source vessel at one-minute intervals, using current RTP measurement data to calculate the change in liquid level from the original level. When this change in level is greater than the "level change indicator"(2) (contained in the TANK I.D. file), the liquid level change has been confirmed. The program then begins monitoring, at one-minute intervals, the destination and alternate destination vessels.

During each one-minute interval, the program collects RTP level measurement data, calculates the change in liquid level from the original level, and compares it to the level change indicator. If the change in level is greater than the indicator, the change in level is flagged. The program then prints the time and date, change in level for each tank, and any flags that have been set. See Exhibit 9-1 for example of the report.

When the operator confirms that the correct transfer route was chosen, the program is terminated and the terminal assumes a nondedicated mode.

9.2 Test

To test this program, transfers were made from a PPC plutonium product storage tank (35-D-304) to a PNSA plutonium product storage tank

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(1) An analysis has been made for each transfer route (i.e., point A → B, A → C, etc.) identifying potential alternate destination vessels. Unauthorized transfer to these other destination vessels could occur because of valving errors, leaky valves, plugged lines, or use of the wrong transfer device at the source vessel.

(2) The "level change indicator," which is the amount the level can change due to normal variation in the transmitter, was set on all vessels at an arbitrary number. It will be possible, after collecting enough data on each vessel, to set this value based on a statistical variance.

(36-D-312A). Instead of terminating the program when the correct transfer route was confirmed, it was allowed to run until the transfer was complete. During one of the transfers, a misdirection test was done by opening the inlet valves on two of the alternate destination vessels.

9.3 Evaluation

The only input from the operator for this program is:

(1) Start program
(2) Enter source and destination vessel measurement point numbers
(3) Stop program.

If the wrong numbers were entered for either the source or destination vessel, the program would do all of its operations on the wrong vessels. Therefore, it is important to enter the proper measurement point numbers.

This program ran smoothly during all transfers, including the misdirection test. The dialog between the program and the operator was easy to understand and the final printout clearly showed the vessels which were out of limits.

9.4 Recommendations

(1) After entering the source and destination vessel measurement points, the program should print them back to the operator and ask for confirmation.

(2) Historical information should be collected on each measurement point to determine what the "level change indicator" for that vessel should be.

(3) The program should be set up to run as a subprogram of the Quantity Transferred Versus Received Comparison (QTVRC) program.

(4) Development work should be done to tie this program into the Closed-Loop Control* (CLC) demonstration in the PNSA. (See Report No. AGNS-35900-3.2-57 for explanation of CLC system.)

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*An Advanced Safeguards System Development Activity.

EXHIBIT 9-1

TRANSFER FLOW DIRECTION CONFIRMATION PRINTOUT

02011 1 PU PROD ST TK

TRANSFERRED TO

03025 PU NIT STR #5

13-Sep-79 07:40 PM

TIME	TANK 02011	TANK 03025	TANK 03003	TANK 03009	TANK 03015	TANK 03021	TANK 03026	TANK 03027	TANK 03028	TANK 03029	TANK 03030	TANK 03033	TANK 03039	TANK 03045
ORIG	265.211	130.751	-1.28055	-.781342	-.195343	-4.64468	75.2698	61.8295	59.4963	62.3287	-88.314	91.9114	78.8835	72.6599
TFDC> YOU MAY NOW START THE TRANSFER														
2007	228.59	131.277	-1.30768	-.781342	-.195343	-4.64468	75.2698	61.7699	58.9972	61.8567	-88.314	91.4122	78.7696	72.5514
FLAG														
TFDC> TYPE 'S' TO EXIT TFDC> ....PROCEEDING....														
2009	229.002	144.777	-1.28055	-.781342	-.195343	-4.64468	74.5753	61.7699	58.9972	61.8567	-88.314	91.4122	78.7696	72.5514
FLAG														
TFDC> TYPE 'S' TO EXIT TFDC> ....PROCEEDING....														
2011	229.002	144.777	-1.28055	-.781342	-.195343	-4.64468	75.1342	61.938	59.800_	62.6869	-88.2869	92.2207	78.9107	72.8281
FLAG														
TFDC> TYPE 'S' TO EXIT TFDC> ....PROCEEDING....														
2014	213.133	149.53	-1.28055	-.781342	-.195343	-4.64468	75.1342	61.938	59.8002	62.6869	-88.2869	92.2207	78.9107	72.8281
FLAG														
TFDC> TYPE 'S' TO EXIT TFDC> ....PROCEEDING....														
2016	213.133	164.224	-1.28055	-.781342	-.195343	-4.64468	74.4396	61.5474	58.8289	61.6342	-88.314	91.3851	78.7425	72.5242
FLAG														
TFDC> TYPE 'S' TO EXIT TFDC> ....PROCEEDING....														
2018	178.832	164.224	-1.28055	-.781342	-.195343	-4.64468	74.4396	61.5474	58.8289	61.6342	-88.314	91.3851	78.7425	72.5242
FLAG														
TFDC> TYPE 'S' TO EXIT TFDC> ....PROCEEDING....														
2020	178.832	164.891	-1.28055	-.781342	-.195343	-4.64468	74.8303	61.7156	58.9646	61.8024	-88.314	91.6076	78.6882	72.5514
FLAG														
TFDC> TYPE 'S' TO EXIT TFDC> ....PROCEEDING....														
2022	178.869	164.891	-1.28055	-.781342	-.195343	-4.64468	74.8303	61.7156	58.9646	61.8024	-88.314	91.6076	78.6882	72.5514
FLAG														
TFDC> TYPE 'S' TO EXIT TFDC> ....PROCEEDING....														
2025	178.92	164.029	-1.28055	-.781342	-.195343	-4.64468	74.8303	61.8024	59.2468	62.1063	-88.314	91.6944	78.8022	72.6056
FLAG														
TFDC> TYPE 'S' TO EXIT TFDC> ....PROCEEDING....														
2027	178.92	164.029	-1.28055	-.781342	-.195343	-4.64468	74.8303	61.8024	59.2468	62.1063	-88.2869	92.2207	78.9649	72.8281
FLAG														
TFDC> TYPE 'S' TO EXIT S														
TFDC> [EXIT]														

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10.0 PNSA STORAGE FUNCTION

10.1 Description

A Storage Function (SF) Program has been developed to monitor static conditions in a vessel. The program alarms when a significant change occurs. This program monitors specified vessels for changes in either the indicated level reading or in the mass of solution. When either the indicated level or the mass of solution exceeds a preset limit, an appropriate message is provided to operating personnel requiring corrective action. The Storage Function Program consists of two parts. One part collects RTP measurement data, calculates the mass of solution, compares current level reading and mass with original level reading and mass, and stores these data in the SF data base. The second part of the program generates alarm and detailed data reports.

10.2 Test

10.2.1 Storage Function

The storage function was tested using 21 of the plutonium nitrate storage tanks. With water in each of these tanks, the Storage Function Program was started, monitoring these 21 tanks. The program collected and stored level and density values for each of these vessels every 20 minutes for a 23-hour period. At the end of this period, a summary report for each tank was obtained. Two examples of these summary reports are provided as Exhibit 10-1.

10.2.2 Theft/Diversion

To provide information on the sensitivity of process instrumentation to liquid removals, a test was conducted. With the storage function monitoring six tanks, water was drained from one tank in 0.1-liter increments. The 0.1-liter removals were taken four minutes apart with tank instrument data collected by the program after each removal and additional manual readings taken from a Ruska DDR-6000 precision pressure gauge hooked in parallel to the process instrumentation.

10.3 Evaluation

10.3.1 Storage Function

The program performed as designed. The measurement data were collected and stored as expected. Reports of these data were produced for individual tanks and for summary of alarm conditions. The measurement data stored consist of an average of four to five individual readings collected over a 40-second span.

A preliminary evaluation of these data indicates that monitoring the process transmitters provides a detection sensitivity of less than 0.6 liter for an individual tank. Additional data are needed on effects

of time and temperature on transmitter variability and stability to provide a more definite assessment.

10.3.2 Theft/Diversion Tests

The theft/diversion test data showed a significant shift in level after 0.6 liter was removed. Additional data are required to determine the sensitivity when instrument drifts with time and environmental conditions.

Manually collected data showed that the level change associated with a 0.1-liter removal was clearly detectable. These data are presented in Exhibit 10-2.

10.4 Recommendations

- Further testing and development work should be done to establish the drift and variation of the process transmitters.

- Work should be completed to tie this program into the Closed-Loop Control* (CLC) demonstration in the PNSA.

- The following things should be tested while the storage function is in operation:

  (1) Theft/diversion test of a module
  (2) Determine if pulling a sample can be detected
  (3) Determine the effect of mixing a tank or a module (pump holdup).

*An advanced safeguards system development activity.

EXHIBIT 10-1

STORAGE FUNCTION SUMMARY REPORT

DATE	TIME	TANK ID	MASS (KG) ORIG	MASS (KG) CURR	MASS (KG) CHNG	MASS (KG) LIMIT	MASS (KG) FLAG	LEVEL (CM SOLN) ORIG	LEVEL (CM SOLN) CURR	LEVEL (CM SOLN) CHNG	LEVEL (CM SOLN) LIMIT	LEVEL (CM SOLN) FLAG	DENS
9/24/79	19:34	03035	380.910	380.910	NA	1.500		122.56	122.56	NA	.500		1.1608
9/24/79	19:50	03035	380.910	380.998	.0874	1.500		122.56	122.59	.027	.500		1.1608
9/24/79	20: 6	03035	380.910	380.910	NA	1.500		122.56	122.56	NA	.500		1.1608
9/24/79	20:22	03035	380.910	380.998	.0874	1.500		122.56	122.59	.027	.500		1.1608
9/24/79	20:37	03035	380.910	380.998	.0874	1.500		122.56	122.59	.027	.500		1.1608
9/24/79	20:53	03035	380.910	380.998	.0874	1.500		122.56	122.59	.027	.500		1.1608
9/24/79	21: 9	03035	380.910	381.454	.5436	1.500		122.56	122.73	.168	.500		1.1608
9/24/79	21:24	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/24/79	21:40	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/24/79	21:56	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/24/79	22:12	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/24/79	22:28	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/24/79	22:43	03035	380.910	380.734	-.1758	1.500		122.56	122.51	-.054	.500		1.1608
9/25/79	9:21	03035	380.910	380.717	-.1930	1.500		122.56	122.50	-.060	.500		1.1608
9/25/79	9:41	03035	380.910	380.279	-.6313	1.500		122.56	122.37	-.195	.500		1.1608
9/25/79	10: 1	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	10:21	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	10:41	03035	380.910	380.717	-.1930	1.500		122.56	122.50	-.060	.500		1.1608
9/25/79	11: 1	03035	380.910	380.805	-.1054	1.500		122.56	122.53	-.033	.500		1.1608
9/25/79	11:21	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	11:41	03035	380.910	381.453	.5424	1.500		122.56	122.73	.168	.500		1.1608
9/25/79	12: 1	03035	380.910	380.998	.0874	1.500		122.56	122.59	.027	.500		1.1608
9/25/79	12:21	03035	380.910	380.980	.0699	1.500		122.56	122.59	.022	.500		1.1608
9/25/79	12:42	03035	380.910	380.892	-.0177	1.500		122.56	122.56	-.005	.500		1.1608
9/25/79	13: 2	03035	380.910	380.892	-.0177	1.500		122.56	122.56	-.005	.500		1.1608
9/25/79	13:22	03035	380.910	380.998	.0874	1.500		122.56	122.59	.027	.500		1.1608
9/25/79	13:42	03035	380.910	380.892	-.0177	1.500		122.56	122.56	-.005	.500		1.1608
9/25/79	14: 2	03035	380.910	380.980	.0699	1.500		122.56	122.59	.022	.500		1.1608
9/25/79	14:22	03035	380.910	380.892	-.0177	1.500		122.56	122.56	-.005	.500		1.1608
9/25/79	14:42	03035	380.910	380.892	-.0177	1.500		122.56	122.56	-.005	.500		1.1608
9/25/79	15: 2	03035	380.910	380.892	-.0177	1.500		122.56	122.56	-.005	.500		1.1608
9/25/79	15:22	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	15:42	03035	380.910	380.910	NA	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	16: 2	03035	380.910	380.279	-.6309	1.500		122.56	122.37	-.195	.500		1.1608
9/25/79	16:21	03035	380.910	380.910	NA	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	16:45	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	17: 5	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	17:25	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	17:45	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	18: 5	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	18:25	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	18:45	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	19: 4	03035	380.910	381.173	.2625	1.500		122.56	122.64	.081	.500		1.1608
9/25/79	19:24	03035	380.910	380.823	-.0875	1.500		122.56	122.54	-.027	.500		1.1608

EXHIBIT 10-1 (CONTINUED)

DATE	TIME	TANK ID	MASS (KG) ORIG	MASS (KG) CURR	MASS (KG) CHNG	MASS (KG) LIMIT	MASS (KG) FLAG	LEVEL (CM SOLN) ORIG	LEVEL (CM SOLN) CURR	LEVEL (CM SOLN) CHNG	LEVEL (CM SOLN) LIMIT	LEVEL (CM SOLN) FLAG	DENS
9/25/79	19:44	03035	380.910	380.823	-.0875	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	20: 4	03035	380.910	380.823	-.0875	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	20:24	03035	380.910	380.910	NA	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	20:44	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	21: 4	03035	380.910	381.349	.4384	1.500		122.56	122.70	.136	.500		1.1608
9/25/79	21:24	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	21:43	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	22: 3	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	22:23	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	22:43	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	23: 3	03035	380.910	380.823	-.0875	1.500		122.56	122.54	-.027	.500		1.1608
9/25/79	23:23	03035	380.910	380.910	-.0003	1.500		122.56	122.56	NA	.500		1.1608
9/25/79	23:43	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	NA : 3	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	NA :23	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	NA :43	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	1: 2	03035	380.910	380.823	-.0875	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	1:22	03035	380.910	380.823	-.0875	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	1:42	03035	380.910	380.823	-.0875	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	2: 3	03035	380.910	380.823	-.0875	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	2:23	03035	380.910	380.910	NA	1.500		122.56	122.56	NA	.500		1.1608
9/26/79	2:42	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	3: 2	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	3:22	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	3:42	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	4: 2	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	4:22	03035	380.910	381.628	.7182	1.500		122.56	122.79	.222	.500		1.1608
9/26/79	4:42	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	5: 2	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	5:21	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	5:41	03035	380.910	381.628	.7182	1.500		122.56	122.79	.222	.500		1.1608
9/26/79	6: 1	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	6:21	03035	380.910	380.735	-.1750	1.500		122.56	122.51	-.054	.500		1.1608
9/26/79	6:41	03035	380.910	380.998	.0874	1.500		122.56	122.59	.027	.500		1.1608
9/26/79	7: 1	03035	380.910	380.823	-.0875	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	7:21	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608
9/26/79	7:41	03035	380.910	380.734	-.1758	1.500		122.56	122.51	-.054	.500		1.1608
9/26/79	8: 1	03035	380.910	380.822	-.0879	1.500		122.56	122.54	-.027	.500		1.1608

EXHIBIT 10-2

RUSKA READINGS FROM THEFT/DIVERSION TEST

The following are the Ruska readings taken after each 100 milligrams of solution was removed:

Number		Ruska Reading	Zero Reading	Ruska - Zero	Converted to Centimeters
1	LR =	.7517	-.0011	.7528	52.85
Original	DR =	.3988	-.0006	.3994	28.04
2	LR =	.7515	-.0010	.7525	52.83
	DR =	.3975	-.0006	.3981	27.95
3	LR =	.7510	-.0010	.7520	52.80
	DR =	.3973	-.0005	.3978	27.93
4	LR =	.7505	-.0010	.7515	52.76
	DR =	.3955	-.0006	.3961	27.81
5	LR =	.7502	-.0011	.7513	52.75
	DR =	.3950	-.0006	.3956	27.77
6	LR =	.7594	-.0011	.7505	52.69
	DR =	.3944	-.0005	.3949	27.72
7	LR =	.7484	-.0010	.7495	52.62
	DR =	.3936	-.0005	.3941	27.67
8	LR =	.7483	-.0011	.7494	52.61
	DR =	.3934	-.0005	.3939	27.65
9	LR =	.7482	-.0011	.7493	52.61
	DR =	.3930	-.0005	.3935	27.63
10	LR =	.7478	-.0010	.7488	52.57
	DR =	.3933	-.0006	.3939	27.65
11	LR =	.7475	-.0012	.7487	52.56
	DR =	.3923	-.0007	.3930	27.59
12	LR =	.7464	-.0012	.7476	52.49
	DR =	.3924	-.0007	.3931	27.60
13	LR =	.7462	-.0012	.7474	52.47
	DR =	.3917	-.0007	.3924	27.55
14	LR =	.7458	-.0012	.7470	52.44
	DR =	.3912	-.0007	.3919	27.51
15	LR =	.7448	-.0012	.7460	52.37
	DR =	.3907	-.0007	.3914	27.48
16	LR =	.7447	-.0012	.7459	52.37
	DR =	.3903	-.0007	.3910	27.45
17	LR =	.7441	-.0012	.7453	52.33
	DR =	.3897	-.0007	.3904	27.41

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11.0 HAF FLOW RATE PROGRAM

11.1 Description

The PM/PS subsystem has a program which calculates the flow rate of the High-Activity Feed (HAF) stream. The program computes the flow rate two separate ways and displays the results of both methods on a CRT in the control room. One method is a subprogram which uses the output from the HAF flow transmitter and calculates the flow in liters per hour (lph) and metric tonnes uranium (MTU)/day. The other method is a subprogram which measures the depletion out of the No. 1 and No. 2 Feed Adjustment Tanks (FAT's) and out of the HA feed tank, adds them together, and converts it to a flow rate in lph and MTU/day.

11.1.1 HAF Flowmeter Subprogram

Between the HA feed tank and the HA contactor, there is a flow transmitter which measures the flow rate of the HAF stream (see Exhibit 11-1). The HAF flowmeter subprogram gets a raw reading from RTP for this flow transmitter and does a calculation to convert it to lph. Then, the program gets the RTP raw reading for the HA feed tank density transmitter and calculates the density. Using that density and assuming the acid molarity in the HA feed tank is 2.5 M, the program calculates a uranium concentration using the UCALC* formula. Next the program calculates metric tons of uranium per day (MTU/day). This final answer is displayed on a CRT in the control room. This flow rate is updated every 20 minutes.

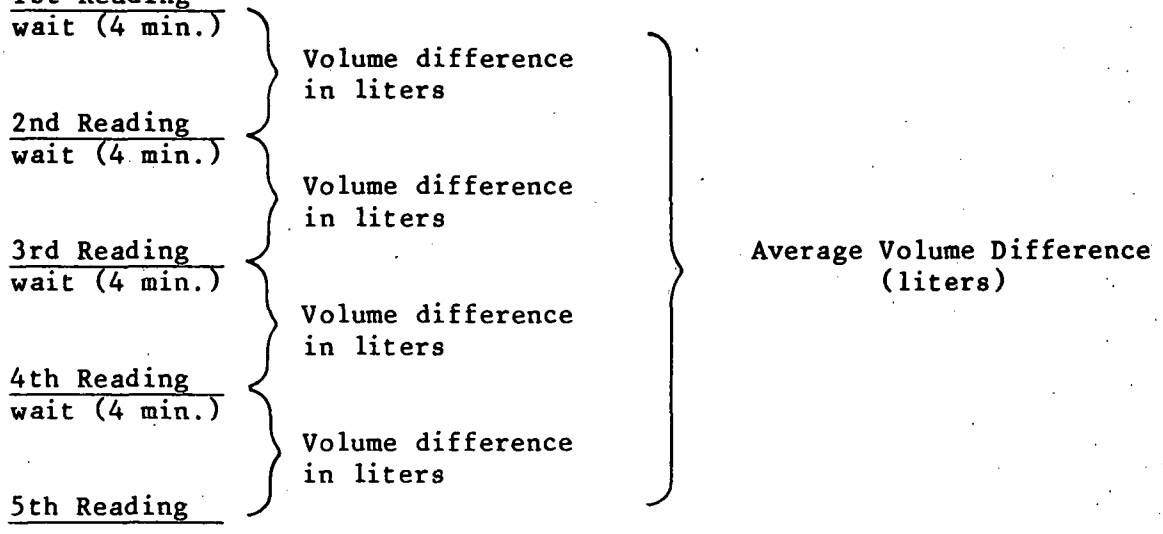
11.1.2 HAF Tank Depletion Subprogram

After the solution in either of the feed adjustment tanks (FAT) has been adjusted, it is jetted through the centrifuge to the HA feed tank from which it is continuously fed to the solvent extraction system. The tank depletion program uses RTP readings to calculate the flow (depletion) in liters per hour for each of the three tanks. The following is a breakdown of how the calculation is done:

$$*UCALC = \frac{-105.82 - 4.473(H^+) + \sqrt{-1.6057E\text{-}5 - 5.2388E\text{-}7(H^+) + 1.743E\text{-}8(H^+) + 1.6388E\text{-}5(DN)}}{8.194E\text{-}6}$$

Where $H^+ = HNO_3$ molarity and DN = solution density in gm/cc.

RTP Readings



$$\frac{\text{Average Volume Difference (liters)}}{1} \times \frac{15}{\text{hour}} = \text{lph}$$

A nominal 5% dilution factor (typical for a steam jet transfer system) is added to the calculated flows for the No. 1 and the No. 2 feed adjustment tanks and the three rates are combined to yield an HAF flow rate. Now the tank depletion program goes through the same calculation that the flowmeter method does to figure MTU/day. The final result is displayed on the CRT in the control room directly underneath the flowmeter result (see Exhibit 11-2).

11.2 Test

Testing of this program consisted of allowing it to run on its 20-minute cycle during normal process operations and comparing randomly-selected flow rates against manually-derived data.

11.3 Evaluation

This program ran with no problems during the second and third campaigns of the 1979 integrated uranium run. It proved to be an accurate calculation of the flow rate in lph and in MTU/day. Since the flow rate was constantly displayed on the CRT in the control room, it was always available to assist process operation.

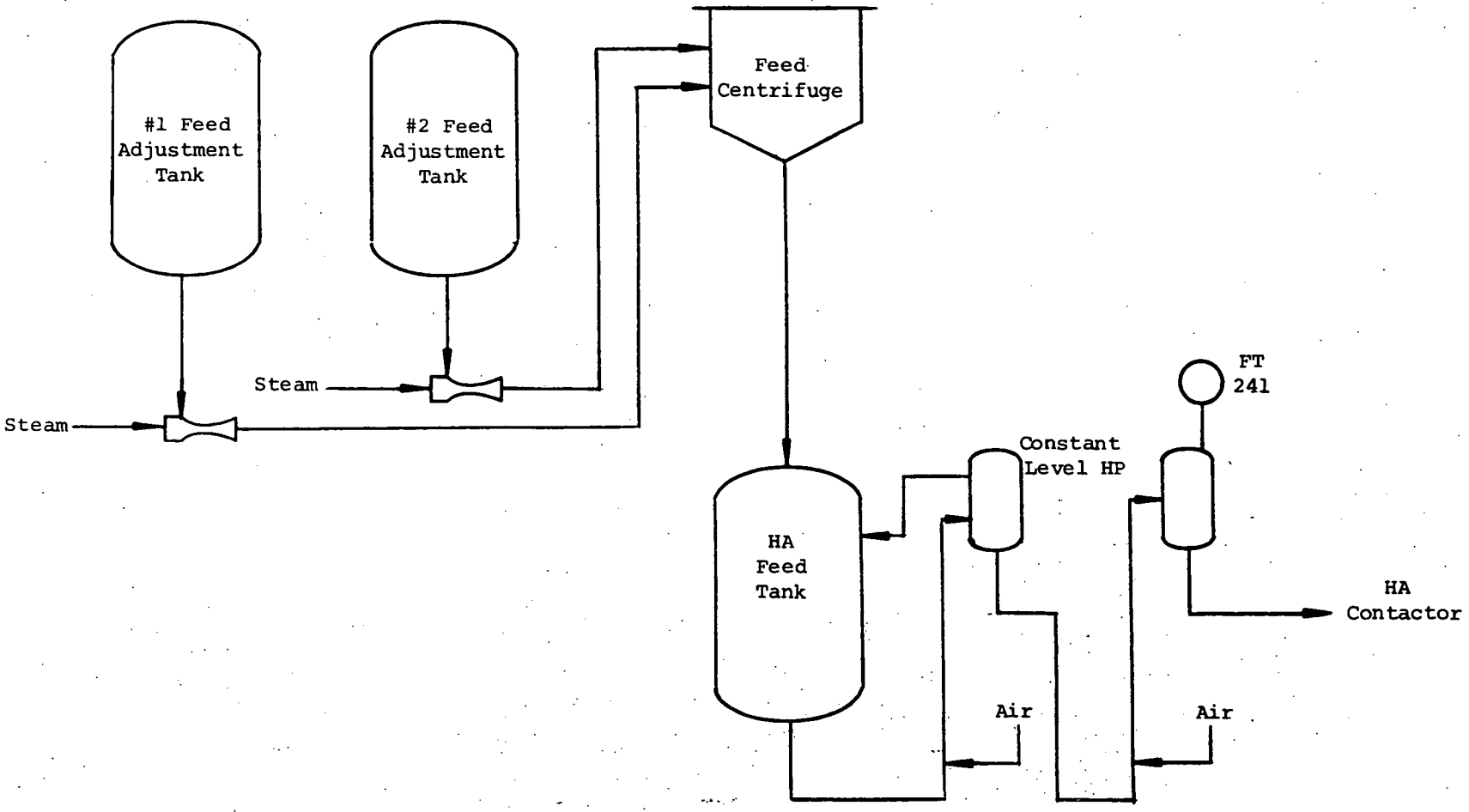
The uranium concentration of the HA feed tank is constantly changing because either one or the other of the FAT's is almost always being jetted into it and the HA feed tank is continuously transferred to the HA contactor. Normally, the HA feed tank is not sampled. For this reason, the UCALC method is used for determining the uranium concentration in the HA feed tank.

11.4 Recommendations

(1) There are other flows in the process which are also important and it would be advantageous to automatically calculate them and display the results along with the HAF flow. For example:

- HAX = 1ph
- 2DX = 1ph
- 2EU concentrator overflow rate = 1ph + MTU/day
- HWW buildup rate = 1ph
- HWW concentration factor = $\frac{\text{HAF + HSS}}{\text{HWW}}$ = K

(2) Because intentional changes in flow rate can be accomplished in one or two minutes, the capability should be provided to calculate flow rates on request as well as under the automatic 20-minute cycle.



HAF FLOW RATE

EXHIBIT 11-1

EXHIBIT 11-2

DISPLAY OF HAF FLOW RATE

The HAF flow rate is displayed on the color CRT directly underneath the status of the four measurement programs.

Measurement Program Status as of July 6, 1979 — 01:45 pm

Tank ID	Batch Number	Initial	BR	BS	Sample	AS	Transfer	AT
02003	296	F	F	F	F			
02007	163	F	NA	F	F	F	F	F
02023	229	F	NA	F	F			
02028	685	F	NA	F	F	F	F	F

Flow Rate = 6.17 MTU/day (1,039 liters/hour) by flowmeter.

Flow Rate = 5.71 MTU/day (960 liters/hour) by depletion.

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12.0 CONCLUSIONS

This section provides a summary of the conclusions drawn from the evaluation of the PM/PS subsystem.

12.1 Accomplishments

An overall look at the PM/PS subsystem indicated that the programs, which were written and tested this year, formed a good foundation for future development of the system.

- It was demonstrated that during nearly every minute of operation all process instruments could be read, compared to a preset limit, and an alarm given if outside that limit.

- Monitoring vessels for a level increase after they have been inventoried and alarming any abnormal conditions were demonstrated.

- Calculation of the quantity of solution transferred and the quantity of solution received, comparison of these two values, and printing out the results were demonstrated for the Separations and the PNSA areas. Also in the PNSA, the QTVRC program demonstrated the ability to coordinate the collection of measurement data needed to complete the calculation, comparison, and printout.

- The ability to collect real-time information on selected sections of the process and produce a printout of it was demonstrated.

- The communications link between the Lab Data System (LDS) and CNMCAS was used to collect selected analytical information and make it available on command to the operator.

- Calculation of an important flow rate and displaying it continuously was accomplished.

- Monitoring the level of the sending and receiving vessels, as well as the level of possible receiving vessels in order to confirm flow direction, was demonstrated.

- A system which monitors the level and kilograms of solution in the PNSA storage tanks for change and alarms when an abnormal change occurs was demonstrated.

- Evaluation of the PM/PS prototype instruments indicated that a possible theft/diversion could be detected by using one or more of these instruments on a purge air line, a sparger line, or a pump flush line.

12.2 Problem Areas

- As could be expected with all programming, we had typical software "bugs".

- Although there were no problems with the Remote Data Acquisition System (RDAS) this year, a problem could arise when more than one program is running. Some of the programs collect data on a large number of measurement points and may slow down the RDAS system. For example: (1) Process Status Function, (2) PNSA Storage Function, and (3) Physical Inventory Monitoring.

13.0 RECOMMENDATIONS

13.1 Software

13.1.1 Parameter Monitoring and Alarm Program

In order to more rapidly survey the operation of the entire process, it would be helpful to combine this PAMALA information with the information gathered by the Process Status Function and the Analytical Summary Program.

- Use of a combined colorgraphic display of PAMALA, PSF, and AS data, by process systems, appears to be an excellent way to transmit the data. The program would be designed to cycle through the systems (i.e., co-decontamination, second uranium, second plutonium, etc.) automatically with a manual override to lock a specific system on the screen if desired. A schematic of the system could be displayed with parameters shown at their actual plant locations.

- The program should be expanded to permit multiple alarm levels to be applied to a given reading. Responses to various alarm levels would be different in terms of timing, degree of corrective action applied, etc.

- An alarm evaluation and suggested response(s) should be added to the program. This would necessarily have to be an on-going effort because of the variety of possible causes for a given alarm.

- The capability to promptly update the RDAS data base file when an instrument range is changed should be provided. This would also be useful for making limit adjustments on readings that may change from process campaign to process campaign.

- The capability to review and flag out-of-limit values for analytical results would be another useful addition to PAMALA. An operations input for each PAMALA alarm should be included to provide documentation of the response to each alarm. At present, there is no explanation as to how, when, or who cleared an alarm.

- The capability of being able to run this program independently of the graphics display should be retained.

13.1.2 Quantity Transferred Versus Received Comparison

- The QTVRCP program should require the operator to double check the source and destination vessel measurement point numbers before any measurements are made.

- Include the Transfer Flow Direction Confirmation (TFDC) program run as a subprogram of the QTVRC program.

- Have the QTVRCP program to automatically enter the destination vessel in the list of tanks being monitored by the PNSA Storage Function Program.

- Have a Product Transfer Authorization Program which would require Operations to request permission to transfer a quantity of SNM. The transfer would be approved by NMC, and the transfer and receiving points would be checked by the QTVRC program.

13.1.3 Process Inventory Monitoring

- Set up PIM to take RDAS readings at timed intervals.

- This program and the Physical Inventory Program should work in conjunction with each other or be combined into one big program. As a vessel is entered into the PIM program, the volume, kilograms of solution, and kilograms uranium should be calculated.

- Set the amount that a level can change before getting an alarm to a minimum.

- When they occur, alarms should be transmitted to the Safeguards Control Center (SCC) for recording and monitoring of response.

13.1.4 Process Status Function

As with the PAMALA program, the capability of being able to run this program independently of the graphics display should be retained.

- This program should be set up to take readings only on the process section that has been requested.

- As an aid in identifying vessels, the tank identification file should be updated to include the vessel name or flow name for every measurement point.

13.1.5 Analytical Summary Program

Retain the capability of being able to run this program independently of the graphics display.

- Update the tank identification file to include all measurement points and sample points.

- Expand the types of analysis reported by this program to include N_2H_4, % organic, disengaging time, % TBP, etc.

- Improve the link between LDS and CNMCAS. In particular, reprogram the LDS to use the same computer language operating system as the CNMCAS.

13.1.6 Transfer Flow Direction Confirmation

- The program should require the operator to double-check the source and destination vessel measurement points before the program progressed.

- Historical information should be collected on each measurement point to determine the amount of level change that can be tolerated before a misdirection of flow is claimed.

- This program should be set up to run as a subprogram of the Quantity Transferred Versus Received Comparison Program.

- Development work should be done to tie this program into the Closed-Loop Control* (CLC) system in the PNSA. (See Report No. AGNS-35900-3.2-57 for explanation of CLC system.)

13.1.7 PNSA Storage Function

- This program should be tied to the Closed-Loop Control (CLC) system in the PNSA.

- Further testing and development work should be done to establish the drift and variation of the process transmitters.

- The following things should be tested while the storage function is in operation:

  (1) Theft/diversion test of a module
  (2) Determine if pulling a sample can be detected
  (3) Determine the affect of mixing a tank or module (pump holdup).

13.1.8 HAF Flow Rate Program

- There are other flows in the process which are also important, and it would be advantageous to calculate them and display the results along with the HAF flow.

- Because intentional changes in flow rate can be accomplished in one or two minutes, the capability should be provided to calculate flow rates on request as well as under the automatic 20-minute wait.

13.2 PM/PS Prototype Instrument Test

- Further testing and development work should be done on all three of these systems. At least part of these tests should be conducted when there is uranium solution in the plutonium product storage tank.

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*An advanced safeguards system development activity.

- All the instruments on these systems should be tied to CNMCAS and either included in the Parameter Monitoring and Alarm Program or in the Storage Function Program.

- On Test 2, a differential pressure transmitter should be connected across the flow orifice to detect sparger flow.

- The conductivity indicator on Test 3 needs to be moved to a lower line.

- In Test 3, the line between FSL-328 and the pump needs a check valve in it to prevent a reverse flow from causing a flush flow indication.

- Other instrumentation which may be used to detect a diversion should be tested for applicability.

13.3 Additional Video Terminal

Install a video terminal in the control room for use by the control room operators and their supervisors.

- A simple program can be written that would figure the volume of any vessel and display the result (used when making batch transfers).

- A simple program can be written which would contain the elevation and west coordinate of every value in the piping and instrument galleries and would display this location upon request.

- This terminal would give the control room operator and the shift supervisor immediate access to real-time information collected by the PM/PS and CNMCAS programs.

- By using a combination of the video and graphics terminal (from Section 13.1.1), operation of the process could be improved.

All of these things would help the operator keep the process running smoothly, and that is an important factor in accomplishing effective SNM control.

PROCESS MONITORING AND PROCESS SURVEILLANCE
DEMONSTRATION PROGRAM

APPENDIX A

SOFTWARE CONTROL SPECIFICATIONS FOR PROCESS MONITORING/PROCESS SURVEILLANCE PROGRAMS

Chapter VIII: Process Monitoring/Process Surveillance System

Scientific Systems Services, Inc.

February 1979

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BARNWELL, SOUTH CAROLINA 29812

EXCERPTS FROM CHAPTER 8.

CONTROL-SPEC ®

FOR THE

URANIUM INPUT/OUTPUT DEMONSTRATION PROGRAM

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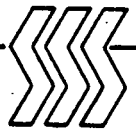
TABLE OF CONTENTS



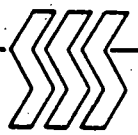
SECTION VIII

PROCESS MONITORING/PROCESS SURVEILLANCE SYSTEM

The purpose of the Process Monitoring/Process Surveillance (PM/PS) System is to monitor selected vessels in the separations and PNSL areas and to alarm the Control Room operator of situations that require investigation. The PM/PS System consists of the following programs:

- Transfer Flow Direction Confirmation (TFDC)
- Process Status Function (PSF)
- Analytical Summary Function (ASF)
- Storage Function (SF)
- Quantity Transferred Versus Received Comparison-Separations (QTVRCS)
- Quantity Transferred Versus Received Comparison-PNSA (QTVRCP)
- Physical Inventory Monitoring (PIM)

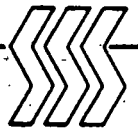
These programs are described in Sections 8.1 through 8.7.



8.1 TRANSFER FLOW DIRECTION CONFIRMATION PROGRAM

The purpose of the Transfer Flow Direction Confirmation (TFDC) Program is to monitor a transfer route and alarm the operator of situations where the solution flow is misdirected (completely or partially). This function requires a dedicated terminal.

When activated by the operator, the TFDC Program prompts the operator for the source and destination vessel identification. The program accesses the TFDCDB File to determine which alternate destination vessels must be monitored, and gets RTP level measurement data for the source vessel, destination vessel, and all alternate destination vessels. The program then monitors the source vessel at one-minute intervals, using current RTP measurement data to calculate the change in liquid level from the original level. When this change in level is greater than the "level change indicator" (contained in the TANKID file), the liquid level change has been confirmed. The program then begins monitoring, at one minute intervals, the destination and alternate destination vessels.



During each one-minute interval, the program collects RTP level measurement data, calculates the change in liquid level from the original level, and compares it to the level change indicator. If the change in level is greater than the indicator, the change in level is flagged. The program then prints the time and date, change in level for each tank, and any flags that have been set. See Fiqure 8.1 for format of the report.

When the operator confirms that the correct transfer route was chosen, the program is terminated and the terminal assumes a nondedicated mode.

TRANSFER FLOW DIRECTION CONFIRMATION

02011 #1 PU PROD STR TK

TRANSFERRED TO

03025 PU NIT STR TK

25-AUG-79

TIME	02011 LR-301	03025 LJR-3602-1	03003 LJR-3601-3	03009 LJR-3601-9	03015 LJR-3601-15	03021 LJR-3601-21	03026 LJR-3602-2	03027 LJR-3602-3	03028 LJR-3602-4	03029 LJR-3602-5	03030 LJR-3602-6	03033 LJR-3602-9	03039 LJR-3602-15	03045 LJR-3602-21
1300 LL														
1301 LL														
1302 LL														
1303 LL														
1304 LL														
1305 LL														

FIGURE 8-1. TRANSFER FLOW DIRECTION CONFIRMATION REPORT

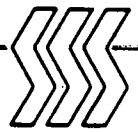
Scientific Systems Services
1135 JOHN RODES BOULEVARD • P.O. BOX 610 • MELBOURNE, FLORIDA 32901 • (305) 725-1300

8.2 PROCESS STATUS FUNCTION

The purpose of the Process Status Function (PSF) is to replace manual data collection with computerized data collection, storage, and retrieval. This function consists of two programs, one for data collection and storage and another for data retrieval. These programs are described in Sections 8.2.1 and 8.2.2.

8.2.1 Process Status Data Collection and Storage Program

The Process Status Collection and Storage Program is automatically activated by the PSF Data Retrieval Program after operator communication is completed. The program accesses the RTPID File and determines which instruments have a PSF indicator set. RTP data is collected for these instruments. This data is saved in the PSF data base in a circular file which has space allocated for a maximum of ten measurements per instrument. Each time a new measurement is taken, the oldest reading is deleted from the file.



8.2.2 Process Status Data Retrieval Program

When activated by the operator, the Process Status Data Retrieval Program asks the operator if the report should be printed on the NMC printer. If the response is YES, all output is spooled to the printer. Otherwise, the output is transmitted to the operator's terminal. The program now asks the operator if a list of report types is desired. If the response is YES, the following list is displayed at the terminal:

0 = TERMINATE PROGRAM

1 = FEED PREPARATION

2 = CO-DECON AND PARTITIONING

3 = 2ND U CYCLE

4 = U PRODUCT CONCENTRATION AND STORAGE

5 = 2ND PU CYCLE

6 = 3RD PU CYCLE

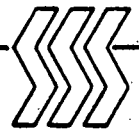
7 = PU PRODUCT CONCENTRATION AND STORAGE

8 = VOG/DOG

9 = HAW CONCENTRATOR

10 = GENERAL PURPOSE CONCENTRATOR

11 = LAW CONCENTRATOR



12 = SERVICE CONCENTRATOR

13 = ACID FRACTIONATOR AND OVERHEAD VAPORIZER

14 = 1S SYSTEM

15 = #1 SOLVENT SYSTEM

16 = #2 SOLVENT SYSTEM

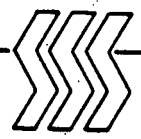
17 = CHEMICAL TANKS

The program now prompts with the following:

ENTER LIST OF REPORT NUMBERS (SEPARATED BY COMMAS) OR ALL .

If ALL is entered, the program prints the 17 reports. Otherwise, the program prints only the reports specified by the input list. When all operator communication is completed, the program activates the PSF Data Collection Program to get RTP measurement data. (See Section 8.2.1.)

To print a specific report, the program accesses the PSFRPT File which identifies the tanks and instruments associated with the report. This file also contains indexes into the PSFDAT file which contains the RTP measurement data. The data is then printed in the format shown in Figure 8-2. If all desired reports have been generated, the program exits.



FEED PREPARATION hh:mm dd mmm yy PAGE 1

DATE	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm
TIME	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm
2-01 FEED SURGE TANK 17D-113										
LR-121										
0-343 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
DR-164										
25.4-48.3 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
2-03 ACCOUNTABILITY TANK 18D-101										
LR-125										
0-546 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
DR-166										
25.4-48.3 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
2-02 DISSOLVER FLUSH ACCUMULATOR 17D-111										
LR-128										
0-736.6 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
DR-167										
25.4-48.3 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
2-05 NO. 1 FEED ADJUSTMENT TANK 17D-103										
LR-129										
0-724 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
DR-168										
25.4-48.3 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
2-06 NO. 2 FEED ADJUSTMENT TANK 17D-104										
LR-130										
0-724 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
DR-169										
25.4-48.3 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
2-127 FEED CENTRIFUGE 16K-153										
LI-131										
0-167.6 CM	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x

ONLY ON PRINTED REPORTS

DATE	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm	dd/mmm
TIME	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm	hr:mm

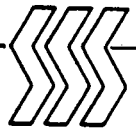
FEED PREPARATION hh:mm dd mmm yy PAGE 1

FIGURE 8-2. PSF REPORT FORMAT

8.3 ANALYTICAL SUMMARY PROGRAM

The purpose of the Analytical Summary (AS) Program is to provide a printout of analytical data for any measurement point that the lab has analyzed. As the analytical data is transmitted over the LDS output-only terminal, the data is routed to CNMCAS and stored in the data base by measurement point. A typical file format is shown in Figure 8-3. The data base retains only the four most recent weeks of data for each point. As the file is updated, any data over four weeks old is discarded.

When the AS Program is activated by the operator, the measurement point of the desired data is entered, and the entire contents of the file is printed to the terminal in the format shown in Figure 8-4. The program now exits.



BATCH NUMBER

SAMPLE LOG NUMBER

TIME/DATE (Y,M,D,H,M)

LAB DENSITY

LAB TEMPERATURE

LAB ACID

U CONCENTRATION # 1 PRIMARY

U CONCENTRATION # 2 PRIMARY

U CONCENTRATION # 1 BACKUP

U CONCENTRATION # 2 BACKUP

METHOD # 1 PRIMARY

METHOD # 2 PRIMARY

METHOD # 1 BACKUP

METHOD # 2 BACKUP

SPARE

SPARE

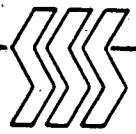
SPARE

---

28 WORDS/ENTRY

9 ENTRIES/BLOCK

FIGURE 8-3. ANALYTICAL SUMMARY DATA FILE



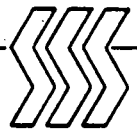
ANALYTICAL SUMMARY

02003 ACCT TK

25-AUG-79 15:25

BATCH NUMBER	LOG NUMBER	DATE	TIME	DENSITY	TEMP	ACID	U CONCENTRATION				METHOD			
							#1P	#2P	#1B	#2B	#1P	#2P	#1B	#2B
1234	12345	8/20	18:42	1.1234	32.6	12.8	.1234	.1234	.1234	.1234	VI	VP	P	MSID
1235	12346	8/22	3:18	1.1234	31.7	7.3	.1234	.1234			MSID	P		

FIGURE 8-4. ANALYTICAL SUMMARY FORMAT



8.4 STORAGE FUNCTION

The Storage Function (SF) Program monitors particular storage vessels for a change in solution mass and alarms the control room operator of a situation where the change is out-of-limits and requires investigation. The SF Program consists of two programs. The first program collects RTP measurement data, calculates the mass of solution, compares current mass with original mass, and saves the current mass in the SF data base. The second program generates the Alarm Summary and Current Change-In-Mass reports.

8.4.1 Storage Data Collection and Alarm Program

When activated by the operator, the program collects RTP measurement data for the instruments that have an SF indicator set in the RTPID File. The program now calculates the original mass of the solution in each vessel and saves this value with time and date in the SF data base. The program sleeps for 10 minutes.

When "awakened", the program again collects RTP data and calculates a current mass of solution. The program then saves the current mass in the data base. The program now compares the current mass with the original mass.

If the difference is greater than the specified limit (contained in the TANKID File), the program prints a "flagged" message on the terminal. (See Figure 8-5.) The program sleeps another 10 minutes, then performs the function again. This program must be terminated by the operator.

The SF data base is contained in SFDAT, a circular file with space allocated for a maximum of six values per tank (one hour of data). As the most recent value is added to the data base, the oldest value is thrown out.

8.4.2 Storage Report Generation Program

When activated by the operator, the program prompts with the following options:

1 = ALARM REPORT

2 = CURRENT REPORT

ENTER REPORT OPTION

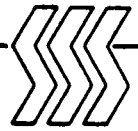
If a 1 is entered, the program (1) accesses the SFDAT file, (2) calculates the current change in mass from the original mass, and (3) prints the values shown in Figure 8-6 if the change is out-of-limits. All data for each time reference are grouped together. When all out-of-limit data are printed, the program exits.

Date	Time	Measurement Point Number	Original Q (kilograms)	Current Q (kilograms)	Current ΔQ (kilograms)	Acceptable ΔQ Range (kilograms)
xx/xx/xx	0000-2400 hours	xx-xxx	xxxx.xx	xxxx.xx	±xxxx.xx	±xx.xx

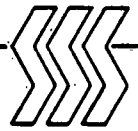
FIGURE 8-5. PNSA STORAGE ΔQ ALARM REPORT — EXAMPLE FORMAT

Date	Time	Measurement Point Number	Original Q (kilograms)	Current Q (kilograms)	Current ΔQ (kilograms)	Acceptable ΔQ Range (kilograms)
xx/xx/xx	1300	xx-xxx	xxxx.xx	xxxx.xx	±xxxx.xx	±xx.xx
	1300	xx-zzz	zzzz.zz	zzzz.zz	±zzzz.zz	±xx.xx
	1310	xx-xxx	xxxx.xx	xxxx.xx	±xxxx.xx	±xx.xx
	1310	xx-zzz	zzzz.zz	zzzz.zz	±zzzz.zz	±xx.xx
	1320	xx-xxx	xxxx.xx	xxxx.xx	±xxxx.xx	±xx.xx
	1320	xx-zzz	zzzz.zz	zzzz.zz	±zzzz.zz	±xx.xx
	1330	xx-xxx	xxxx.xx	xxxx.xx	±xxxx.xx	±xx.xx
	1330	xx-zzz	zzzz.zz	zzzz.zz	±zzzz.zz	±xx.xx
	1340	xx-xxx	xxxx.xx	xxxx.xx	±xxxx.xx	±xx.xx
	1340	xx-zzz	zzzz.zz	zzzz.zz	±zzzz.zz	±xx.xx
	1350	xx-xxx	xxxx.xx	xxxx.xx	±xxxx.xx	±xx.xx
	1350	xx-zzz	zzzz.zz	zzzz.zz	±zzzz.zz	±xx.xx

FIGURE 8-6. PNSA STORAGE ΔQ ALARM SUMMARY REPORT - EXAMPLE FORMAT



If a 2 is entered in response to the above option, the program accesses the SFDAT File and prints for each measurement point, the data displayed in Figure 8-7. When all measurement point data are printed, the program exits.



PNSA STORAGE CURRENT ΔQ REPORT - ALL POINTS
EXAMPLE FORMAT

Date: xx/xx/xx Time: 1400 hours

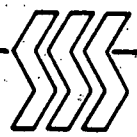
Measurement Point Number	Original Q (kilograms)	Current Q (kilograms)	Current ΔQ (kilograms)	Acceptable ΔQ Range (kilograms)	Alarm Flag
03-001	xxxx.xx	xxxx.xx	xxxx.xx	xx.xx	
03-002	yyyy.yy	yyyy.yy	yyyy.yy	xx.xx	"FLAG"
↓	↓	↓	↓	↓	
03-048	zzzz.zz	zzzz.zz	zzzz.zz	xx.xx	

FIGURE 8-7. PNSA STORAGE CURRENT ΔQ REPORT - ALL POINTS EXAMPLE FORMAT

8.5 QUANTITY TRANSFERRED VERSUS RECEIVED COMPARISON-SEPARATIONS SUBPROGRAM

The purpose of this program is to compare the quantity of solution transferred from the uranium product sample tank to the quantity of solution received in the accountability tank and alarm the operator of a situation that requires investigation. The Quantity Transferred Versus Received Comparison - Separations (QTVRCS) Subprogram is integrated with the measurement programs for the uranium product sample tank and the accountability tank.

When the uranium product sample tank's measurement program completes the AT measurement, the quantity of solution transferred is calculated and is saved in the accountability tank's temporary file. When the accountability tank's measurement program is reactivated by the operator (after the transfer into the tank is completed), the measurement program gets BS RTP data, calculates the quantity of solution received, and saves this value in the accountability tank's temporary file. The QTVRCS subprogram is now activated (by the accountability tank's measurement program).



The QTVRCS subprogram accesses the accountability tank's temporary file and compares the quantity transferred with the quantity received. If the difference is greater than the specified limit (contained in the CONLIM File), the comparison is flagged. The subprogram now prints on the terminal the report shown in Figure 8-8 which also contains a flag if the comparison is out-of-limits. The QTVRCS subprogram now returns control to the accountability tank's measurement program.

SOLUTION QUANTITY TRANSFERRED VERSUS RECEIVED
(Example Report Format)

TRANSFER: 02007 to 02003

Transferred Data	Received Data
Batch No.: 02-007-XXX	Batch No.: 02-003-XXX
Sol Kg = XXXX.X	Sol Kg = XXXX.X

TRANSFERRED VERSUS RECEIVED DIFFERENCE = XXXX.X

ACCEPTABLE RANGE = XX.X

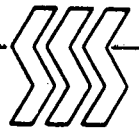
FIGURE 8-8. SOLUTION QUANTITY TRANSFERRED VERSUS RECEIVED (EXAMPLE REPORT FORMAT)

8.6 QUANTITY TRANSFERRED VERSUS RECEIVED COMPARISON - PNSA PROGRAM

PNSA PROGRA

The purpose of the Quantity Transferred Versus Received Comparison - PNSA (QTVRCP) Program is to compare the quantity of solution transferred with the quantity of solution received and alarm the control room operator of a situation that requires investigation. The sending/receiving vessel combination is such that the transfer may be from the PPC area to the PNSA or may be within the PNSA. Consideration is also given to the fact that the sending or receiving vessel may be a module (combination of six tanks) as opposed to a single tank.

The QTVRCP program consists of a general measurement routine similar to the measurement programs for the four I/O points. (See Section 2.1.) This measurement routine allows for data collection and temporary data storage. The sequence of the measurement routine is detailed in the following descriptions of STATES 1 through 24.



STATE 1

When the program is activated by the operator, the program prompts:

ENTER SOURCE VESSEL ID

When the operator enters a valid measurement point ID, the program prompts:

ENTER DESTINATION VESSEL ID

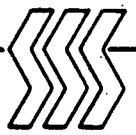
When the operator enters a valid measurement point ID, the program updates the state pointer to STATE 2 and passes control to that STATE.

STATE 2

The program communicates with the RTP System to collect BS measurement data for the source vessel. This data is saved in the program's temporary data area. The state pointer is updated to STATE 3 and control is passed to that STATE.

STATE 3

The program removes the source and destination vessels from the active PIM data base. (See Section 8.7.) The state pointer is updated to STATE 4, and control is passed to that STATE.



STATE 4

The program determines if the source vessel is in the PPC area or PNSA. If the vessel is in the PPC area, the state pointer is updated to STATE 5. If the vessel is in the PNSA, the state pointer is updated to STATE 7. The program passes control to the next STATE to be executed.

STATE 5

The program prompts the operator to determine if the solution in the source vessel is to be recirculated. If the operator responds with YES, the state pointer is updated to STATE 6. If the response is NO, the state pointer is updated to STATE 9. The program now passes control to the next STATE to be executed.

STATE 6

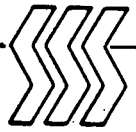
The program prints the following message:

CALL ME BACK WHEN RECIRCULATION IS COMPLETE

The state pointer is updated to STATE 9 and the program exits.

STATE 7

The program prompts the operator to determine if the solution in the source vessel is to be mixed. If the operator responds with YES, the state pointer is updated to STATE 8.



If the response is NO, the state pointer is updated to STATE 9. The program now passes control to the next STATE to be executed.

STATE 8

The program prints the following message:

CALL ME BACK WHEN MIXING IS COMPLETE

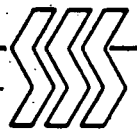
The state pointer is updated to STATE 9 and the program exits.

STATE 9

The program communicates with the RTP System to collect AS measurement data for the source vessel. This data is saved in the program's temporary data area. The state pointer is updated to STATE 10 and control is passed to that STATE.

STATE 10

The program now makes a BS to AS solution quantity comparison as defined in Section 3.2.13(h). The difference in solution quantity is saved in the temporary data area, the state pointer is updated to STATE 11, and control is passed to that STATE.



STATE 11

The program communicates with the RTP System to collect BR measurement data for the destination vessel. This data is saved in the program's temporary data area. The state pointer is updated to STATE 12 and control is passed to that STATE.

STATE 12

The program prints the following message:

CALL ME BACK WHEN TRANSFER IS COMPLETE

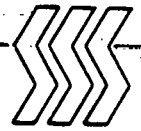
The state pointer is updated to STATE 13 and the program exits.

STATE 13

The program communicates with the RTP System to collect AT measurement data for the source vessel. This data is saved in the program's temporary data area. The state pointer is updated to STATE 14 and control is passed to that STATE.

STATE 14

The program reinstates the source vessel in the active PIM data base, updates the state pointer to STATE 15, and passes control to that STATE.



STATE 15

The program makes a BS to AT solution quantity comparison and an AS to AT solution quantity comparison. The program then saves these comparison values in the temporary data area. The calculation is made only for the source vessel. The program updates the state pointer to STATE 16 and passes control to that STATE.

STATE 16

The program communicates with the RTP System to collect BS measurement data for the destination vessel. This data is saved in the program's temporary data area. The state pointer is updated to STATE 17 and control is passed to that STATE.

STATE 17

The program prompts the operator to determine if the solution is to be mixed in the destination vessel. If the operator responds with YES, the state pointer is updated to STATE 18. If the response is NO, the state pointer is updated to STATE 19. The program now passes control to the next STATE to be executed.

STATE 18

The program prints the following message:

CALL ME BACK WHEN MIXING IS COMPLETE

The state pointer is updated to STATE 19 and the program exits.

STATE 19

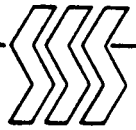
The program reinstates the destination vessel in the active PIM data base, updates the state pointer to STATE 20, and passes control to that STATE.

STATE 20

The program communicates with the RTP System to collect AS measurement data for the destination vessel. This data is saved in the program's temporary data area. The state pointer is updated to STATE 21 and control is passed to that STATE.

STATE 21

The program now makes a BS to AS solution quantity comparison as defined in Section 3.2.13(h). The difference in solution quantity is saved in the temporary data area, the state pointer is updated to STATE 22, and control is passed to that STATE.



STATE 22

The program now makes a BR to BS solution quantity comparison and a BR to AS solution quantity comparison and saves these comparison values in the temporary data area. The calculation is made only for the destination vessel. The program updates the state pointer to STATE 23 and passes control to that STATE.

STATE 23

The program makes the quantity transferred versus received comparison and saves the difference in the temporary data area. The state pointer is updated to STATE 24 and control is passed to that STATE.

STATE 24

The program prints a summary of the transfer for both the source and destination vessels on the terminal and the NMC printer. The state pointer is updated to STATE 1 and the program exits.

8.7 PHYSICAL INVENTORY MONITORING (PIM) PROGRAM

8.7.1 Description of the PIM Program

The purpose of the Physical Inventory Monitoring (PIM) Program is to monitor the liquid level in a process vessel and alarm the operator of any change that requires investigation. Once a vessel has been isolated for inventory purposes, the vessel must be added to the active PIM data base.

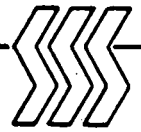
Initially, all tanks in the PNSA are contained in the active data base, but separations vessels must be added. When a vessel is added to the data base, the vessel's PIM indicator (contained in the TANKID File) is set. Upon operator request, the PIM Program accesses the TANKID File and collects RTP level measurement data for all tanks that have a set indicator. This data is saved in the PIM data base with time and date of measurement. The difference in level between the original measurement and the current measurement is compared to a preassigned limit (also contained in the TANKID File). If the difference is greater than the limit, a message indicating the situation is printed on the Intecolor 8001 CRT in the control room and on the NMC terminal in the Safeguards Coordination Center (SCC).

At any point during the data retention period, the operator can request a summary for all active vessels. The summary includes (1)date and time of each measurement, (2)original and current liquid level, (3)change in liquid level, and (4)the specified limit. If any measurement is outside this limit, a flag is also included in the summary. (See Figure 8-9.)

When the inventory process is completed, the PIM data base must be reset. Upon operator request, the program accesses the TANKID File, resets all PIM indicators, and deletes all files associated with the PIM function.

When a transfer is started and is monitored by the QTVRCP Program (See Section 8.6), the source and destination vessels are temporarily removed from the active PIM data base (by QTVRCP). This allows the transfer to be completed without alarming the operator of the liquid level change. When the transfer is completed, the removed vessels are added back to the data base.

Operator communication for the PIM program is described in the following section.



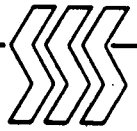
02003 ACCOUNTABILITY TANK (LR-125)

DATE	TIME	LEVEL	LEVEL CHANGE	ΔLEVEL LIMIT	FLAG
9-SEP-78	15:23	32.4		3.5	
10-SEP-78	2:15	32.9	0.5	3.5	
10-SEP-78	20:42	34.8	2.4	3.5	
11-SEP-78	5:18	31.7	-0.7	3.5	
11-SEP-78	17:02	33.6	1.2	3.5	
12-SEP-78	3:34	36.1	3.7	3.5	*
12-SEP-78	19:51	33.7	1.3	3.5	

02052 HA FEED TANK (LR-201)

DATE	TIME	LEVEL	LEVEL CHANGE	ΔLEVEL LIMIT	FLAG
9-SEP-78	15:31	15.6		2.0	
10-SEP-78	2:21	14.2	-1.4	2.0	
10-SEP-78	20:49	14.6	-1.0	2.0	
11-SEP-78	5:24	13.8	-1.8	2.0	
11-SEP-78	17:11	14.0	-1.6	2.0	
12-SEP-78	3:39	13.2	-2.4	2.0	*
12-SEP-78	19:57	13.7	-1.9	2.0	

FIGURE 8-9. PHYSICAL INVENTORY MONITORING SUMMARY



8.7.2 PIM Operator Communication

When the PIM program is activated by the operator, the program prompts (Prompt #1) with the following options:

1 = LIST ACTIVE VESSELS

2 = ADD NEW POINTS

3 = GET RTP LEVEL MEASUREMENTS

4 = PRINT SUMMARY ON ALL ACTIVE POINTS

5 = CLEAR DATA BASE

The program now prompts in one of the five ways depending on the code entered by the operator for Prompt #1.

1. If a 1 is entered (in response to Prompt #1), the program accesses the TANKID File and prints the name of each tank that has a PIM indicator that is set. The program returns to Prompt #1.
2. If a 2 is entered (in response to Prompt #1), the program responds with Prompt #2:

   ENTER MEASUREMENT POINT

   If an invalid measurement point (or a carriage return with no data) is entered, the program returns to Prompt #1. Otherwise, the program

searches the TANKID File, sets the PIM indicator for the input measurement point, and returns to Prompt #2.

3. If a 3 is entered (in response to Prompt #1), the program searches the TANKID File for any PIM indicators that are set. When one is found, the program communicates with the RTP System to get level data for that point, makes the required comparison, prints the data if it is out-of-range, and saves the data in the data base. When all active points have been measured, the program exits.

4. If a 4 is entered (in response to Prompt #1), the program searches the TANKID File for any PIM indicators that are set. When a PIM indicator is found, the program accesses and prints all data contained in the data base for that particular tank in the format shown in Figure 8-9 . When data for all active points have been printed, the program exits.

5. If a 5 is entered (in response to Prompt #1), the program searches the TANKID File for any PIM

PROCESS MONITORING AND PROCESS SURVEILLANCE DEMONSTRATION PROGRAM

APPENDIX B

PROCESS MONITORING/PROCESS SURVEILLANCE DEMONSTRATION SOFTWARE/DATA BASE -- FY 1979

B. W. Rogers

February 1979

ALLIED-GENERAL NUCLEAR SERVICES
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Appendix B lists the programs, modules, and data base files developed and used for the Process Monitoring/Process Surveillance subsystem of the Computerized Nuclear Material Control and Accounting System for the FY 1979 demonstration. The lists are tabulated as follows:

- Table B-1: PM/PS Programs and Modules which include:
  1. Quantity Transferred Versus Received Program
  2. Physical Inventory Monitoring Program
  3. Process Status Function Program
  4. Analytical Summary Program
  5. Transfer Flow Direction Confirmation Program
  6. Storage Function Program
  7. HA Feed Tank Flow Rate Program

- Table B-2: RTP Program which includes as an integral part the Process Alarm Monitoring Function

- Table B-3: LDS and RTP Network Communication Programs and Modules

- Table B-4: Miscellaneous/Support Programs

- Table B-5: PM/PS Data Base Files.

Information presented in the tables includes program/module/file name, identifier, and purpose.

Many of the data base files are represented by a letter followed by a five-digit number. In this representation, the five-digit number corresponds to the measurement point number associated with a particular vessel, while the prefixing letter denotes the type of the data file. Table B-5 identifies these files with the letter followed by "nnnnn" (ex. Xnnnnn). The "nnnnn" stands for the five-digit measurement point number.

TABLE B-1

PROCESS MONITORING/PROCESS SURVEILLANCE PROGRAMS AND MODULES

	Name	ID	Purpose
	Quantity Transferred Versus Recieved Program:		
1.	Main Program installed as:	PQTVRC QTVRC	To coordinate and monitor a vessel to vessel transfer, collect and store measurement data, and print transfer comparison and summary report.
2.	Calculation Module	CALCQT	Make instrument and solution comparisons, convert RTP readings, calculate liquid level, volume (via TVOL), and solution quantities, initialize batch parameters, mark option and marginal indicators.
3.	Volume Calculation Module	TVOL	Calculates solution volume given level and density.
4.	Password Module	PASQT	Determines if an enterred supervisor password is valid.
5.	Operator Initials Module	OPIQT	Requests and stores the operator's initials at each step of the measurement sequence.
6.	Branch Option Module	OPTQT	Based on operator decision, performs a branch to the desired step in the measurement sequence. (Ex. If, for any reason, an invalid measurement is taken, the operator can decide to remeasure.)
7.	Initialization Module	INITQT	Initializes the temporary data file and common area at the start of each transfer.
8.	Measurement Data Collection Module	RTPQT	Assembles measurement request parameters and initiates measurement requests and recieves measurement data from the preprocessor (RTP system).
9.	PNSA Ruska Transducer Units Module	RUSKA2	Transforms units of data recieved from the PNSA Ruska Universal Controller into standardized units.
10.	Reading Summary Module	RUSQT	Summarizes measurement readings for operator approval.
11.	Response Module	RESQT	Get a 'YES' or 'NO' response from the terminal.
12.	Vessel Input Module	VESQT	Get a vessel ID from the terminal and store it in the temporary data file.
13.	Physical Inventory Module	PIMQT	Remove and reinstall a vessel from the active Physical Inventory Monitoring data base.
14.	Temporary File Update Module	TPUD	Update the temporary data file.
15.	Transfer Summary Module	SUMQT	Print the transfer summary report at the operator's terminal and at the NMC Administration office.
16.	Data Base Update Module	DBUDQT	Update the permanent PM/PS data base with measurement data at the end of a transfer measurement sequence.
17.	Product to Input Quantity Transferred vs. Recieved	QTVRC	A module of the measurement programs which monitors and compares the solution and uranium quantity transferred from the Uranium Product Sample Tank to the Input Accountability Tank with the quantity recieved in the Accountability Tank.

TABLE B-1 (CONTINUED)

PROCESS MONITORING/PROCESS SURVEILLANCE PROGRAMS AND MODULES

Name	ID	Purpose
Physical Inventory Monitoring Program:		
1. Main Program	PIM	Monitor the liquid level in process vessels that have been isolated for inventory purposes and alarm the operator of any change that requires investigation.
2. Add Vessel Module	PIMADD	Add a new vessel to the active PIM data base.
3. Disable Vessel Module	PIMDIS	Disable RTP measurement for a vessel in the active PIM data base but retain the data accumulated prior to disabling.
4. Delete PIM Data Base Module	PIMDEL	Delete the entire PIM data base at the end of a physical inventory.
5. List Active Vessels Module	PIMLIS	List the vessels currently active in the PIM data base.
6. Measurement Data Collection	PIMRTP	Collect vessel measurement data from RTP for vessels in the active PIM data base.
7. Summary Module	PIMSUM	Print a summary history of all PIM measurements taken during the current physical inventory for all vessels in the current PIM data base.
8. Time and Date Module	YMDHM	Get the current time and date from the system clock.
Process Status Function Program:		
1. PSF Data Collection, Storage and Retrieval Program	PSF	To replace manual data collection with computerized data collection, storage and retrieval.
2. PSF Data Base Builder Program	PSFBLD	Create the Process Status Function Data Base.
Analytical Summary Program:		
1. Analytical Summary Program #1	ASP	To provide a printout of analytical data for any measurement point for which the laboratory performs routine analyses. Results for the last 50 samples analyzed are reported.
2. Analytical Summary Program #2	ANSUM	Identical to ASP except the table is printed in reverse order with the latest sample results first.
Transfer Flow Direction Confirmation Program:		
1. Transfer Flow Direction Confirmation Program	TFDC	Monitor a transfer route and alarm the operator of situations where the solution flow is misdirected (completely or partially).
2. Time and Date Module	YMDHM	Get the current time and date from the system clock.

TABLE B-1 (CONTINUED)

PROCESS MONITORING/PROCESS SURVEILLANCE PROGRAMS AND MODULES

Name	ID	Purpose
Storage Function Program:		The storage function monitors particular storage vessels for a change in solution mass and alarms the control room operator of a sitiation where change is out-of-limits and requires investigation. The SF consists of two programs; an operator option select and report generation program (SF) and a storage data collection and alarm program (SFRTP).
1. Main Program	SF	Controls the execution of the Storage Report Generation Function Program, permitting the operator to select the desired report or function option.
2. Add Vessel Module	SFADD	Add a new vessel to the active SF data base.
3. Disable Vessel Module	SFDIS	Disable RTP measurement for a vessel in the active SF data base but retain the data accumulated prior to disabling.
4. Current Report Module	SFCUR	Print a summary report of the most current measurement data for all vessels in the SF data base.
5. Delete SF Data Base Module	SFDEL	Delete the entire SF data base at the end of a monitoring session.
6. List Active Vessels Module	SFLIS	List the vessels currently active in the SF data base.
7. Summary Module	SFSUM	Print a summary history of all SF measurements taken since the last deleting of the SF data base for one vessel which must be in the current SF data base.
8. Storage Data Collection and Alarm Report Program	SFRTP	To collect RTP measurement data on all measurement points which have an SF indicator set in the RTPID file, calculate solution mass, and alarm the operator whenever the solution mass changes in any vessel.
9. Volume Calculation Module	TVOL	Calculates solution volume given level and density.
10. Time Ans Date Module	YMDHM	Get the current time and date from the system clock.
HA Feed Tank Flow Rate Program:		
1. Flow Rate Program	FLOW	Read flowmeter and depletion parameters and calculate the throughput of uranium through the HA Feed Tank. Results are printed by the status program in MTU / Day and are updated every 10 minutes.

TABLE B-2

REMOTE DATA ACQUISITION SYSTEM PROGRAM -- MAIN FUNCTONS

Name	ID	Purpose
1. Executive Operating System	3SXMOD	As a priority interrupt executive, this routine initializes system parameters and contains the entry point to start system operation.
2. Scheduler Function	SCHED	Controls execution of other main functions.
3. Collect Function	COLECT	Collects data from process instruments interfaced via the Computer Products, Inc. RTP equipment.
4. Operator Function	OPR	To allow the operator to enter the system time, activate alarm edit, request dumps, ask for help, activate floppy data logging, and activate hard copy alarm reports.
5. Communication Function	COMMC	To process requests for data from the Central System communication link.
6. Calibrate Function	CALIBR	To calibrate the programmable voltage calibration devices.
7. Alarm Checking Function	TMPALM	To examine each point in the system and report any that are alarming.
8. Ruska Collect Function	RUSCOL	To collect data from the Ruska transducers.

TABLE B-2 (CONTINUED)

REMOTE DATA ACQUISITION SYSTEM PROGRAM -- SUBROUTINES

	Name	ID	Purpose
1.	Address Find	ADDFND	To find any word location in any table.
2.	Alarm Edit	AEDIT	To enable or disable alarming for one or all channels.
3.	ASCII to Binary	ATOB	To convert ASCII data in contiguous memory locations to an absolute binary value in one 16-bit word.
4.	Average	AVRGE	To average scan mode 2, 3, and 4 point readings. Calculates the most recent reading by dividing the accumulation by the sample count. The most recent reading becomes the first reading while the oldest reading is deleted. The accumulation and sample count are cleared.
5.	BCD to Binary Conversion	BCDB	To convert a BCD number to a positive binary integer.
6.	Binary to ASCII Decimal Conversion	BTOA	To convert a single 16-bit binary value into five decimal ASCII characters.
7.	Check Device Readiness	CHECK	To check if input device is clear and wait until clear if the device is busy.
8.	Clear History	CHIST	To clear the priority tables; P2T, P3T, P4T, and Ruska P2T.
9.	Interrupt Service Routine for CPI 7480	CPIDT1	Handles data interrupt from the CPI 7480 Analog Input System on parallel link.
10.	Julian Date	DAYMON	To convert Julian days to months and days.
11.	Fixed Point to ASCII	FP2A	To convert fixed point to binary, and then to its decimal ASCII equivalent.
12.	Gain Value	GAINVL	To find the gain value associated with a point number.
13.	High-Low Sample Routine	HILOW	To compare the last sample with the high and low values accumulated and replace them if appropriate.
14.	Input	INPUT	To request data from CPI channel.
15.	Interpolation Table Entry Point	ITEP	To find the interpolation table entry point number and determine whether the LIT or PLIT tables are to be accessed.
16.	Linear Interpolation Function	LIF	To determine Y on a set curve with the following equation: Y = (X-X1) / (X2-X1) * (Y2-Y1) + Y1
17.	Measure	MEASURE	To calculate via interpolation in the interpolation table the engineering units for measurements of all instrument types.
18.	Month-Day to Julian Date	MONDAY	To convert the month and day to the Julian date.
19.	Multiply and Divide	MUDIV	To perform software multiply and divide operations.
20.	Piecewise Linear Interpolation Function	PLIF	To convert raw readings to engineering units via interpolation in the Piecewise Linear Interpolation table.

TABLE B-2 (CONTINUED)

REMOTE DATA ACQUISITION SYSTEM PROGRAM -- SUBROUTINES

	Name	ID	Purpose
21.	Point Device Locator	PNTDEV	To determine device number from point number.
22.	Put Current Time In Global Common	PUTTIM	To convert current time and date to ASCII and store in global common memory.
23.	Programmable Voltage Calibration Device Routine	PVCDEV	To determine the device number from the point number, check for PVC on device, and return the calobrated voltage.
24.	Convert Rad 50 to ASCII	RD50TA	To convert Rad 50 format to 3 ASCII characters.
25.	Read All Ruska Points	RRPT	To zero if necessary, lock up the DVMs, and read all Ruska transducers.
26.	Request Time and Date	RTD	To request time and date from the operator; and to update the system clock and time table.
27.	Short Integer Multiply	SMUL	To perform a short integer multiplication.
28.	Target Update	TARGET	To update a Time Table Entry.
29.	Time Check	TIMCHK	To adjust the time for 60 seconds/minute, 60 minutes/hour, 24 hours/day, and 365 days/year (except leap years, 366 days/year).
30.	Fixed to Floating Subroutine	TOFLT	To convert a fixed point number to floating point.
31.	Word to Serial Output Format	W2SOF	To convert a data stream to a serial link format.

TABLE B-2 (CONTINUED)

REMOTE DATA ACQUISITION SYSTEM PROGRAM -- TABLES

	Name	ID	Purpose
1.	Alarm Table	ALT	Entries in the Alarm Table provide high and low alarm limit values. The value of minus one (-1) implies there is no alarm limit.
2.	Calibration Point Definition	CPDT	Contains 26 entries for each programmable voltage calibrator which describe the calibration points.
3.	Data Base Table	DBASE	Contains general information including addresses and offsets for other tables in the Data Base Table structure.
4.	Device Table	DEVT	Contains hardware interface information required to communicate with CPI front end gear equipment.
5.	Gain Table	GNT	The gain table is 26 words configured as 13 fixed point numbers, one for each gain range. The values are constants (in units of millivolts/bit) which, when multiplied by a raw datum gives a reading in millivolts.
6.	Interpolation Tables	LIT	Defines the Linear Interpolation Table, the Piecewise Linear Interpolation Table, and the Calibration Linear Interpolation Table. These tables provide the means to convert raw values in millivolts to engineering units.
7.	Transducer Point Definition Table	PDT	The PDT table contains pertinent information describing the measurement point (scan mode, instrument class and type, etc.) and pointers to other applicable tables.
8.	Priority Tables	PRIOR	Each scan mode 2, 3, and 4 measurement point has a unique entry in one of the priority tables; the P2T, the P3T, or the P4T respectively. Each entry in these tables provides data storage for multiple readings and high and low samples.
9.	Ruska Device Table	RDEVT	The RDEVT contains information for each remote serial link universal controller pair.
10.	Ruska Transducer Point Definition Table	RPDT	Describes each Ruska measurement point. The RPDT provides storage for the last data sample and the Ruska Priority Table entry number.
11.	Time Table	TTBL	The Time Table provides target time data for each of the eight function codes; FC 1 = Start scan mode 2, FC 2 = Start scan mode 3, FC 3 = Scan interval 2 complete, FC 4 = Scan interval 3 complete, FC 5 = Start calibration, FC 6 = Trigger alarm function, FC 7 = Start scan mode 4, and FC 8 = Scan interval 4 complete.
12.	Unithermal Reference Table	UTRT	Contains the scale factors and variability constants required to carry out the temperature conversion calculations involving the thermocouples.

TABLE B-3

LDS AND RTP NETWORK COMMUNICATION PROGRAMS AND MODULES

	Name	ID	Purpose
1.	LDS Data Recievins Prosram	LDSLN2 *	Recieves laboratory data at the Central System as sent from the LDS via the DATA program. The data type is determined, the data properly formatted and stored in the Analytical Summary Data File. If the data is associated with the Accountability Tank or the Uranium Product Sample Tank, Uranium Concentration data is filed in the permanent Analytical file for that tank and a flag is set which will cause the DBUPD module of the Accounting Program to update the data base for this tank on its next pass.
2.	LDS Read Module	LDSRED *	Subprogram of LDSLN2 which queues nine reads on the LDS channel for processing by LDSLN2.
3.	Analytical Sample Request Sending Program -- installed as:	LDSLN1 * LDSCOM *	Processes sample requests from the request queue buffer, formats the sample request parameters, and passes the request over the communication line to the LDS Sample Authorization Program.
4.	Request Getter Module	LDSGET *	Module of the LDSLN1 Program which gets sample requests from the request queue buffer. The requests are put in the buffer by the LDS module of the Measurement Programs.
5.	LDS Intermediate Module	LDSINT *	Subroutine of the LDS Module of the Measurement Programs which puts sample requests in the request queue buffer.
6.	Analytical Chemistry Methods Programs (n = a sequenced digit, aaaa = an acronym for the method name)	Mnaaaa **	Accepts analytical data, computes results, sends results to control room and the Central System Computer, reports them to the analyst, and stores the results on disk.
7.	Data Reporting Program	DATA **	Selects and controls the execution of the appropriate Methods Program.
8.	Sample Authorization Program	SPLAUT **	Accepts requests for analysis from any device on the LDS confisured as a terminal including the CNMCAS Central System. The request is passed on to Analytical personnel, with an updated (if necessary) batch number.
9.	RTP Communications Program	RTOCOM *	Gathers requests for RTP measurement data from the RTP request buffer queue on a first-in-first-out basis, formats the request and transmits it down the serial communications link to the remote data acquisition system computer.
10.	Send RTP Request Module	SEND *	A subroutine module of all programs which access RTP measurement data. Its function is to format the request parameters and place the measurement request in the RTP request buffer queue in preparation for transmittal to the RTP system.

* Denotes Programs and Modules resident on the CNMCAS Central System
** Denotes Programs and Modules resident on the Laboratory Data System

TABLE B-4

MISCELLANEOUS/SUPPORT PROGRAMS

	Name	ID	Purpose
1.	Create Analytical Summary File Program	ASPCRE	Create a circular file for laboratory analytical data for an operator entered measurement point.
2.	Downloader Program	DWNLDR	Download the RTP Program to the remote data acquisition system computer from the host system.
3.	Laboratory Data Find, List and Edit Program	LAB	Check to see if a laboratory analytical sample request was properly sent and to list the results for the current batch at any material balance measurement point. The operator may edit the results if any are in error.
4.	Measurement Programs Status Program	STATUS	Runs in the background mode once every minute to constantly update the color CRT monitor display of the progress of every measurement program through the measurement sequence. Also prints plant flow rate on the color monitor.
5.	Temporary, Miscellaneous and Support Data File List Programs	LSTxxx	To list the contents of the various temporary, miscellaneous, and support data files. (xxx = a mnemonic identifying which file is to be listed.)
6.	Temporary, Miscellaneous and Support Data File Edit Programs	EDxxx	To edit the contents of the various temporary, miscellaneous, and support data files. (xxx = a mnemonic identifying which file is to be editted.)

TABLE B-5

PM/PS DATA BASE FILES

	Name	ID	Purpose
1.	Calculation File	CALCUL	Contains indexes into the Temporary file for the storage of the results produced by the CALCQT module of the Quantity transferred vs. recieved program.
2.	Control Limits File	CONLIM	Contains the limits for the various comparisons made during execution of the Quantity transferred vs. recieved program.
3.	Message File	MESAGE	Contains message text used by the QTVRC program in constructing the dialog and operator information messages.
4.	Message Help File	MESHLP	Contains numerical fields for use by the QTVRC program in printing message text containing numerical data.
5.	Password File	PASSWD	Contains a list of supervisor passwords against which password input is compared whenever the supervisor password is required by the QTVRC program.
6.	Physical Inventory Monitor Data File for Separations Area Vessels	PIMSEP	Data file in which the Physical Inventory Monitoring data is stored for Separations Area vessels.
7.	Physical Inventory Monitor Data File for PNSA Vessels	PIMPNS	Data file in which the Physical Inventory Monitoring data is stored for PNSA vessels.
8.	Process Status Function Data File	PSFDAT	Contains the measurement data collected by the Process Status Function Program.
9.	Process Status Function Data Base Structure Definition File	PSFINT	Used by the PSF Data Base builder program to define the three levels of the PSF Data Base including the process sections, measurement points, and individual instruments.
10.	PSF Item Data File	PSFITM	Gives header information corresponding to the PSFDAT file and contains various indices into the TANKID and RTPID files which are used and stored by the Process Status Function Program.
11.	PSF Title File	PSFTIT	Contains report titles and index to the first report item in the PSFITM file.
12.	QTVRC Measurement Collection Data File	Qnnnnn	Contains measurement data obtained via the Quantity Transferred vs. Recieved Program for each measurement point monitored by the QTVRC Program and organized by batch number.
13.	RTP Instrument Data File	RTPID	Contains instrument and channel identification parameters and cross-referrences used by the various programs which access RTP data.
14.	Storage Function Data File	SFDAT	Contains measurement data collected by the Storage Function Program.
15.	State Table File	SQTVRC	The state decision table associated with the QTVRC program. Its function is to direct the progression of the QTVRC program through its various modules.
16.	Measurement Programs Status File	STATUS	Contains the measurement point number, current batch number, and status of progression through the measurement sequence for each material balance measurement point. The status file also contains the most recent plant flow rate data. Its contents are always displayed on the color CRT monitor.

TABLE B-5 (CONTINUED)

PM/PS DATA BASE FILES

	Name	ID	Purpose
17.	Tank Identification File	TANKID	Contains measurement point cross referrence information widely used by most subsystems of the CNMCAS. Two identical copies are maintained to avoid conflicting access situations. (One has the suffix '.DAT' and the other has the suffix '.PIM')
18.	Transfer Flow Direction Confirmation Data Base File	TFDCDB	For each pair of vessels between which the Transfer Flow Direction Confirmation Program monitors transfers, the file contains the pair of measurement points for the transferring and recieving vessels and an associated list of measurement points to be monitored as possible diversion routes for the particular transfer.
19.	Temporary QTVRC Data File	TQTVRC	During each batch transfer monitored by the QTVRC program the measurement data is retained in the TQTVRC until the end of the batch transfer sequence at which time the data is transferred into the appropriate permanent 'Q' files.
20.	Process Status Function Units File	UNITS	Identifies the units associated with the data collected by the Process Status Function Program and printed on the PSF reports.
21.	Volume File	VOLUME	Contains the necessary coefficients for use in calculating the volume for any vessel.
23.	Analytical Summary Data Files	Xnnnnn	Circular files containing the 50 most recent sample results of laboratory analytical data for every measurement point.
24.	Miscellaneous File	ZQTVRC	A file containing the various indicies and message table pointers used by the various states of the quantity transferred vs. recieved program.

PROCESS MONITORING AND PROCESS SURVEILLANCE DEMONSTRATION PROGRAM

APPENDIX C

PROTOTYPE INSTRUMENT MANUFACTURER SPECIFICATIONS

November 1979

ALLIED-GENERAL NUCLEAR SERVICES
POST OFFICE BOX 847
BARNWELL, SOUTH CAROLINA 29812

ENVIROTECH

Sensall® NATIONAL SONICS

PRODUCT DATA SHEET

SECTION 2000
LIQUID CONTROLS

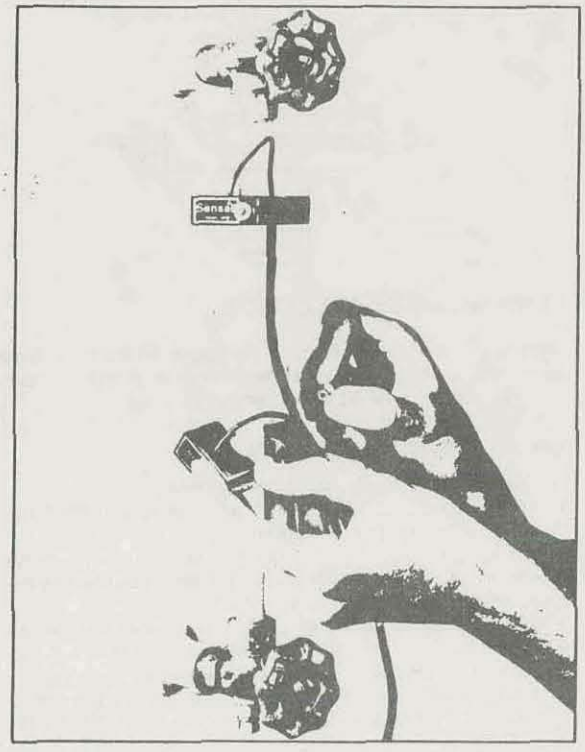
SENSALL MODEL 621S
NON-PENETRATION
LIQUID LEVEL SENSOR

PDS-2103

ULTRASONICALLY SENSES LIQUID LEVELS WITHOUT CONTACT OR PENETRATION

WHAT IT DOES

The Sensall Model 621S non-penetration liquid level system is used to provide point level control of a liquid in an existing tube, pipe or vessel. The ultrasonic sensor can be installed permanently or temporarily without interruption of any process. The non-penetration system can be installed and operating in a matter of minutes. This offers a simple and inexpensive means of point level detection without ever contacting the liquid itself.



OPERATING ADVANTAGES

- The sensor never contacts the process liquid.
- The system can be installed without shutting down plant operations.
- Simple installation requires a minimum amount of time, no holes to be drilled, no welding of fittings, no special tools needed.
- The sensor (if not permanently installed) can be moved to a different level or even moved to another location with minimum effort and without re-adjustment of the system.
- Ultrasonic detection is unaffected by variations in temperature, pressure, reflected light, liquid conductivity or vibration.
- Repeatability of sensing better than 0.02 of an inch.
- The control unit is free from measurement drift; no recalibration is required after initial adjustment.
- The sensing elements are rugged and completely encapsulated.
- Ultrasonic measurement provides a non-hazardous low energy system.
- The control unit incorporates reliable solid-state electronics.

HOW IT WORKS

The Sensall Model 621S Sensor uses a unique ultrasonic signal that can be transmitted through the walls of a tube, pipe, or vessel filled with liquid but will not transmit when the vessel is filled with a gas. In operation, the control unit generates an electrical signal that is converted to an ultrasonic signal at the transmitter transducer. When the vessel is filled with liquid this signal is transmitted through the front walls, through the liquid, through the rear walls, to the receiver transducer and reconverted to an electrical signal. The signal is amplified in the control unit and a relay is energized. When liquid falls below the sensor gap level the signal is attenuated by the air or gas (the electrical signal is greatly reduced) and the relay becomes de-energized.

Litho in U.S.A.

NATIONAL SONICS 250 Marcus Boulevard, Hauppauge, N.Y. 11787, (516) 273-6600
Division of Envirotech Corporation

Telex 14-4545

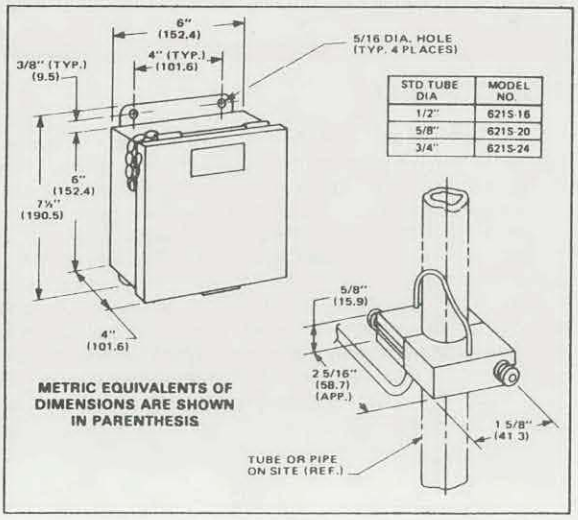
TECHNICAL SPECIFICATIONS

MODEL 621S SENSOR	
Repeatability	0.02 inch (0.51 mm)
Measurement Technique	Ultrasonic
Power Consumption	Less than 10 Milliwatts
Pressure	Vessel rating
Temperature	0°F to +250°F (−18°C to +121°C)
Weight	6 oz.
Housing Material	Epoxy
Cable and Connector	Six feet double coaxial, 50 ohm cable each terminated with shielded plug. (Longer lengths available.)
MODEL 400C-1 CONTROL UNIT	
Input Voltage	Standard 117 volts A.C. 60Hz (50 Hz available) Other voltages available.
Power Consumption	Less than 6 watts
Standard Relay	DPDT — 10 amp, 28 VDC resistive or 240 VAC, 80% PF
Response Time	Standard 0.5 seconds. Shorter or longer response times available.
Temperature	−30°F to +150°F (−34°C to +65°C)
Housing	JIC enclosure standard, NEMA 4 (watertight) and NEMA 7 (explosion proof) available.
Size and Weight	6" x 6" x 4", 5½ lbs.

DIVERSIFIED USES

The Sensall 621S has many diversified uses especially when non-penetration liquid level sensing is a convenience or a must. Non-penetration sensing can be applied to most sight gauges, pipe sections, small diameter vessels, etc. Other Sensall non-penetration systems are available for applications where proportional output is required. For accurate evaluation of your intended application, contact the factory or your local Sensall representative.

DIMENSIONAL DATA

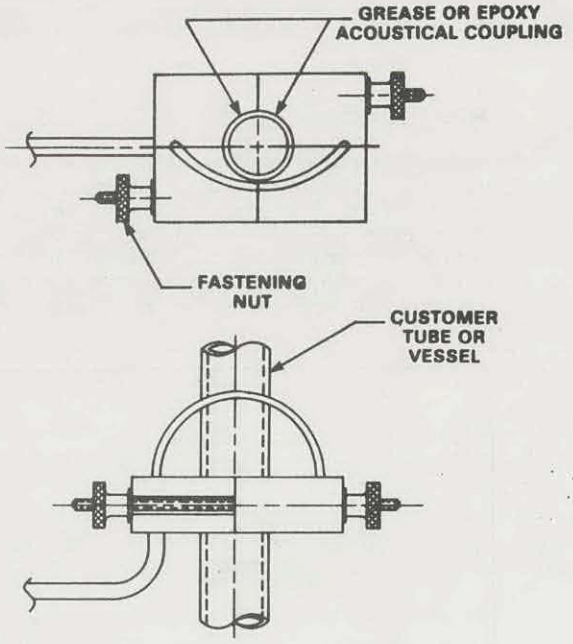


SIMPLE INSTALLATION

The Sensall Model 621S installs quickly, easily, and without any special tools. Installation of the sensor does not require any modification of the existing vessel. The sensors are acoustically coupled with grease or epoxy onto the walls of the vessel 180° apart and in-line at the required height. The sensors are connected to the control unit with the double coaxial cable terminated in shielded plugs and the installation is complete.

TEMPORARY INSTALLATION

Requires placing a small amount of silicone grease on the transducer faces and joining together at the desired level on the vessel to achieve acoustical coupling. This type of installation is best in applications where the sensor must be moved occasionally to sense at different levels or in requirements where the sensor must be removed for reinstallation onto another vessel.



PERMANENT INSTALLATION

Requires placing a small amount of epoxy on the transducer faces and bonding together at the desired level on the vessel. (Epoxy, factory supplied with every order.)

ORDERING INFORMATION

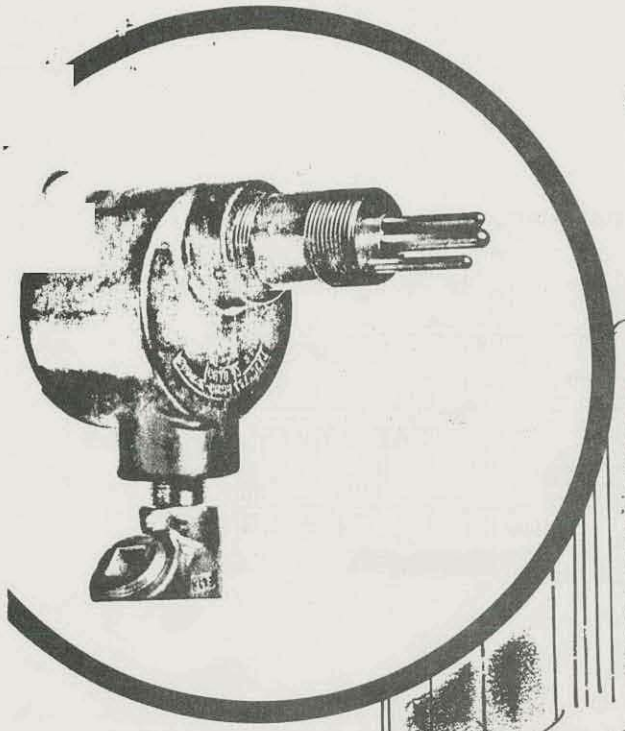
To order a complete Sensall system specify:
1. Sensor Model 621S supplied with six feet Teflon* coaxial cable, terminated with connectors.
2. For longer cable lengths (in excess of six feet) order extension cable per length needed. Cable supplied terminated with connectors on both ends.
3. Specify outside diameter of pipe or vessel that sensor will be affixed to. Standard models are available to fit diameters of ½", ⅝" or ¾" (other sizes available optional).
4. Model 400C-1 Control Unit in a JIC enclosure (for watertight specify NEMA 4; for explosion proof specify NEMA 7).

NOTE: Epoxy adhesive, factory supplied with every sensor order.

* Dupont Trademark

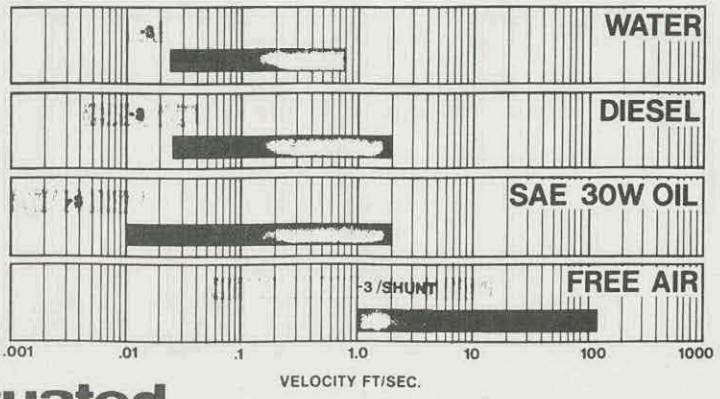
01750

FCI
Series 12-64
Thermally Actuated Flow Switch/Monitor



FLUID COMPONENTS, INC. P.O. BOX 1165, CANOGA PARK, CA 91304 · Phone (213) 341-7722 · Toll Free (800) 423-5081

Field adjustable switch point range for typical media



FCI Series 12-64 Thermally Actuated Flow Switch/Monitor

The FCI 12-64 Series Flow Switch/Monitor is a thermally actuated, ruggedly designed flow sensor that will provide maintenance-free performance over long periods of time in a wide range of applications. It features:

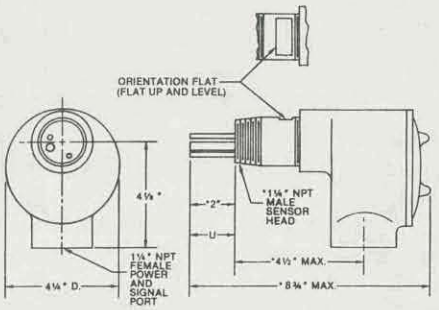
Versatility — The 12-64 will detect the flow of virtually any medium at virtually any pressure, temperature or viscosity. Design variations are available for all mounting requirements. Electrical options include SPDT, DPST and dual switch point contacts as well as millivolt and milliamp analog outputs.

Reliability — No moving parts assures years of reliable, maintenance-free operation. The Switch/Monitor is designed to withstand abnormally high flow velocities. All wetted parts are of stainless steel.

Sensitivity — Flow velocities as low as 0.01 ft/sec in liquids and 0.05 ft/sec in gases may be detected regardless of process line diameter.

Rangeability — Switch points may be field adjusted over a range of 100 to 1.

Repeatability — 0.5 to 1.0% of full signal (depending on medium) at constant conditions.

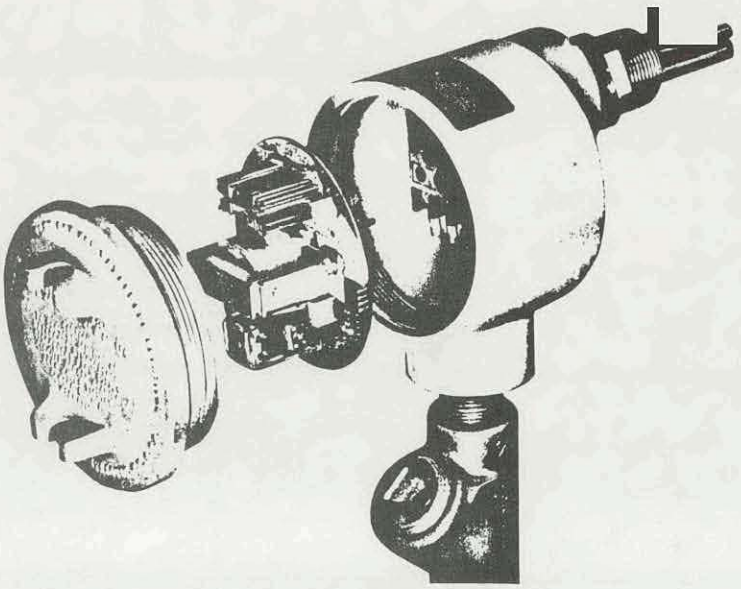


*FOR ILLUSTRATED CONFIGURATION. OTHER MOUNTINGS AND OPTIONAL "U" LENGTHS AVAILABLE.

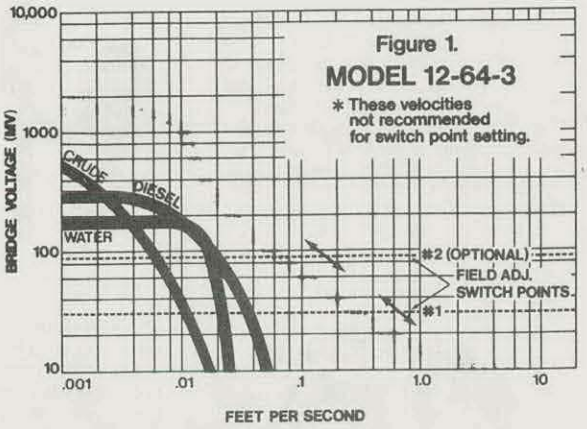
PRINCIPLE OF OPERATION

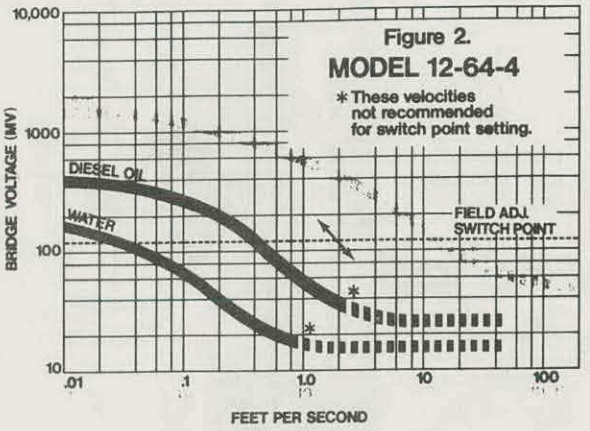
The Model 12-64 detects variations in flow velocity by sensing changes in the heat transfer properties of the flowing medium. The sensing head consists of three stainless steel thermowells in direct contact with the product. A matched pair of resistive temperature sensors, one active and one reference, is precisely located in respective wells. These sensors are self-compensating for fluctuations in product temperature. A low-powered heating element is installed in the third well and is located so that it will always preferentially heat the active temperature sensor. This creates a temperature differential between the active and reference temperature sensors. Minute changes in flow rate alter the heat transfer path between the heater and active temperature sensor causing a relative change in temperature differential.

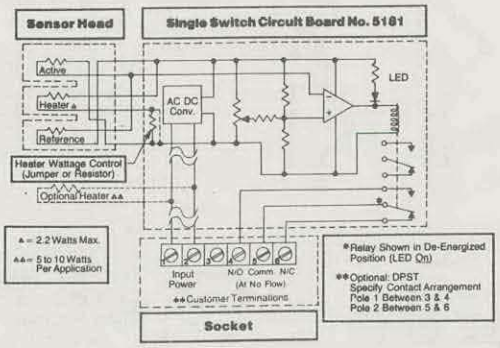
This temperature differential is electronically converted to a signal that is inversely related to actual flow rate. (See Figure 1 and 2.) At any predetermined level of this signal, a potentiometer can be field adjusted to actuate the relay. External voltage is switched across the normally open or normally closed contacts of the SPDT relay to indicate that flow rate is above or below the desired switch point. The standard circuitry is designed so that at low flow or no flow the signal is greatest and the relay is de-energized.

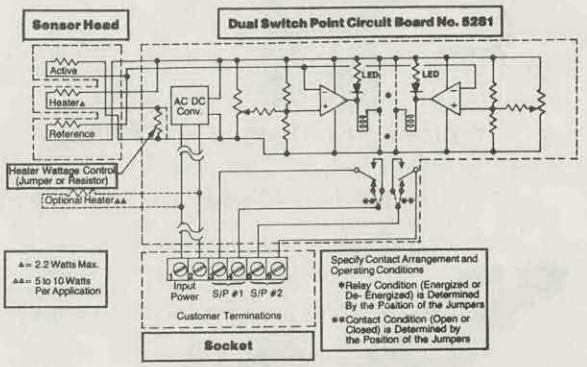


Approximate bridge voltage for typical media.









SPECIFICATIONS

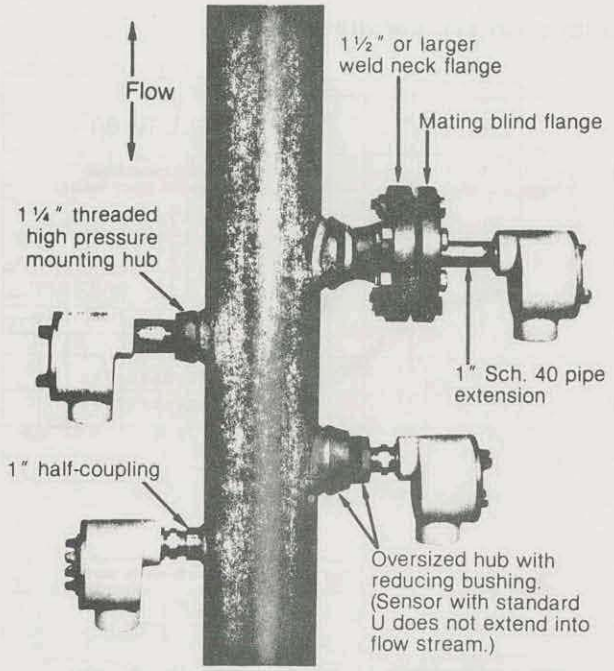
Process connections: 1" or 1¼" MNPT; flanged mountings available.
Insertion length: 2" tip of probe to process connection (U dimension), customer specified U length available.
Material: All wetted surfaces 316 stainless steel and nickel brazed per process specifications AMS 4777. Other materials, welding materials, brazing processes and coatings available.
Field adjustable switch point: Any value within the indicated flow range. 5 millivolt deadband. All units preset with switch point at mid-range in water. Factory certified switch points available.
Electrical connections: 1¼" FNPT
Relay: SPDT contacts rated at 2 amps @ 115 VAC or 24 VDC resistive, relay coil de-energized at no flow. Other contacts and/or coil arrangements available.
Power input: 100-130 VAC, 50 or 60 Hz 6 watts maximum, 24 VAC or DC and other power inputs available.
Electrical rating: The control circuit is mounted in a junction box rated for hazardous areas and complies with NEC Class I, Groups C and D, Div. 1 and 2; Class II, Groups E, F and G, Div. 1 and 2; UL standard 886. Class I, Group B, Div. 1 and 2 junction box available.
Repeatability: 0.5 to 1.0% of full signal range (depending on medium) at constant conditions.
Operating temperatures: Sensor head: -100° to +350°F, sensor heads to +750°F available.
Electrical controls: -50° to +150°F.
Note: For applications where control housing temperature exceeds 150°F, the control electronics should be located remotely. See Model 12-64R on back page, photo 4.
Operating pressure: Sensor assembly hydrostatically pressure checked to 4000 PSIG. Units for higher pressure applications available.
Shipping weight: 7 lbs. standard, 14 lbs remote
Options:
Sensor assembly: Retractable probe and packing gland assembly to fit through 1¼" full bore ball valve.
Sanitary construction with ferrule mounting flanges.
Shroud assembly (S A) for higher switch point flow ranges.
Electronic circuitry:
Dual switch point circuit board.
Analog output; either millivolt or milliamp.

INSTALLATION RECOMMENDATIONS

MODEL	SERVICE	RECOMMENDED HEATER WATTAGE	PROCESS PIPING ARRANGEMENT	PROBE ORIENTATION
12-64-3/S	Gas	2.2	Any	Any (3)
12-64-3	Liquid	5	Any (1,2)	Side mounted, orientation flat must be up and level ±2°
12-64-4	Gas	2.2	Any	Any (3)
	Liquid	5	Any (1,2)	

NOTES

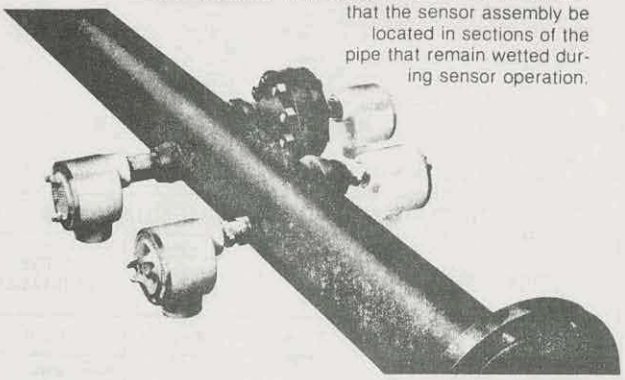
(1) The 12-64 specified for liquid service should be located in the process pipe so that it will remain wetted at all times during operation. If periodic draining or partially filled flowing lines normally occur, consult manufacturer or representatives for recommendations.
(2) The 12-64 mounted in a tee or section of pipe larger than the normal process pipe should be located in a vertical run of pipe with flow upward. This will prevent the trapping of air or gas bubbles at the sensor assembly.
(3) The 12-64-3/S and 12-64-4 will function in any orientation, but caution must be taken to prevent condensation build-up in a sensor assembly that is installed with the probe inserted downward.



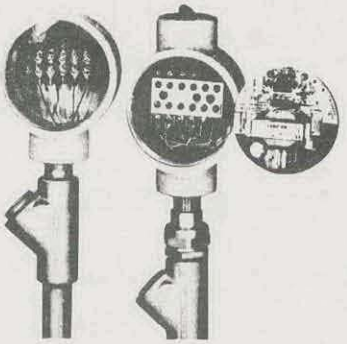
TYPICAL MOUNTING IN A VERTICAL PIPE

TYPICAL MOUNTING IN HORIZONTAL PIPE

For horizontal pipe, the preferred probe orientation is side mounted. In liquid service, it is recommended that the sensor assembly be located in sections of the pipe that remain wetted during sensor operation.



Equipped with 1.2" sensor probes, the **1" MNPT 12-64** sensor assembly may be mounted in a 1" NPT tee. This mounting arrangement, with reducing bushings, will accommodate smaller than 1" NPT pipe or tubing.

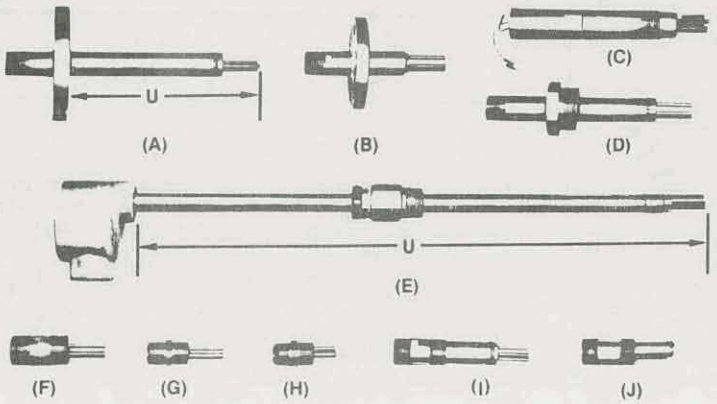


The 12-64R remote electrical enclosure must be used in areas of high temperature, excessive vibration and extreme radiation. It is also desirable for remote control panels, where the illustrated extra electrical housing may not be necessary, or inaccessible sensor assembly locations. The sensor and control circuitry may be separated up to 500 ft. with a shielded interconnecting cable.

FSR STRIP CHART RECORDER

FM-71 MONITOR/ CALIBRATOR

The FM 71 Monitor/ Calibrator and **FSR Strip Chart Recorder** are used to display and/or record flow changes at the sensor assembly. These accessories aid in establishing and verifying a switch point, and trouble shooting process and instrument problems. Either device may be plugged directly into the control circuitry of all FCI switch/ monitors.



EXAMPLES OF OPTIONAL 12-64 SENSOR ASSEMBLIES

(A) and (B). Flange mounted with customer specified insertion length (U).

(C) Special oil well production monitor.

(D) 2" MNPT mounting with customer specified U.

(E) Retractable probe including gland nut packing assembly for insertion through 1¼" full bore ball valve.

(F) 1¼" MNPT with standard 2" U.

(G) 1" MNPT with standard 2" U.

(H) 1" MNPT with 1.2" U to fit in a 1" NPT tee.

(I) 1¼" MNPT with customer specified U.

(J) 1¼" MNPT with shroud assembly (SA) option for high flow switch point.

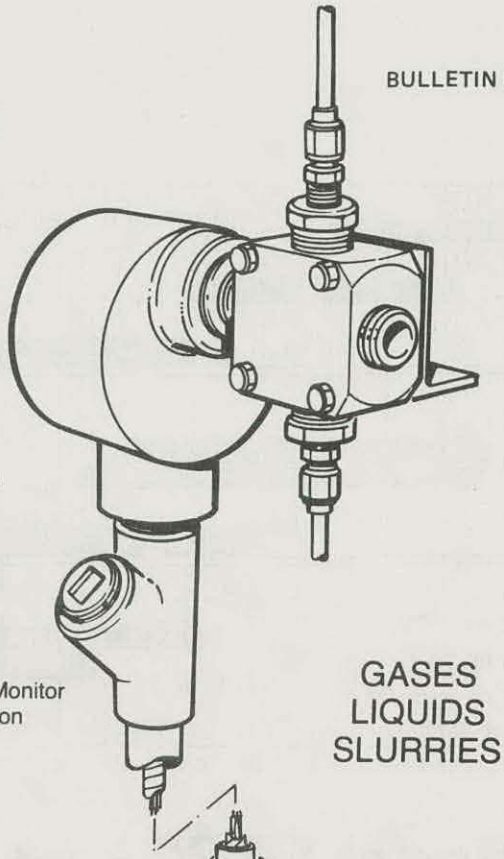
Manufactured by

FCI FLUID COMPONENTS, INC.
P. O. Box 1165 Canoga Park, Calif. 91304
(213) 341-7722 Toll Free (800) 423-5081

Represented by

FCI Model FR 70 Low Flow Monitor

BULLETIN FR 70/3



GASES
LIQUIDS
SLURRIES

Start/Stop

Normal

Off Normal

Spray System

Blocked Nozzle - Monitor Identifies Malfunction

To Analyzer

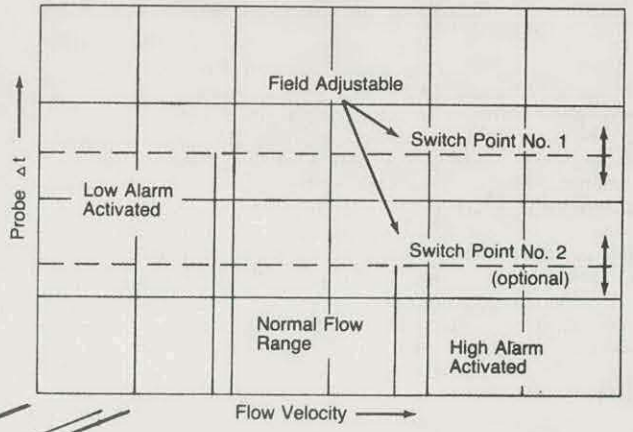
Verifies Sample Rate Within Specified Limits

Sampler

No Flow

Flow

Typical Flow Characteristic



Monitors Injection of Additive

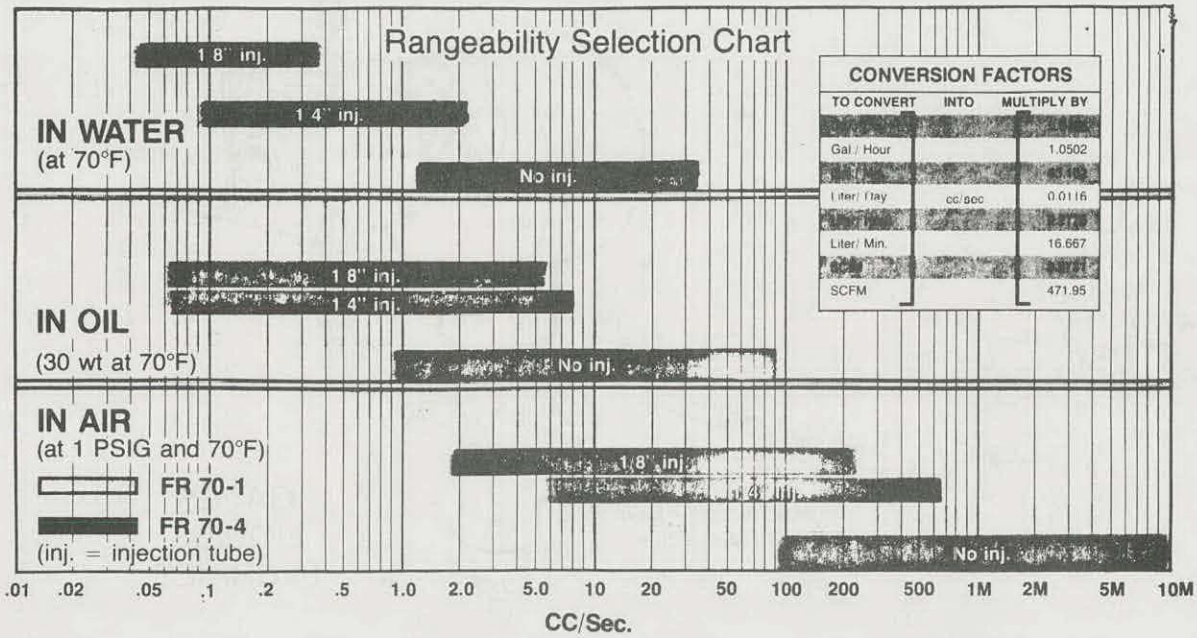
Feeder Pump

Bearing Lube Oil Monitor

Process Pump

Bearing Seal Leak Detector

FCI FLUID COMPONENTS, INC. Canoga Park, Calif. 91304



FCI Model FR 70 Low Flow Monitor

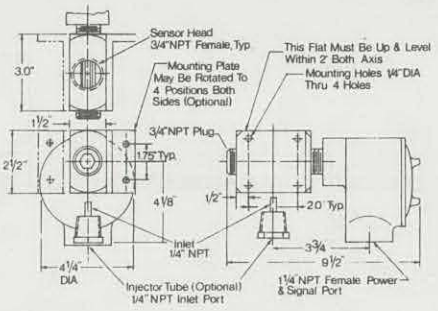
The FR 70 Flow Monitor can detect flow rates starting as low as 1 qt/day in any liquid and 25 cc/min in any gas. This capability, coupled with the field adjustable switch point and characteristic wide rangeability, makes the FR 70 uniquely applicable in all types of fluid handling systems.

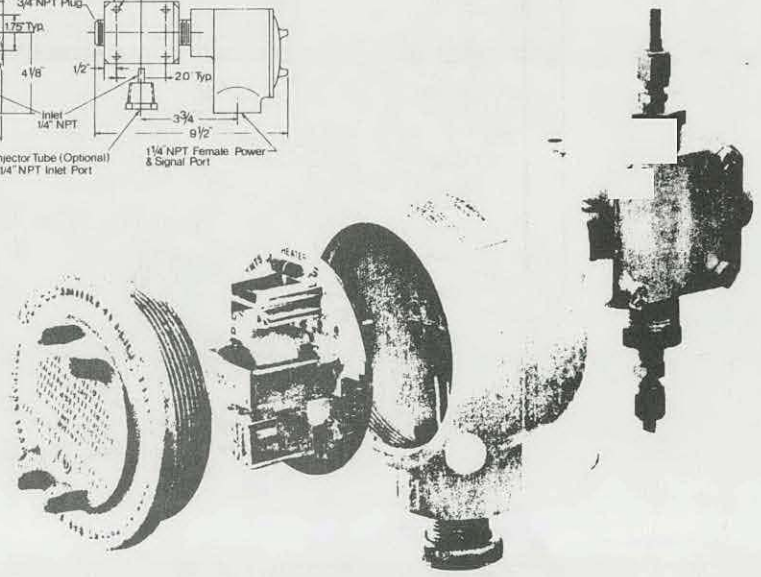
The switch point can be set to operate in any product at any pressure, temperature or viscosity. The FR70 is thermally actuated with no moving parts, assuring years of reliable, maintenance-free operation.

The sensing head consists of three stainless steel thermowells in direct contact with the product. A matched pair of resistive temperature sensors, one active and one reference, is precisely located in their respective wells. These sensors are self-compensating for fluctuations in product temperature. A low-powered heating element is installed in the third well and is located so that it will always preferentially heat the active temperature sensor. This creates a temperature differential between the active and reference temperature sensors. Minute changes in flow rate alter the heat transfer path between the heater and active temperature sensor, causing a relative change in the temperature differential.

This temperature differential is electronically converted to a signal that is inversely related to actual flow rate. (See Fig. 1 and 2.) At any predetermined level of this signal, a potentiometer can be field adjusted to actuate the relay. External voltage is switched across the normally open or normally closed contacts of the SPDT relay to indicate that flow rate is above or below the desired switch point. The standard circuitry is designed so that at low flow or no flow the signal is greatest and the relay is de-energized.

With an optional dual switch point circuit board, two separate potentiometers may be adjusted to actuate separate, independent relays at two discrete switch points. This arrangement permits the setting of high and low velocity alarms, two-stage alarms or a fail-safe alarm.





INSTALLATION RECOMMENDATIONS

MODEL	SERVICE	PIPING ARRANGEMENT		FLOW DIRECTION
		HORIZONTAL	VERTICAL	
FR 70-1	Gases	Yes	FR 70-1 will not function in a vertical position	Bi-directional
	Liquids	Yes (2)		Bi-directional
FR 70-1 w/injector tube (4)	Gases	Yes		Uni-directional (5)
	Liquids	Yes (2)		Uni-directional (5)
FR 70-4	Gases	Yes	Yes	Bi-directional
	Liquids	See notes (1) (2)	Yes (3)	Bi-directional
FR 70-4 w/injector tube (4)	Gases	Yes	Yes	Uni-Directional (5)
	Liquids	See notes (1) (2)	Yes (3)	Uni-directional (5)

(1) It is recommended that all FR70-4 Flow Monitors in liquid service be installed **vertically**, with flow upward, for self-purging of entrained gases.
(2) All FR70 Flow Monitors installed **horizontally** in liquid service must have a vent and bleed port. (specify when ordering.)
(3) The **vertical** positioning of the FR70-4 with flow downward, is only recommended for higher flow rate applications (consult manufacturer).
(4) When used, the injector tube on all models **MUST** be installed in the inlet port.
(5) See photo 4 on back cover.

Note: When using liquids within 10°F of boiling or volatile liquids such as acetone, a back pressure regulator valve should be installed downstream of the flow monitor.

SPECIFICATIONS

Field adjustable switch point: Any value within the indicated flow range. 5 millivolt dead band. All units shipped with switch point set at mid-range (in water) unless otherwise specified.

Relay: SPDT contacts rated at 2 amp @ 115 VAC or 24 VDC resistive (10 amp 115 VAC opt.)

Operating temperatures: Sensor head: −100 to +350°F (higher temperature on application). Electronic control: −50 to +150°F. (Note: For applications where control housing temperature exceeds 150°F, the control electronics should be located remotely. See Model FR70R on back page, photo 2.)

Operating pressure: To 2000 psi (higher on application).

Repeatability: 2½ millivolts (Constant or equal flow condition).

Power input: 90-130 VAC, 60 Hz, 2 watts nominal (models available for 24 volts AC or DC).

Electrical rating: The control circuit is mounted in a junction box rated for hazardous areas and complies with: NEC Class I, Groups C and D; Class II, Groups E, F, and G; UL standard; 866.

Material: All wetted surfaces 316 stainless steel and nickel brazed per process specifications AMS 4777. Viton O-ring MS 28778-2 used on vent and bleed port. (Other materials or various coatings available on application.)

Pipe connections: ¾" NPT ports. (When using injection tube inlet port will be ¼" NPT.)

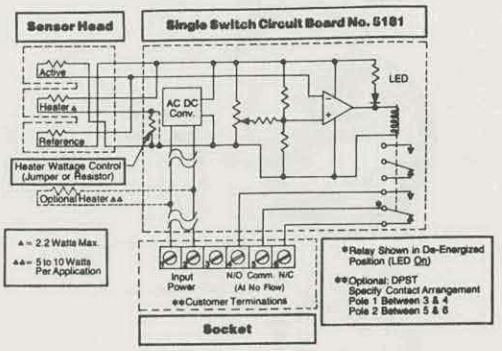
Electrical connections: 1¼" female port.

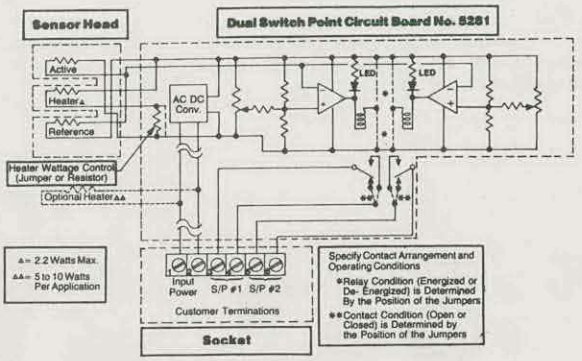
Shipping weight: 8 lbs. standard; 14 lbs. remote.

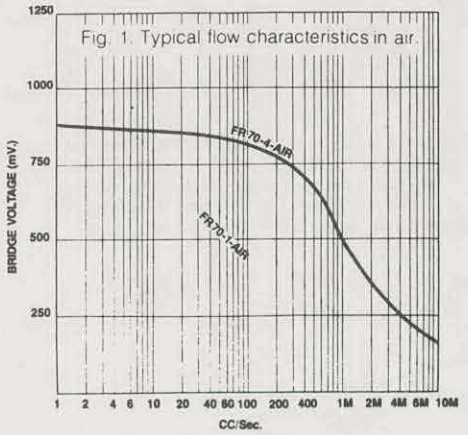
Options: Dual switch point circuit board. Injection tube for very low flow rates (interchangeable in field). Bleed and vent port for horizontal mounting. Flange mounted line sizes to 1" pipe. Analog signal available. Mounting bracket for installation in any position.

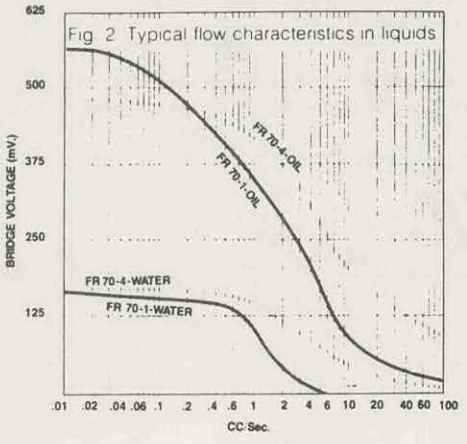
HEATER WATTAGE CONTROL

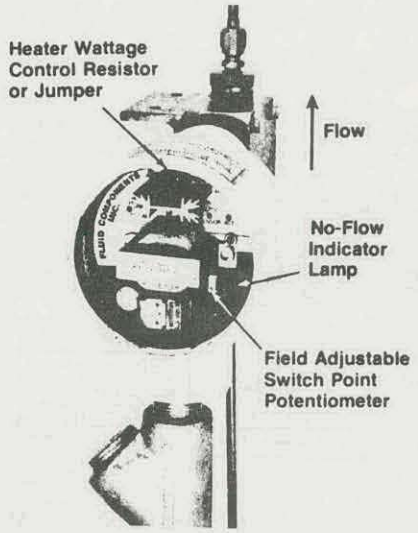
Control Resistor		Heater Wattage
None (jumper)	=	2.2
33 ohm	=	1.5
91 ohm	=	1.0
220 ohm	=	0.5



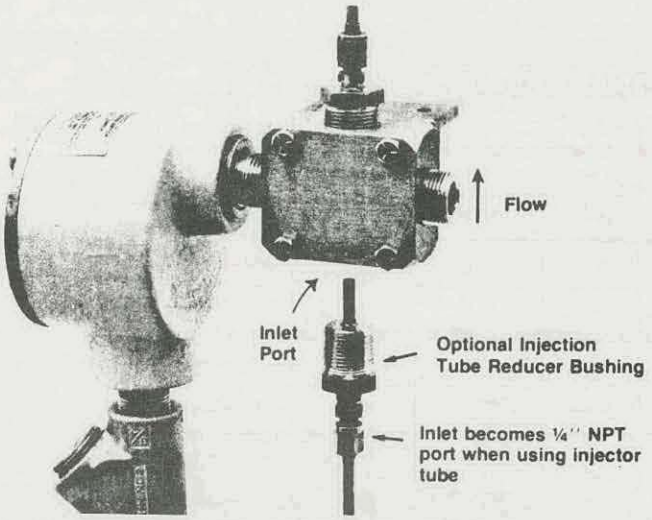




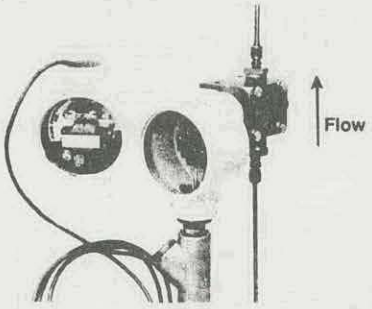




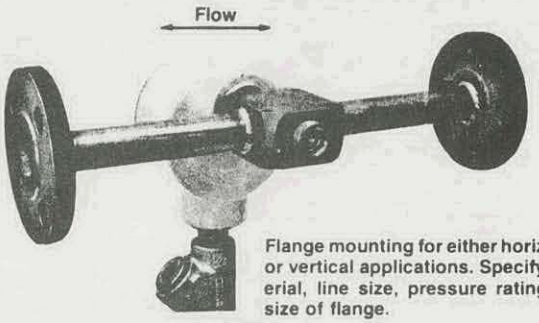
Vertical mounting recommended for liquid service (self-purges entrained gases). Heater wattage control resistor may be changed in the field to adjust heater wattage output.



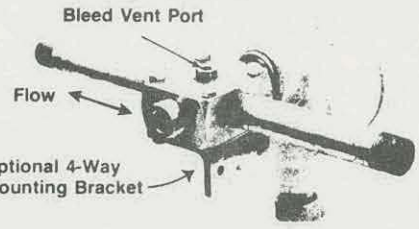
Vertical mounting for liquid service with optional injection tube for low flow applications. Injection tube may be used in either vertical or horizontal applications.



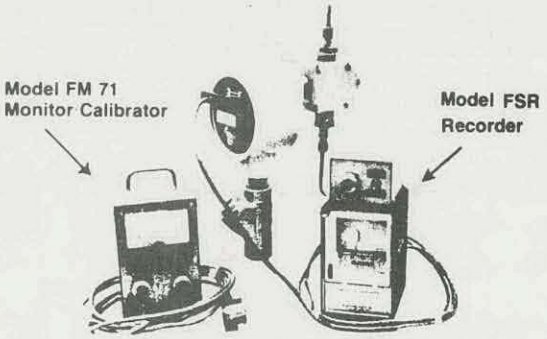
Model FR70R remote electronics for applications that require separation of control electronics and sensor assembly, includes high temperature, high vibration, and remote control panel applications. Electronics may be separated up to 200 ft. from sensor.



Flange mounting for either horizontal or vertical applications. Specify material, line size, pressure rating and size of flange.



Horizontal mounting in ¾-in. pipe, showing bleed and vent port for purging entrapped air or gases when used in liquid service.



FM-71 Monitor/calibrator indicates the analog output of the control circuitry. Unique calibration circuit aids in the adjustment and verification of switch point setting. FSR recorder records the analog output for permanent record of flow characteristics. Both are powered from FR 70 circuit board.

MANUFACTURED BY

FCI FLUID COMPONENTS, INC.
P. O. Box 1165 Canoga Park, Calif. 91304
(213) 341-7722 Toll Free (800) 423-5081

DISTRIBUTED BY

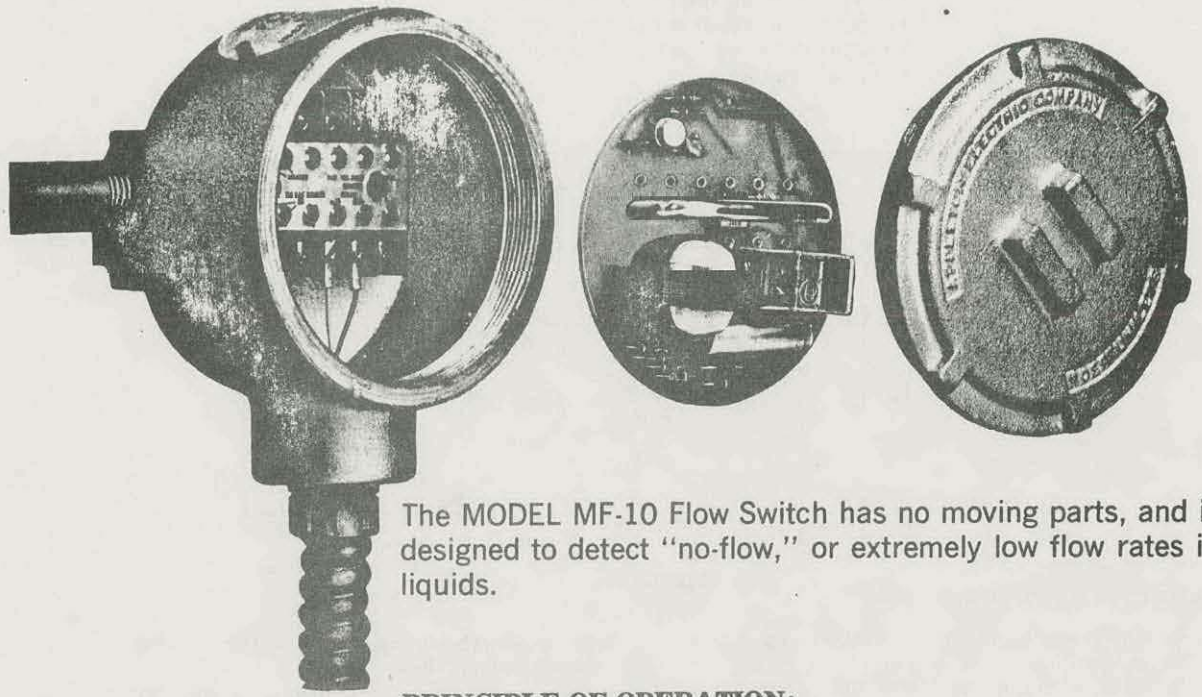
MF-10 MICRO-FLOW SWITCH

SOLID-STATE HEAT ACTUATED

HEAT ACTUATED

FLOW MONITOR

Detects liquid flow rates as low as
0.1 milliliter per minute (2 drops per minute)



The MODEL MF-10 Flow Switch has no moving parts, and is designed to detect "no-flow," or extremely low flow rates in liquids.

PRINCIPLE OF OPERATION:

Detection in the sensor head is achieved by the use of a sensing thermo-resistor, a reference thermo-resistor and a heater.

The heater is located in the flow stream so that, during flow, the heat is carried away from both sensors. When the flow stops, convection currents heat one sensor above the temperature of the other. This temperature imbalance causes a voltage change in the bridge circuitry, signaling a flow stoppage.

The unique sensor head creates an increasing signal as the flow rate decreases. Extremely stable in operation, this unit is virtually unaffected by line-voltage fluctuations and wide temperature changes in fluids or ambient conditions.

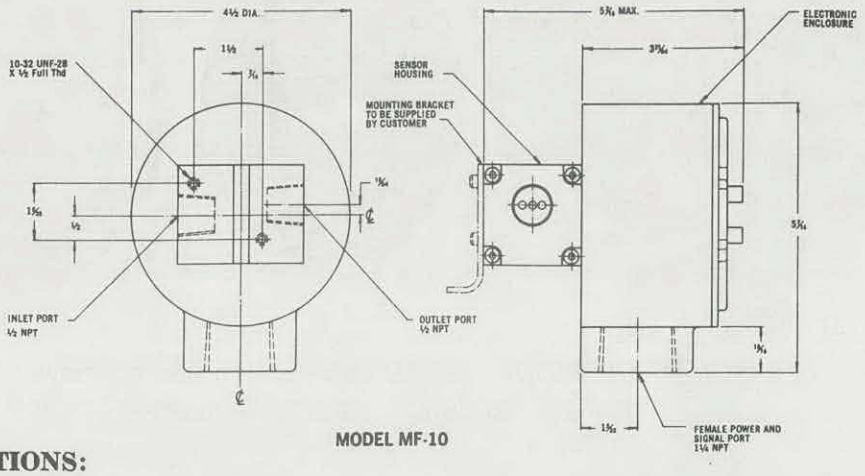
Celesco Transducer Products, inc.
division of Transducer Controls Corporation
7800 Deering Ave • Canoga Park • California 91304 • (213) 884-6860 • Telex: 67-3382 • TWX: 910-494-1951

MF-10 MICRO-FLOW SWITCH

SOLID-STATE HEAT ACTUATED

FEATURES:

- Detects flow rates as low as 2 drops per minute
- No moving parts
- Adjustable switch point
- Low pressure drop
- Fluid temperatures to +300°F. (higher on application)
- Pressures up to 2000 PSI (higher on application)
- All wetted surfaces are stainless steel
- Viton "O" rings
- Explosion proof housing
- Solid state circuitry throughout
- One-piece electronics, module construction
- In-place, in-line calibration during operation or shut-down
- Thermal delay characteristics accommodate pulsating flows
- Analog signal available



MODEL MF-10

SPECIFICATIONS:

- Switching velocities: Adjustable switch points can be set at flow rates as low as 2 drops per minute and higher depending on liquid properties.
- Power input 90-130 VAC 60 cps 2 watts. Model available for 28 Volt DC.
- Circuit components: All solid state elements, isolation transformer provided.
- Relay type: SPDT Contacts rated at 1 amp @ 115 VAC or 24 VDC resistive.
- Pipe connections ½" NPT ports.
- Operating Temperatures:
  Electronic Control: −50 to 135°F
  Sensor Head: −100 to 300°F
  Note: When used in temperatures above 150°F sensor head should be separated from electronic control. (Interconnecting cable available.)
- Material stainless steel (all wetted parts), viton "O" ring seals.
- Weight 9 lbs.
- Pressure 0 to 2000 psi. (higher on application)
- Electronics mounted within explosion-proof housing, Rated — dust-ignition-proof, weather resistant and raintight
  Class I, Groups C and D; Class II, Groups E, F and G; Class III.
- Fail Safe.
- Specify service, temperature range and desired trigger velocities.

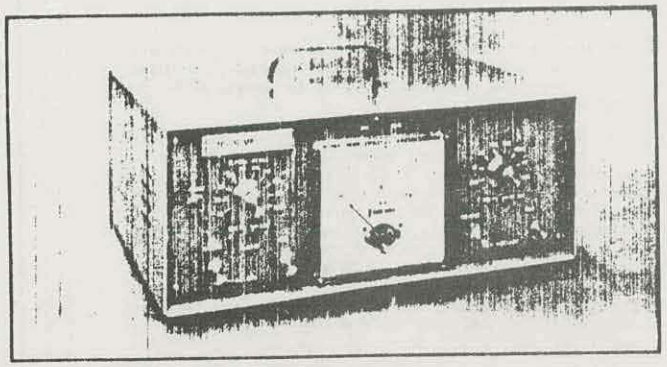
MICRO-FLOW SWITCH

Specify MODEL MF-10.

Celesco Transducer Products, inc.
division of Transducer Controls Corporation
7800 Deering Ave • Canoga Park • California 91304 • (213) 884-6860 • Telex 67-3382 • TWX: 910-494-1951

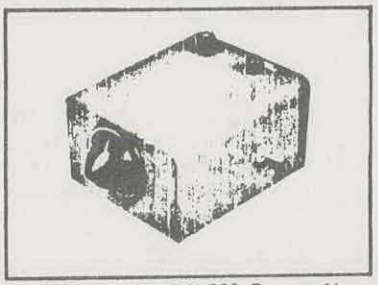
RATEMETER

LABORATORY MONITOR MODEL 904-443



SPECIFICATIONS

Input Sensitivity	Minus 0.5 - 10V, adjustable
Ranges	0-300, 1,000, 3,000, 10K, 30K, 100K cpm
Coincidence Loss	Less than 3% full scale, all ranges
Count Accuracy	Better than 5% full scale, all ranges 3% at recorder outputs.
Time Constants	1 second, 10 seconds
Calibration	Internal 3600 cpm (60 Hz)
Aural Output	3 1/2" loudspeaker. Adjustable independent drive circuit prevents volume changes when changing scales.
Recorder Output	10 mv and 1 ma.
Alarm	Trip-point continuously variable from 10% to 100% full scale, selected by front-panel control. 2 amp normally open or normally closed contacts. Latching operation (front panel reset button). Built-in test mode. Int-Ext alarm select.
HV Supply	0 - 2150V, regulated 0.1% per 1% change in line voltage. Coarse and fine controls.
Connectors	Detector input. Combined HV and signal UG-931/U (MHV type) in rear. Additional signal input on terminal strip.
Power	110V, 60 Hz, 10 watts. (220/50 optional)
Controls	Master (for calibration, HV and CPM ranges). High Voltage (separate knobs for coarse and fine adjust, 0 to 2150V). Volume Off-On (adjustable to room volume). Calibration (adjusts all scales simultaneously with internal 3600 cpm Pulser). Time Constant, 1 or 10 seconds. Discriminator (1/2V to 10V via internal pot).
Size	5 1/2"H x 14"W x 10"D.
Shipping Weight	25 lbs.



941-233 Remote Alarm

DESCRIPTION

Model 904-443 Solid State Laboratory Monitor presents visual and aural indications of radioactivity for research purposes and for alerting personnel to the presence of radiation hazards. Its applications include continuous background monitoring, educational demonstrations and experiments, medical isotope studies, and measuring laboratory contamination. A front panel red alarm flashes on at an alarm value preset from 10% to 100% full scale, all ranges. Simultaneously, an optional remote alarm is triggered.

Model 904-443 uses GM detectors, gas flow counters or scintillation detectors.

MODELS

904-443 Lab. Monitor Ratemeter for GM scintillation and gas detectors

904-445 Lab Monitor System Consists of: 904-443 plus 908-108 End Window GM Tube and 904-168 Tube Holder

ACCESSORIES

Listed Elsewhere in this Catalog:

941-233 Alarm
Gas Flow Counters
Scintillation probes
GM complete probes, use the Model 904-168 plus choice of GM tube or use the 908-289 End window Probe with tube. Includes a 949-623 cable.

REMOTE ALARM MODEL 941-233

Model 941-233 is a remote alarm unit for the 904-443 Lab. Monitor Ratemeter. Consisting of a flashing lamp and horn, the 941-233 is activated when radiation levels exceed the set-point selected on the 904-443 Ratemeter. The horn may be switched off so that only the light flashes to indicate a radiation hazard. A fuse protects the 941-233 and flashes an auxiliary light in case of a blown fuse. Twenty five feet of wire is included so that the alarm can be used long distances away from the ratemeter. The alarm requires connection to 110V/60 Hz. (220/50 optional) Size: 8½" x 5½" x 3½". Weight: 5 lbs.

BAIRD-ATOMIC

BAIRD-ATOMIC, INC., 125 Middlesex Turnpike, Bedford, Massachusetts 01730 Tel. 617-276-6204
Sao Paulo, Brazil • Braintree, Essex, England • The Hague, Holland

GEIGER TUBES

DESCRIPTION

Geiger tubes come in many shapes and sizes depending on the radiation to be detected. The most common configuration has a narrow wire anode centered in a metal cylinder which serves as the cathode. The electrodes are separated by a glass or ceramic insulator.

Self-Quenched Gas Mixtures

Hermetically sealed within the tube is a highly purified mixture of gases in proportions determined by the characteristics desired. To prevent the tube from going into continuous discharge after a pulse is initiated by radiation, a self-quenching gas is included in the gas mixture. There are 2 types of self-quenching tubes: organic and halogen. Both types are processed to avoid errors due to hysteresis and photosensitivity.

Organic: Almost 100% efficiency for particles entering the sensitive volume of the tube. Ideal for low-energy betas. Tube life about 5×10^9 counts. Model 908-064 is the most sensitive GM tube for detecting weak betas.

Halogen: Neon-halogen filling assures almost infinite life. Extremely stable but not quite as sensitive as organic tubes. Not damaged by over-voltages or by temperature changes from −55° to +75°C.

For detecting alphas, betas, low-energy x- and gamma radiation, GM tubes have a mica "window" thin enough to permit this radiation to enter the sensitive volume of the tube and still maintain the hermetic seal. Mica window thickness determines the type of radiation detected. Windows less than 2 mg/cm² will detect gammas, alphas and low-energy betas such as C-14, Ca-45 and S-35. Windows from 3 - 4 mg/cm² will detect high-energy betas (P-32 and Sr-90 – Y-90) with practically no absorption in the window. End-window tubes are also used to detect low-energy x- or gamma rays and contain gas mixtures with higher absorption coefficients for such radiation.

Thin-wall (or "side-window") stainless steel tubes are many times thicker than the end-window types and are designed especially for gammas and hard betas. They can be used in high radiation fields, beta-gamma survey meters, or for "dip" counting of medium-energy beta particles in liquids.

SPECIFICATIONS (See photos next page.)

908-141 DIA. = 1 3/8"

Model	Quench O Organic H Halogen	Operating Voltage	Plateau Length (V)	Plateau Slope %/100V	Window/Wall Thickness (mg/cm²)	Effective Window or Cathode Dia.	Overall Length (in.)	Type of Base	Applications α β γ	General Information	B/A Tube *Holder	Instrument Used In*	Tube *Stand
END-WINDOW													
908-064	O	1300	250	1.5	1.4-2.0	1.1"	4-3/8"	4 pin	x x x	Highly sensitive to weak betas; uniform stable characteristics.	904-168		908-020
908-071	O	1300	250	1.5	3-4	1.1"	4-3/8"	4 pin	x x		904-168		908-020
908-108	H	900	200	10	1.4-2.0	1.1"	4-3/8"	4 pin	x x x	Electrically very rugged and stable; almost infinite life.	904-168		908-020
908-141	H	900	200	10	3-4	1.1"	4-3/8"	4 pin	x x		904-168		908-020
908-151	H	900	180	10	1.4-2.0	1.0"	6	cap	x x	For probe-type survey meters.	904-137	904-122	
908-290	H	500	225	2	1.4-2.0	0.4"	1 5/3"	pigtail	x x x	Small size and low cost; ideal for educational use. Bkgd. 15-20 cpm. Dead Time 100 μsec	908-289		908-274
THICK-WALL (Metal)													
908-508	H	650	160	15	90	0.2"	1.5	pigtail	>0.5 mev x	Used in high radiation fields; miniaturized.		904-517	
THIN-WALL (Metal)													
908-623	H	900	75	20	30	5/8"	3-3/4	3 pin	x	For beta-gamma survey meters.	904-389 904-132	904-700 904-121	
LOW-ENERGY X-RAY													
908-116	H	1200	300	10	1.4-2.0	1.1"	4 3/8	4 pin	x	Electrically very rugged.			

*See complete descriptions elsewhere in this catalog.

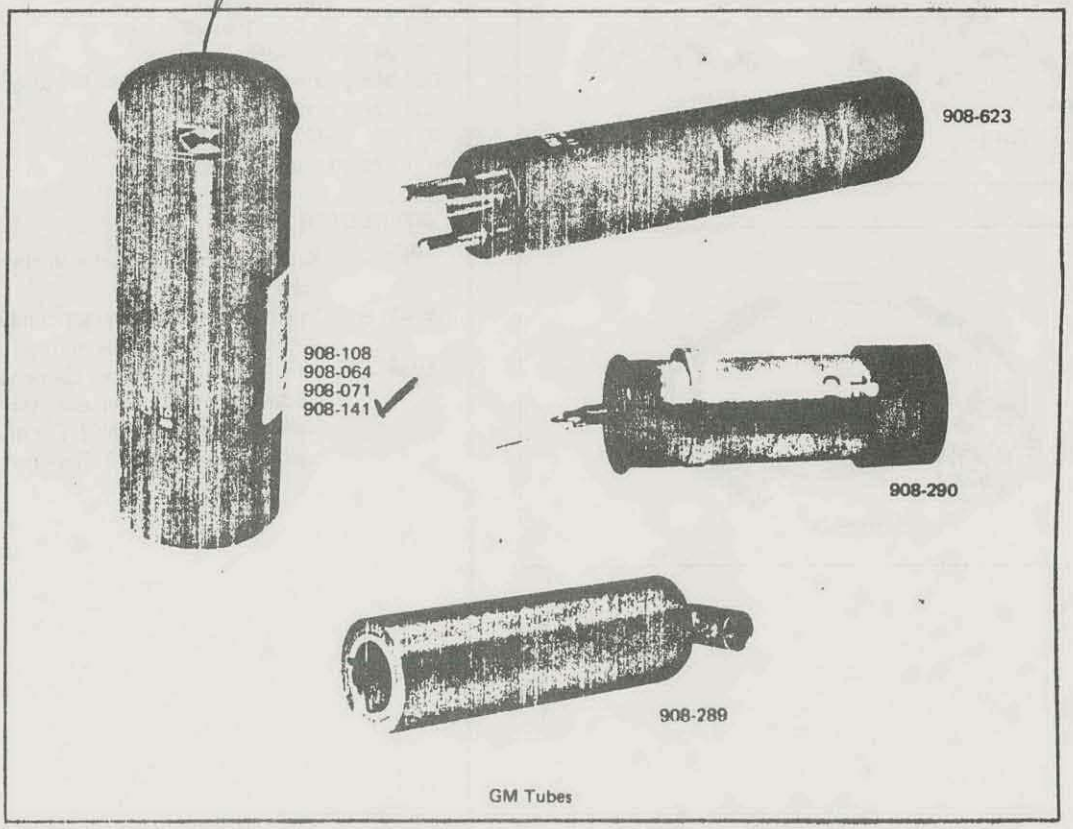
The GM tubes listed above are detectors only, and cannot be used by themselves with most display instruments. Instead they must be used with a tube holder or mount of some sort. For survey work and general lab monitoring, a hand held GM probe assembly such as those listed next page is ideal. For more exacting measurements requiring repeatably accurate geometries, a tube stand should be used.

G.M. TUBE HOLDERS HAND HELD PROBE ASSEMBLIES

DESCRIPTION GM TUBE HOLDERS AND PROBES

- 904-419 End Window Probe. Used specifically with the 904-122 Survey Meter. Has a screw-on microphone type connector and 40 inch cable. The 904-419 Probe Assembly consists of a cable and a 908-152 end window GM tube.
- 904-133 Side Window Probe. Used specifically with the 904-121 Survey Meter. Has a screw-on microphone type connector and 40 inch cable. The 904-133 Probe Assembly consists of a 904-132 Tube holder with cable and a 908-623 Side window GM tube.
- 904-168 GM Tube Holder. General purpose probe assembly less tube for all Baird-Atomic 4 pin GM tubes. Has a cable with MHV connector for direct attachment to all Baird Atomic scalers and ratemeters. Includes mounting magnet.

  The 904-168 uses the following B/A GM tubes:
  908-064 908-108
  908-071 908-141
- 908-289 Complete End Window Probe includes a 908-290 end window halogen-quenched tube for alpha, beta and gamma. The 908-289 has a right angle female BNC connector. Includes the model 949-623 cable (MHV to BNC) for connection to all Baird-Atomic Scalers and ratemeters.
- 904-369 Side Window Tube Holder with a rotating side shield and attached cable with MHV connector. Uses a 908-623 side wall GM tube. (not included)



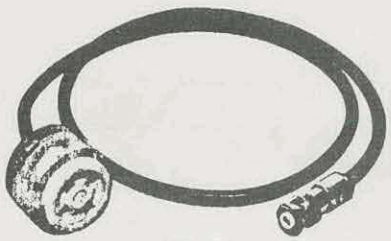
GM Tubes

CABLES, CONNECTORS, ADAPTERS

001-947 002-025 002-081

000-946

021-399



949-423

CABLES, CONNECTORS, ADAPTERS

DESCRIPTION

CABLES

MODEL	CABLE NO.	USAGE	USED BETWEEN RECEPTACLE TYPES FROM	TO	LENGTH
001-947	2	High Voltage to 3000 Volts	MHV	MHV	7'
001-985	5	Signal	BNC	BNC	7'
002-025	9	High Voltage to 3000 Volts	HN	MHV	6'
002-073	15	Ratemeter 980-435 or Scaler 955-123 or 955-150 to Sealed Geiger Tube.	MHV	Right-Angle for 4-pin GM Tube	6'
002-081	17	Ratemeter to Recorder	Spade Lugs	Bare Ends	6'
009-863	20	Preamplifier Power Signal, B+ Ground (980-530 to 988-10C) Connects Geiger tube to scaler.	AN	AN	7'
949-423			4-pin GM to	MHV	3'
949-623		Connects 908-289 GM probe to 916-355 scaler.	BNC	MHV	3'

CONNECTORS AND ADAPTERS

021-399 "T" Connector, BNC
001-041 HN to MHV
000-946 Adapters Right-angle, male HN to female HN
034-274 Female MHV to male HN
021-398 Male HN to Male HN
031-671 "T" Connector, MHV

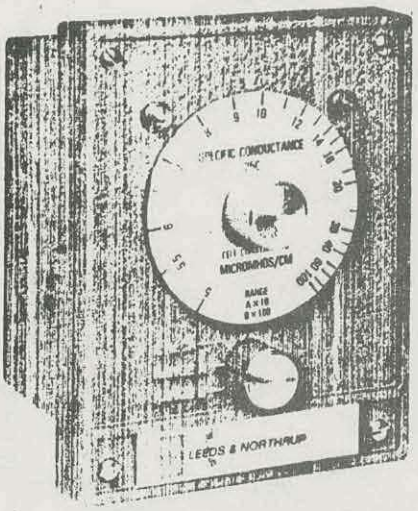
CONNECTOR TYPES

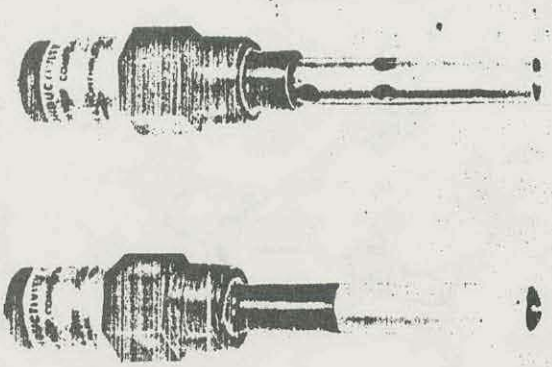
HN – Threaded single conductor shielded, high voltage

BNC – Small bayonet mount single conductor shielded, for low (signal) voltages

MHV – (Miniature High Voltage) Larger version of the BNC with bayonet mount (not interchangeable with the BNC). For high voltage, often made with Teflon insulation.

7085 Dual-Range Conductivity/Resistivity Controller





- **Low-cost, rugged compact controller**
- **Switch-selected dual ranges (1:10) for wide versatility, more accurate readability on 7-inch scale circumference**
- **Wide choice of linear resistance ranges up to 20 megohms, expanded conductance ranges down to 0.05 micromho**
- **Solid-state circuitry with built-in alarm/control function**
- **Setability on resistance ranges better than ±1% of reading**
- **Red (high) and amber (low) LEDs indicate measured value above or below set-point. Delay circuit permits reading value on setter dial without upsetting control**
- **Automatic temperature compensation on all ranges to assure accuracy under varying process conditions**
- **Weatherproof, dust-proof and corrosion-resistant plastic case**
- **Panel- or wall-mounting**
- **Used with 7086 conductivity cells of molded Ryton.**

The 7085 Conductivity/Resistivity Controller, designed for use with the 7086 Cells, is a low-cost, non-indicating instrument for accurate, continuous control of electrolytic conductivity in such varied applications as plating rinse tanks, cooling towers, boiler water, boiler condensate demineralizers and ion exchangers.

Control set point is established by a circular scale with 7" calibrated circumference. (One side of the scale is calibrated in conductivity, the reverse side in equivalent resistivity.) Red and amber LED lights above the scale indicate when the reading is above or below the set point.

A rotary selector switch permits choice of dual ranges (10:1), with the appropriate range multipliers for "A" and "B" indicated on the scale. A "Check" position permits a calibration check against internal precision resistors. A time-delay circuit prevents alarm action when the operator changes the setting to check the instrument operation or read the measured value (using the alarm lights).

Housed in a rugged, compact, all-plastic case, the 7085 Controller is designed to withstand corrosion in adverse and outdoor environments.

The 7086 Conductivity Cells, with integral automatic temperature compensators, are specifically designed for use with the 7085 Controller. The rugged, corrosion resistant Ryton body is suitable for all related applications.

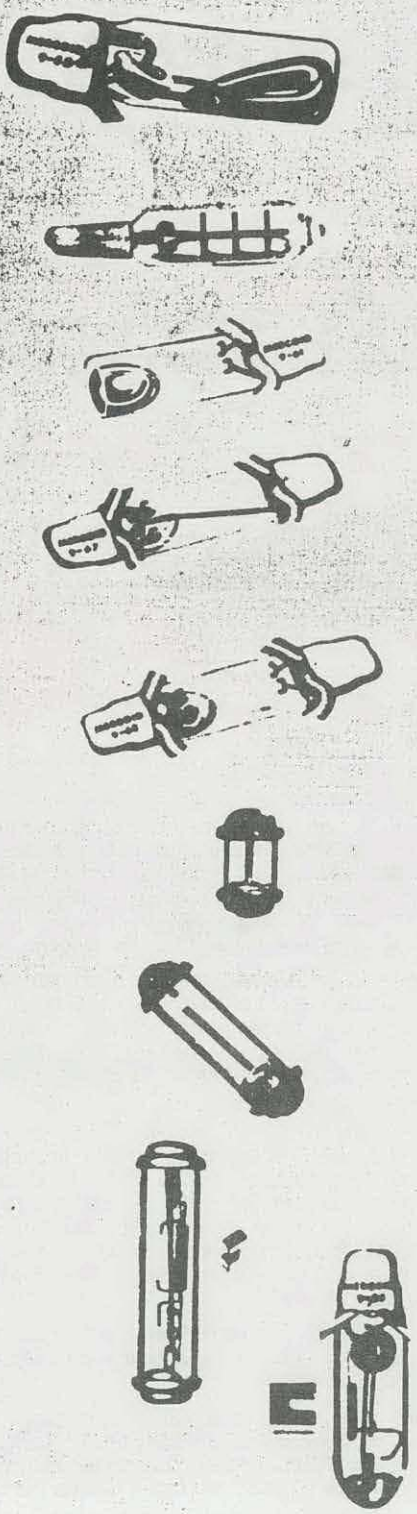
Leeds & Northrup

F-19

5988831 MERCOID CORP FITS ONTO VALVE 57A 00326 D 9-26-11

VPI or VTD

MERCOID®



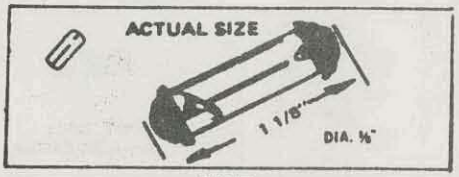
FOR MILLIONS OF "MAKES" AND "BREAKS"

1899

TILTING TYPE
SINGLE POLE – SINGLE THROW

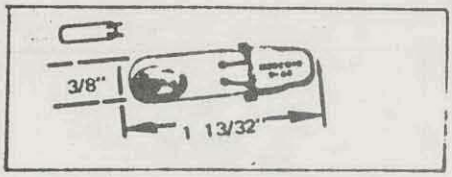
0.6 ampere 120 volts
1.25 amperes 24 volts
Differential angle 20°
Tilt Action - Slow
SWITCH NO. 6-47
WITH METAL-END CAPS

One electrode is attached to each metal cap with a small gap between them at one end of the tube and when the tube is tilted in that direction, the mercury flows and bridges the gap to close a circuit. When tilted in the opposite direction, the mercury flows away to restore the gap and open the circuit. Spring clips or holders are used for mounting purposes.



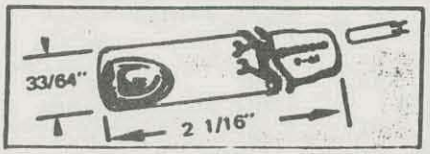
SP-ST
1.75 amperes 120 volts
0.6 ampere 240 volts
Differential angle 8°
Tilt Action - Fast or Slow
SWITCH NO. 6-65

Same as No. 6-47 described above except with higher electrical capacity.

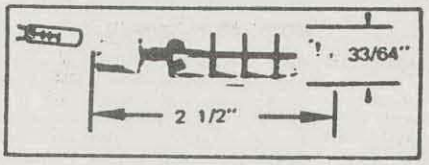


SP-ST
1 amperes 120 volts
0.5 ampere 240 volts
Differential angle 10°
Tilt Action - Fast or Slow
Use Clip No. 7-151
SWITCH NO. 9-65

TILTING TYPE
SINGLE POLE – SINGLE THROW



SP-ST
4 amperes 120 volts
2 amperes 240 volts
1 amperes 440 volts AC
Non-Inductive rating
9A. 120V. 4½A. 240V.
Differential Angle 5°
Tilt Action - Fast or Slow
Use Clip No. 7-57
SWITCH NO. 9-61



SP-ST
4 amperes 120 volts
2 amperes 240 volts
1 ampere 440 volts AC
Differential Angle 5°
Tilt Action - Fast or Slow
Use Clip No. 7-57
SWITCH NO. 9-35
ANTI-VIBRATION SWITCH

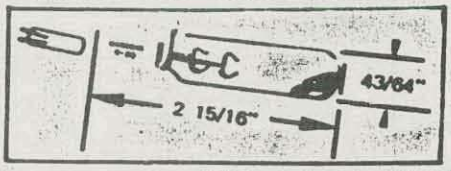
Minimizes false contact under severe high frequency vibrations. (The mils shown in the following values are actually double the amplitude 60 mils means 30 mils in each direction).

Cyles Per Second	Vibration (Mils .001") Vertical	Horizontal
120	30	25
60	45	55
30	72	100

4 amperes 120 volts
2 amperes 240 volts
1 ampere 440 volts AC
Differential Angle 5°
Tilt Action - Fast or Slow
Use Clip No. 7-57
SWITCH NO. 9-43
MOMENTARY CONTACT

Electrodes are located in the center of the tube, hence, each time the tube is tilted, the mercury flows past the electrodes to provide a momentary "pulse".

TILTING TYPE
SINGLE POLE -- SINGLE THROW



SP-ST
6 amperes 120 volts
3 amperes 240 volts
1 ampere 440 volts AC
Differential Angle 2½°
Tilt Action – Slow
Use Clip No. 7-39
SWITCH NO. 9-78

SP-ST
10 amperes 120 volts
5 amperes 240 volts
3 amperes 440 volts AC
Non-Inductive Rating
17A. 120V/240V. AC.
Differential Angle 8°
Tilt Action - Fast or Slow
Use Clip No. 7-59
SWITCH NO. 9-51

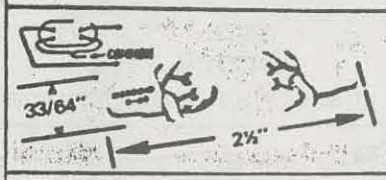
SP-ST
25 amperes 120 volts
15½ amperes 240 volts
6 amperes 440 volts AC
Non-Inductive rating with
Type SF leads (page 4)
25 amperes 120 volts 2875 watts
25 amperes 240 volts 5000 watts
Use Clip No. 7-191
SWITCH NO. 9-56
HEAVY DUTY SWITCH

ALL TYPES AVAILABLE WITH OR WITHOUT LEADS - SEE PAGE 60.
MOUNTING CLIPS - SEE PAGE 60. ENCAPSULATION - SEE PAGE 60.

Mercoid Hermetically Sealed Mercury Switches are backed by over fifty years of engineering know-how. The switches shown in this bulletin are standard items and can be varied to accomodate any need - such as longer tube lengths, changes in electrodes and with special lead construction.

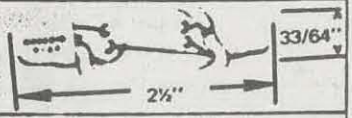
TILTING TYPE

SINGLE POLE–DOUBLE THROW



SP-DT
4 amperes 120 volts
2 amperes 240 volts
1 ampere 440 volts AC
Differential Angle 8°
Tilt Action - Fast or Slow
Use Clip No. 7-57

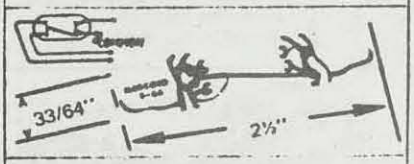
SWITCH NO. 9-62



SP-DT THREE WIRE
4 amperes 120 volts
2 amperes 240 volts
1 ampere 440 volts AC
Differential Angle 8°
Tilt Action - Fast or Slow
Use Clip No. 7-57

SWITCH NO. 9-64

THREE CIRCUIT –
SINGLE CIRCUIT TO DOUBLE CIRCUIT (DOUBLE THROW)



4 amperes 120 volts
2 amperes 240 volts
1 ampere 440 volts AC
Differential Angle 8°
Tilt Action - Fast or Slow
Use Clip No. 7-57

SWITCH NO. 9-66

DOUBLE CIRCUIT – ST

4 amperes 120 volts
2 amperes 240 volts
1 ampere 440 volts AC
Differential Angle 8°
Tilt Action - Fast or Slow
Use Clip No. 7-57

SWITCH NO. 9-67

MAGNET OPERATED

STATIONARY TYPES SP-ST FOR AC OR DC SWITCHING APPLICATIONS

Mercoid magnetic type hermetically sealed mercury switches remain in a stationary position and are operated by magnetic attraction through the glass. They are actuated by small permanent magnets as illustrated by using small milli-ampere electro-magnets. Very little power is required to actuate the magnet to open or close the circuit.

24 volts: .9 ampere AC., .45 ampere DC
120 volts: .3 ampere AC., .15 ampere DC
240 volts: .15 ampere AC., .07 ampere DC

WITH METAL-END CAPS

Very little power is required to operate the switch. They are adaptable to applications where a mechanical movement of approximately 0.007" (min.) with a force of 2 grams is available to move the permanent magnet. Actuation may also be accomplished through the use of DC electro-magnets.

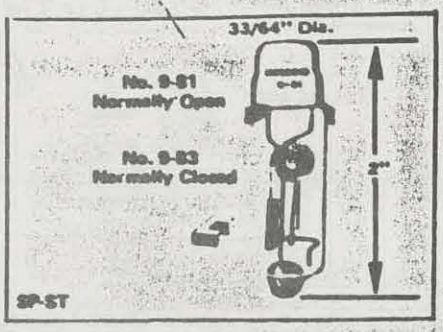
Switches may be mounted at any angle up to 45° from vertical. Will operate at frequencies up to 400 cycles per minute (at maximum rated load) Higher frequencies are obtainable depending on load characteristics.

24 volts: 1 ampere AC., .5 ampere DC
120 volts: .5 ampere AC., .25 ampere DC
240 volts: .25 ampere AC., .12 ampere DC
Use Clip No. 7-57 or 7-167
Use Magnet No. 93-87

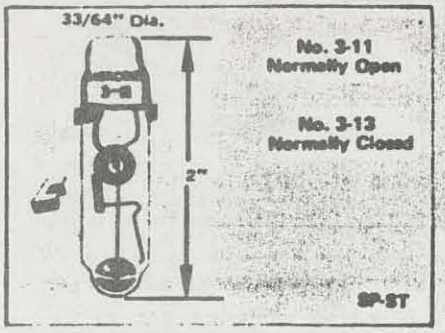
Non Inductive rating AC: 120 volts 1 amp.
240 volts ½ amp.

Similar in operation to Type 6-81 shown above. The movable contact makes contact by penetrating an opening in the capillary tube. The capillary tube is positioned so as to be supplied by the mercury in the well. The bottom of the capillary tube projects below the surface of the mercury pool, consequently the mercury in the capillary is uncontaminated by any oxides or foreign material on the surface of the mercury.

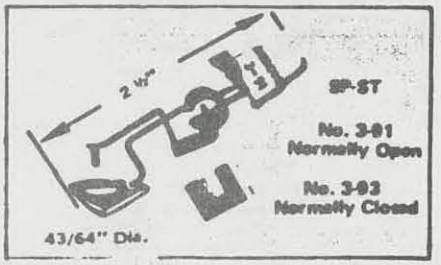
For sensitive operation tube is usually mounted vertically, however, tube can be mounted any angle up to 30° from vertical. Hundreds of cycles per minute are possible depending upon load characteristics.



24 volts: .9 ampere AC., .45 ampere DC
120 volts: .3 ampere AC., .15 ampere DC
240 volts: .15 ampere AC., .07 ampere DC
Use Clip No. 7-57 or 7-167
Use Magnet No. 93-87



120 volts: AC 1 ampere, DC .5 ampere
240 volts: AC .5 ampere, DC .25 ampere
Use Clip No. 7-57 or 7-167
Use Magnet No. 93-86



120 volts: AC 5 amperes, DC 2.5 amperes
240 volts: AC 2 amperes, DC 1 ampere
1/8 hp. 120/240 volts AC Single Phase
1/10 hp. 120/240 volts DC
Use Clip No. 7-39
Use Magnet No. 93-88

Note For No. 393 magnet approaches switch from top.

ALL TYPES AVAILABLE WITH OR WITHOUT LEADS SEE PAGE 60.
MOUNTING CLIPS SEE PAGE 60 ENCAPSULATION SEE PAGE 60

LEAD WIRES - FOR USE WITH TILTING TYPE MERCURY SWITCHES

Lead wires are normally furnished with leads reversed (see illustrations) also available projecting straight out of mercury switch. Switches with lead wires are carried in stock with a No. 8 ring terminal. Other types of terminals are available.

STANDARD LEAD WIRE

TYPE SA: 20 gauge wire with 1/32" silicone rubber insulation. (Underwriters Lab. Style No. 3123.) Standard for switch Nos. 9-51, 9-78.

TYPE SC: 23 gauge wire with 1/32" silicone rubber insulation. (Standard on switch Nos. 9-61, 9-35, 9-62, 9-64, 9-66, 9-67).

TYPE SF: 17 gauge wire with 1/32" silicone rubber insulation. (Standard on switch No. 9-55).

TYPE BB: 20 gauge wire with neophrene insulation. (Standard for switch Nos. 9-81, 9-83, 3-91, 3-93, 3-11, 3-13).

TYPE PH: 23 gauge wire with 1/64" plastic insulation. (Standard for switch Nos. 6-65, 6-81, 6-83, 6-47).

NOTE: Non inductive rated switches shown on preceeding pages must use the following lead wire.

Type 9-51 and 9-55 specify SF lead wire
Type 9-61 and 9-78 specify SA lead wire

LEAD WIRES FOR USE WITH MAGNETIC TYPE MERCURY SWITCHES

All magnet operated mercury switches are available with Neoprene insulated lead wires and a No. 8 ring terminal. Leads are available in various lengths, either with or without terminals to meet your requirements.

PERMANENT MAGNETS

Alnico magnets are generally recommended because of their small mass and great density of magnetic lines of force, however, a small milli ampere electro-magnet may be employed in conjunction with Mercoid Magnetic Mercury Switches.

SPECIAL LEADS

Various lengths, either with or without terminals to meet your requirements - materials such as neophrene or plastic.

57A 00329 - D A-26-11

ENCAPSULATED MERCURY SWITCHES

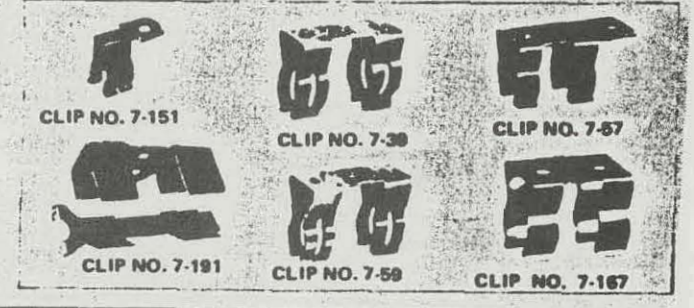
There are certain applications such as the food industry (or military specifications) which require that the switch be encapsulated in a strong plastic which will not break should the mercury switch shatter, thereby preventing any contamination. To meet such conditions Mercoid has selected two materials for encapsulation as follows:

1. PVC (polyvinyl chloride)
   Clear, flame retardent and radiation resistant.
   For temperatures to 220°F.
   U.L. listed - meets Military specification MIL-I 631.
   (Material can be cut by sharp objects or abrasion).

2. KYNAR (polyvinylidene fluoride)
   Extremely resistant to cutting or abrasion as well as chemical or solvent attack. Less resistant to radiation than PVC.
   For temperatures to 347°F.
   Generally used in food industry applications.

MOUNTING CLIPS

Mercoid nickel silver mounting clips are recommended to hold the mercury switch in the correct position as their flexibility relieves expension and contraction strains. The illustrations below show several standard clips. Other styles are available to meet special requirements.



CLIP NO. 7-151 — CLIP NO. 7-39 — CLIP NO. 7-57

CLIP NO. 7-191 — CLIP NO. 7-59 — CLIP NO. 7-167

SILENT AND CHATTERLESS *ONLY ONE MOVING PART* **QUICKLY MOUNTED** **EASILY WIRED** **VISIBLE CONTACT ACTION**

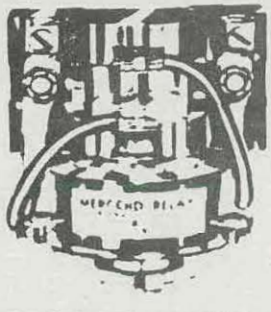
APPLICATION

For heavy duty loads such as resistance heating, (domestic, commercial, industrial), heat treating furnaces, drying equipment, welding, also lighting, illuminated signs, scoreboards and many other applications.

ELECTRICAL RATINGS

(Based On Operating Speeds Up To 100 Per Minute)

	LINE	120V. A.C.	120V. D.C.	240-277V. A.C.	240-277V. D.C.	440V. A.C.
LOAD CAPACITY	General	30A.	15A.	20A.	10A.	10A.
	Tungsten Lamp	30A.	–	20A.	–	–
	Non-Inductive	35A.	–	30A.	–	–
	Motor HP	2	–	2	–	–



HERMETICALLY SEALED

NORMALLY OPEN TYPE W-20-3: Energized Position—*coil pulls plunger down into mercury. Mercury in turn completely engulfs the ceramic cup which already is filled with mercury, thereby assuring a positive mercury to mercury contact* ***De-Energized Position*** — *Plunger floats in mercury Circuit is open as main body of mercury is below lip of ceramic cup.*

COIL RATINGS

A.C. COILS 60 Cyc.	A.C. COILS INPUT	D.C. COILS	D.C. COILS INPUT
24V.	6 watts	48V.	7 watts
60V.	6 watts		
120V.	6 watts	115V.	6 watts
208V.	6 watts	12V.	6 watts
240V.	5 watts	240V.	7 watts
277V.	6 watts	24V.	6 watts
440V.	5 watts	28V.	6 watts

Our experienced field engineers are available to assist you in the selection of a mercury switch to fit your application - no obligation - submit your problem.

THE MERCOID CORPORATION, 4201 BELMONT AVE., CHICAGO, ILL. 60641
PHONE: (312) 736-2100 - TELEX 253470
WILLOW GROVE, PA. 19090 - PHONE: (215) 659-0550

MERCOID SERIES "D" PRESSURE SWITCHES

WITH HERMETICALLY SEALED MERCURY SWITCH CONTACTS OR SNAP-ACTION CONTACTS

BOURDON TUBE POWER ELEMENTS PRESSURES TO TO 5,000 PSIG.

All Dials Calibrated English and Metric Uni

PRESS. SW

4" NPT

1. Select OPERATING RANGE and DIFFERENTIAL required. Check Bourdon Tube Material
2. Select OPERATING REQUIREMENT (FUNCTION) such as FULLY AUTOMATIC with ADJUSTABLE DIFFERENTIAL; FULLY AUTOMATIC with FIXED DIFFERENTIAL or SEMI-AUTOMATIC OPERATION with MANUAL RESET.
3. Select proper ENCLOSURE such as GENERAL PURPOSE, WATERTIGHT-DUSTTIGHT or EXPLOSION PROOF (see next page).

OPERATING RANGES—ADJUSTMENT—DIFFERENTIALS—ELECTRICAL RATINGS

Circuit Suffix Designations	CONTROLS WITH MERCURY SWITCHES -2 (SP-ST) OPENS on increase -3 (SP-ST) CLOSES on increase -153 (SP-DT) One opens as other closes CONTROLS WITH SNAP-ACTION SWITCHES -153 (SP-DT) one opens as other closes		ADJUSTABLE DIFFERENTIAL DOUBLE ADJUSTMENT For making both "on" and "off" operating points. Maximum differential—full scale. Minimum differential listed below.			FIXED DIFFERENTIAL SINGLE ADJUSTMENT Adjustable operating point. Differential fixed NOT ADJUSTABLE	
1 APPLICATION Bourdon tube material	ADJUSTABLE OPERATING RANGE PSIG	RANGE NO.	MERCURY SWITCH SEE CODE A	MERCURY SWITCH SEE CODE B	SNAP-ACTION SWITCH SEE CODE D	MERCURY SWITCH SEE CODE C	SNAP-ACTION SWITCH SEE CODE E
			DA-31	DA-531	DA-7031	DS-231	DS-7231
FOR GASES, STEAM OR LIQUIDS NOT INJURIOUS TO BRASS BOURDON TUBES COMPLETE DETAILS SEE PAGES 6 & 7	0-30" Hg. Vac.	2	2" Hg.	1" Hg.	9" Hg.	0.2" Hg.	3" Hg.
	10" Hg. Vac. 12	3	1 PSIG	0.5 PSIG	4 PSIG	2 oz.	1.5 PSI
	1/8-15 PSIG	1	1 PSIG	0.5 PSIG	4 PSIG	2 oz.	1.5 PSI
	1/8-20 PSIG	3A	1 PSIG	0.5 PSIG	4 PSIG	2 oz.	1.5 PSI
	1-35 PSIG	4	1.75 PSIG	0.75 PSIG	5 PSIG	4 oz.	1.5 PSI
	25" Hg. Vac. 50	27	3.5 PSIG	2 PSIG	8 PSIG	7 oz.	2.5 PSI
	2-60 PSIG	5	3 PSIG	1 PSIG	6 PSIG	6 oz.	2 PSI
	5-100 PSIG	6	3.75 PSIG	2 PSIG	9 PSIG	7 oz.	2.5 PSI
	5-150 PSIG	7	6 PSIG	3 PSIG	16 PSIG	8 oz.	3 PSI
	10-200 PSIG	8	8 PSIG	3.5 PSIG	16 PSIG	12 oz.	4 PSI
	10-300 PSIG	9	12 PSIG	6 PSIG	25 PSIG	16 oz.	5 PSI
FOR GASES OR LIQUIDS NOT INJURIOUS TO 400 STAINLESS STEEL BOURDON TUBES COMPLETE DETAILS SEE PAGES 8 & 9			DA-21	DA-521	DA-7021	DS-221	DS-7221
	30" Hg. Vac. 60	25S	6 PSIG	3 PSIG	12 PSIG	12 oz.	3.5 PSI
	30" Hg. Vac. 75	26S	8 PSIG	4 PSIG	15 PSIG	12 oz.	3.5 PSI
	2-60 PSIG	5S	4 PSIG	2.5 PSIG	9 PSIG	0.5 PSIG	3 PSI
	5-100 PSIG	6S	6 PSIG	3 PSIG	13 PSIG	0.75 PSIG	3.5 PSI
	10-200 PSIG	8S	8 PSIG	4 PSIG	15 PSIG	0.75 PSIG	4 PSI
	10-300 PSIG	9S	14 PSIG	7 PSIG	19 PSIG	1 PSIG	6 PSI
	40-350 PSIG	9AS	14 PSIG	7 PSIG	20 PSIG	1 PSIG	6 PSI
	25-600 PSIG	10S	25 PSIG	15 PSIG	45 PSIG	2.5 PSIG	10 PSI
	50-1000 PSIG	11S	60 PSIG	40 PSIG	95 PSIG	10 PSIG	20 PSI
	100-1500 PSIG	12S	90 PSIG	50 PSIG	130 PSIG	12 PSIG	30 PSI
	300-2500 PSIG	13S	150 PSIG	100 PSIG	260 PSIG	15 PSIG	60 PSI
	500-5000 PSIG	15S	450 PSIG	200 PSIG	900 PSIG	150 PSIG	200 PSI
FOR MEDIUMS NOT INJURIOUS TO 316 STAINLESS STEEL BOURDON TUBES COMPLETE DETAILS SEE PAGES 10 & 11			DA-41	DA-541	DA-7041	DS-241	DS-7241
	5-75 PSIG	23E	3 PSIG	2 PSIG	8 PSIG	0.4 PSIG	4 PSIG
	10-150 PSIG	24E	6 PSIG	3 PSIG	11 PSIG	0.75 PSIG	4 PSIG
	10-300 PSIG	9E	18 PSIG	5 PSIG	28 PSIG	3 PSIG	8 PSIG
	30-400 PSIG	21E	30 PSIG	15 PSIG	52 PSIG	5 PSIG	10 PSIG
	75-800 PSIG	22E	75 PSIG	35 PSIG	120 PSIG	12 PSIG	25 PSIG
	100-1000 PSIG	11E	100 PSIG	45 PSIG	190 PSIG	18 PSIG	35 PSIG
	200-2500 PSIG	13E	210 PSIG	110 PSIG	400 PSIG	50 PSIG	75 PSIG

ELECTRICAL RATINGS

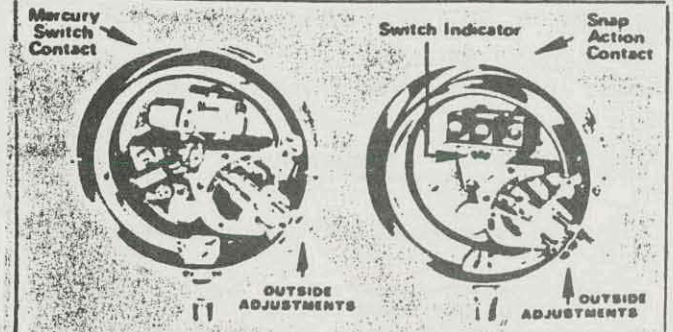
CIRCUIT SUFFIX NOS.
-2 SP-ST OPENS ON INCREASE
-3 SP-ST CLOSES ON INCREASE
-153 SP-DT ONE OPENS AS OTHER CLOSES

CODE	CIRCUIT SUFFIX	AC CAPACITY 120V.	240V.	440V	DC CAPACITY 120V.	240V.	HORSEPOWER AC	DC
A	-2, -3 -153	10A. 4A.	5A. 2A.	3A. ½	10A. 4A.	5A. 2A.	3/4 1/8	1/3 NA
B	-2, -3	5A.	2A	NA	2½A.	1A.	1/8	1/10
C	-2, -3	0.3A.	0.15A	NA	0.15A	0.07A	NA	NA
D	-153	15A	15A	15A 480V.	½A.	¼A	½	NA
E	153	15A	15A	NA				NA

1846

2 SELECT YOUR OPERATING REQUIREMENT

ADJUSTABLE DIFFERENTIAL
FULLY AUTOMATIC – DOUBLE ADJUSTMENTS



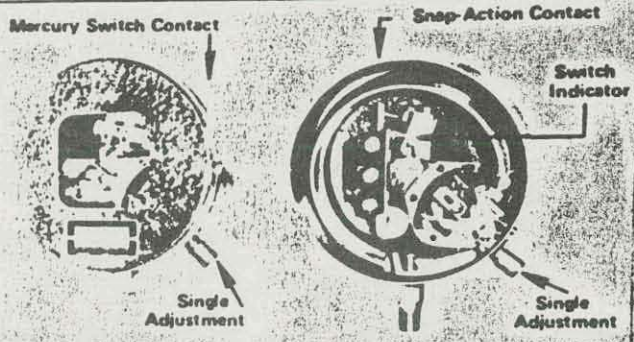
TYPES DA, DAF, DAH, DAHF, DAW, N3-DAW

Equipped with two outside adjustments - one for setting "high" pressure operating point and one for setting "low" pressure set point. Differential (difference between the "high" and "low" set points) is adjustable over the full scale.

Controls with mercury switch contacts are available SP-ST or in a variety of multiple circuits.

Controls with snap-action contacts have a switch indicator for visible operation and are available SP-DT or DP-DT. (2 SP-DT switches).

FIXED DIFFERENTIAL
FULLY AUTOMATIC – SINGLE ADJUSTMENT



TYPES DS, DSF, DSH, DSHF, DSW, N3-DSW

Equipped with a single adjustment for setting operating point only. A single pointer on the scale sets the pressure point where switch operation occurs. Fixed differential is factory set and cannot be changed.

Controls with mercury switch contacts have visible on/off operation and are available SP-ST only.

Controls with snap-action contacts have switch indicator for visible on/off operation and are available SP-DT only.

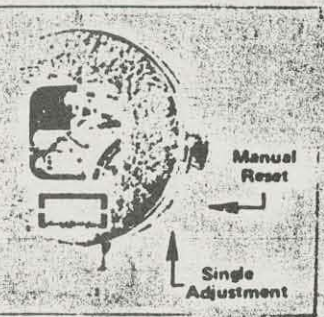
SEMI-AUTOMATIC WITH MANUAL RESET
SINGLE ADJUSTMENT

TYPES DR, DRF, DRH, DRHF, DRW, N3-DRW

A single adjustment sets the operating point to either "OPEN" or "CLOSE" the circuit automatically upon a pressure decrease or increase. A push button reset must be operated manually to restore the circuit to the original position after automatic operation.

Suffix –L after Type No. denotes control will operate automatically on an increase.

Suffix –U after Type No. denotes control will operate automatically on a decrease.



3 SELECT YOUR ENCLOSURE

INDOOR

GENERAL PURPOSE
NEMA 1

TYPES DA, DR, DS: For applications where atmospheric conditions are normal. For protection against dust and light splashing. Heavy gauge plain case (steel) with glass fronted cover. Finish charcoal gray. ½" NPT pressure connection. Electrical connection back of case for ½" Conduit or BX. Locking device to prevent tampering with adjustments. Available with flanged case.

Dimensions Page 65

OUTDOOR

WATERTIGHT – DUSTTIGHT
NEMA 3S and 4

TYPES DAW, DRW, DSW: Meets hose test also requirement for dusttight, dripproof, weather resistant, weather proof, splash proof, sleet proof, moisture resistant, watertight. Standard with flanged case bottom connection (surface mounting only). Pressure connection ½" NPT. Case and cover heavy gauge steel with UL listed metallic acrylic enamel finish. Glass fronted cover. External adjustments protected by bolt gaskets. ½" Conduit opening back of case with ½" removable hub.

WEATHER RESISTANT (RAINTIGHT)
NEMA 3R

TYPES N3 DAW, N3 DRW, N3 DSW: Similar to Watertight except includes drain in cover and does not have removable hub.

Dimensions Page 65

HAZARDOUS LOCATIONS

EXPLOSION-PROOF
Class I Group C & D, NEMA 7 Class II, Group E, F, G, Class III, NEMA 9, 9A Division 1

TYPES DAH, DRH, DSH: The control mechanism is an integral part of the case and cannot be removed in the field. For surface, panel or pipe mounting. Pressure connection ½" male thread with ¼" female thread. External adjustments. Shatter proof glass fronted cover. Finish natural aluminum. Available with breather and drain.

Dimensions Page 65

pressure switches MERCOID

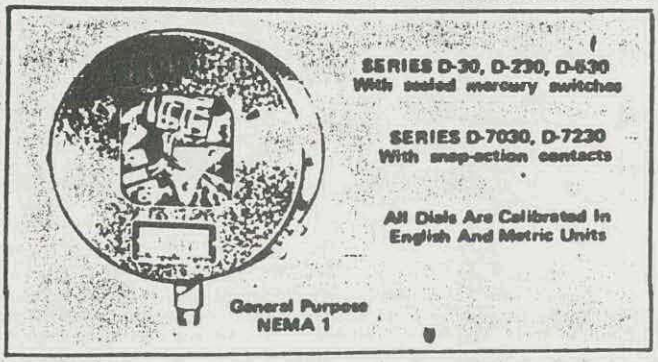
With hermetically sealed mercury switches or snap-action switches

0-30" HG. VAC. TO 300 PSIG. BRASS BOURDON TUBES

ENCLOSURES: GENERAL PURPOSE, WATERTIGHT-DUSTTIGHT OR EXPLOSION PROOF

ADJUSTABLE OR FIXED DIFFERENTIALS

MINIMUM DIFFERENTIAL FOR EACH RANGE OBTAINABLE AT ANY POINT OVER ENTIRE RANGE SCALE



SERIES D-30, D-230, D-630
With sealed mercury switches

SERIES D-7030, D-7230
With snap-action contacts

All Dials Are Calibrated In English And Metric Units

General Purpose NEMA 1

APPLICATION

These pressure actuated switches are suitable for any gas or liquid not corrosive to brass. For steam service 35 psig. or higher (or any high temperature medium) use a siphon or remote connection. Ambient or pressure medium temperature at the control is limited to 180°F. maximum.
For remote connections or mounting bracket see accessories.
DELRIN BUSHED MOVEMENT "B" recommended to resist wear caused by severe vibration or pulsations -see accessories.

OPERATING SPECIFICATIONS

ADJUSTABLE DIFFERENTIALS—FULLY AUTOMATIC
TYPES DA, DAF, DAH, DAHF, DAW, N3-DAW:

Equipped with two outside adjustments one for setting "high" pressure operating point and one for setting "low" pressure set point. Differential (difference between the "high" and "low" set points) is adjustable over the full scale see table next page.

Example: Type DA-31-2 Range 6. With upper pointer set at 75 psig. and lower pointer set at 70 psig. circuit will open when pressure increases to 75 psig. and close when pressure decreases to 70 psig. With both pointers set close together at 75 psig. circuit will open and reclose when pressure decreases to 3.75 psig. which is the minimum differential obtainable. Note: Minimum differential for each range is obtainable at any point over entire range scale.

FIXED DIFFERENTIAL
TYPES DS, DSF, DSH, DSHF, DSW, N3-DSW:

Equipped with a single adjustment for setting operating point only. A single pointer on the scale sets the pressure point where switch operation occurs. Fixed differential is factory set and cannot be changed.

Example setting: Type DS-731-2, Range 2-60 psig. If pointer is set at 40 psig., the control will operate to OPEN circuit at 40 psig. and RECLOSE circuit at the fixed differential of 6 oz.

MANUAL RESET—SEMI-AUTOMATIC

TYPES DR, DRF, DRH, DRHF, DRW, N3-DRW: (With suffix "L" or "U".) A single adjustment sets the operating point to either "OPEN" or "CLOSE" the circuit automatically upon a pressure decrease or increase. A push button reset must be operated manually to restore the circuit to the original position after automatic operation.

Example: Type DA-11-2L Circuit will open automatically on a pressure increase to the pressure indicated by the pointer on the scale ... no matter how much pressure decreases, circuit will not reclose until reset button is operated.

Suffix "L" after Type No. denotes control will operate automatically on an increase.

Suffix "U" after Type No. denotes control will operate automatically on a decrease.

ENCLOSURES
For Complete Description See Page 5

ALL ENCLOSURES HAVE VISIBLE ON/OFF OPERATION

GENERAL PURPOSE—NEMA 1
TYPES DA, DAF, DS, DSF, DR, DRF:
Bottom pressure connection 1/4" NPT. Dimensions drawing No. 1000B. Shipping weight 4 lbs.

WATERTIGHT-DUSTTIGHT—NEMA 3S and 4
TYPES DAW, DRW, DSW:
Bottom pressure connection 1/4" NPT. Dimensions drawing No. 1062. Shipping weight 6 lbs.

WEATHER RESISTANT-RAINTIGHT—NEMA 3R
TYPES N3-DAW, N3-DRW, N3-DSW:
Bottom pressure connection 1/4" NPT. Dimensions drawing No. 1062. Shipping weight 6 lbs.

EXPLOSION-PROOF—Class 1, Group C & D, NEMA 7, Class 2, Group E, F, G, NEMA 9.
TYPES DAH, DSH, DRH, DAHF, DSHF, DRHF.
Bottom pressure connection 1/2" male thread with 1/4" female thread. Shipping weight 8 lbs. (For Other Enclosures See Page 14).

ACCESSORIES

SPECIAL FEATURES ON ORDER

(FACTORY MUTUAL APPROVED CONTROLS) add letter "F" to all prefixes. Example: DAF, DSF, DAHF, DSHF. (Extra charge).

See next page for operating ranges, differentials and electrical ratings.

DIMENSIONS PAGE 65

SEE PAGES 61 to 64

1d48

OPERATING RANGES — DIFFERENTIALS — ELECTRICAL RATINGS

DA-521-3 25S

WITH MERCURY SWITCH CONTACTS
SERIES D-30, D-230, D-530

CIRCUIT SUFFIX NOS. -2 OPENS ON RISE -3 CLOSES ON RISE -153 SP-DT		Adjustable Differential		Fixed Differential
		Double Adjustments to set High & Low operating points		Single Adjustment to set Operating Point only
ADJUSTABLE OPERATING RANGE PSIG.	RANGE NO.	DA-31 DAW-33 DAH-31 *MIN. DIFF.*	DA-531 DAW-533 DAH-531 *MIN. DIFF.*	DS-231 DSW-233 DSH-231
0-30" Hg. Vac.	2	2" Hg.	1" Hg.	0.2" Hg.
10" Hg. Vac. 12	3	1 PSIG.	0.5 PSIG.	2 oz.
1/8-15 psig.	1	1 PSIG.	0.5 PSIG.	2 oz.
1/8-20 psig.	3A	1 PSIG.	0.5 PSIG.	2 oz.
1-35 psig.	4	1.75 PSIG.	0.75 PSIG.	4 oz.
25" Hg. Vac. 50	27	3.5 PSIG.	2 PSIG.	7 oz.
2-60 psig.	5	3 PSIG.	1 PSIG.	6 oz.
5-100 psig.	6	3.75 PSIG.	2 PSIG.	7 oz.
5-150 psig.	7	6 PSIG.	3 PSIG.	8 oz.
10-200 psig.	8	8 PSIG.	3.5 PSIG.	12 oz.
10-300 psig.	9	12 PSIG.	6 PSIG.	16 oz.
MULTIPLE CIRCUITS		See Page 16	Not Available	Not Available
ELECTRICAL RATINGS		See Code A	See Code B	See Code C

ELECTRICAL RATINGS
CIRCUIT SUFFIX NOS.
-2 SP-ST OPENS ON INCREASE
-3 SP-ST CLOSES ON INCREASE
-153 SP-DT ONE OPENS AS OTHER CLOSES

CODE	CIRCUIT SUFFIX	AC CAPACITY 120V.	240V.	440V.	DC CAPACITY 120V.	240V.	HORSEPOWER AC	DC
A	-2, -3 -153	10A. 4A.	5A. 2A.	3A. -	10A. 4A.	5A. 2A.	3/4 1/8	1/3 NA
B	-2, -3	5A.	2A.	NA	2A.	1A.	1/8	1/10
C①	-2, -3	0.3A.	0.15A.	NA	0.15A.	0.07A.	NA	NA

① -153 circuit available 1A. 440V. AC on special order.
② Also rated 0.9 Amps. at 24 V. AC.

WITH SNAP-ACTION CONTACTS
Series D-7030, D-7230

CIRCUIT SUFFIX NO. -153 Single Pole Double Throw		Adjustable Differential	Fixed Differential
		Double Adjustments to set High & Low operating points	Single Adjustment to set Operating Point only
ADJUSTABLE OPERATING RANGE PSIG.	RANGE NO.	DA-7031-153 DAW-7033-153 DAH-7031-153 *MIN. DIFF.*	DS-7231-153 DSW-7233-153 DSH-7231-153
0-30" Hg. Vac.	2	9" Hg.	3" Hg.
10" Hg. Vac. 12	3	4 PSIG.	1.5 PSI
1/8-15 psig.	1	4 PSIG.	1.5 PSI
1/8-20 psig.	3A	4 PSIG.	1.5 PSI
1-35 psig.	4	5 PSIG.	1.5 PSI
25" Hg. Vac. 50	27	8 PSIG.	2.5 PSI
2-60 psig.	5	6 PSIG.	2 PSI
5-100 psig.	6	9 PSIG.	2.5 PSI
5-150 psig.	7	16 PSIG.	3 PSI
10-200 psig.	8	18 PSIG.	4 PSI
10-300 psig.	9	25 PSIG.	5 PSI
Two SP-DT Switches		See page 16	SEE PAGE 16
ELECTRICAL RATING		SEE CODE D	SEE CODE E

ELECTRICAL RATINGS
-153 SP-DT ONE OPENS AS OTHER CLOSES

CODE	CIRCUIT SUFFIX	AC CAPACITY 120V.	240V.	440V.	DC CAPACITY 120V.	240V.	HORSEPOWER AC	DC
D	-153	15A.	15A.	15@480V.	½A.	¼A.	*	NA
E	-153	15A.	15A.	NA	•	•	•	NA

* 1/4 HP at 120V. AC, 1/2 HP at 240V. AC.
• DC rated controls (up to 10 Amps.) see page 16.

HOW TO ORDER

SPECIFY — Type Number, Circuit Suffix Number and Operating Range Number.
EXAMPLE: DA-31-2, Range No. 6

Prefix DA denotes General Purpose Enclosure with adjustable differential.
Suffix -31 designates brass Bourdon tube with bottom connection.
Suffix -2 designates circuit is to OPEN on pressure increase.
Range No. 6 denotes an operating range of 5-100 psig.

Letter "W" in prefix denotes Watertight-Dustlight enclosure (DAW, DSW, DRW, etc.)
Prefix NJ-DAW, NJ-DSW, NJ-DRW denotes Weather Resistant enclosure (Raintight).
Letter "H" in prefix denotes Explosion proof enclosure (DAH, DSH, DRH, etc.)
Letter "E" in prefix denotes Explosion proof enclosure (see accessories page 15.)
Letter "F" in prefix denotes FM approval - DAF, DSF, DRF, DAHF, DSHF etc.

1849

pressure switches MERCOID

With hermetically sealed mercury switches or snap-action switches

30" HG. VAC. TO 5,000 PSIG. 403 STAINLESS STEEL BOURDON TUBES

GENERAL PURPOSE, DRIPTIGHT, WEATHER RESISTANT, WATERTIGHT, DUSTTIGHT OR EXPLOSION PROOF ADJUSTABLE OR FIXED DIFFERENTIALS

MINIMUM DIFFERENTIAL FOR EACH RANGE OBTAINABLE AT ANY POINT OVER ENTIRE RANGE SCALE

Series D-20, D-220, D-520 with sealed mercury switches
Series D-7020 and D-7220 with snap-action switches

All Dials Are Calibrated in English and Metric Units

GENERAL PURPOSE — WATERTIGHT—DUSTTIGHT WEATHER-RESISTANT — EXPLOSION PROOF

Power Element - 403 SS Bourdon Tube

APPLICATION

For use with pressure mediums not injurious to 403 stainless steel. All types incorporate an orifice in the 1/4" pressure connection. Where pulsations, surges or water hammer occur, use a surge tank snubber or capillary tubing connection.

DELRIN BUSHED MOVEMENTS are recommended for extreme vibration or pulsations — prolongs control life (see accessories).

For remote connection or mounting bracket — see accessories.

OPERATING SPECIFICATIONS

ADJUSTABLE DIFFERENTIALS—FULLY AUTOMATIC
TYPES DA, DAF, DAH, DAHF, DAW, N3-DAW:

Equipped with two outside adjustments — one for setting "high" pressure operating point and one for setting "low" pressure set point. Differential (difference between the "high" and "low" set points) is adjustable over the full scale — see table next page. Example: Type DA-21-2 Range 95 (10-300 psig.) Upper point set at 100 psig. and lower pointer set at 75 psig. When pressure increases to 100 psig. circuit will open. When pressure decreases to 75 psig. circuit will automatically close.

Minimum differential for this particular range is 14 psig. (see chart) and is obtained by setting both pointers close together at any desired setting over the entire range scale. Example with both pointers set at 150 psig. Circuit will open when pressure increases to 150 psig. When pressure decreases to 136 psig., circuit will automatically close (150 psig. minus 14 psig. (min. diff.) = 136 psig.).

FIXED DIFFERENTIAL
TYPES DS, DSF, DSH, DSHF, DSW, N3-DSW

Equipped with a single adjustment for setting operating point only. A single pointer on the scale sets the pressure point where switch operation occurs. Fixed differential is factory set and cannot be changed.

Example setting: Type DS-221-2 Range 10-300 psig. If pointer is set at 100 psig., the control will operate to OPEN circuit at 100 psig. and RE-CLOSE circuit when pressure decreases 1 psig which is the fixed differential for this range (see chart).

MANUAL RESET—SEMI-AUTOMATIC

TYPES DR, DRF, DRH, DRHF, DRW, N3-DRW: (With suffix "L" or "U"). A single adjustment sets the operating point to either "OPEN" or "CLOSE" the circuit automatically upon a pressure decrease or increase. A push button reset must be operated manually to restore the circuit to the original position after automatic operation.

Example: Type DA-21-2L. Circuit will open automatically on a pressure increase to the pressure indicated by the pointer on the scale - no matter how much pressure decreases, circuit will not reclose until reset button is operated.

Suffix L after Type No. denotes control will operate automatically on an increase.

Suffix U after Type No. denotes control will operate automatically on a decrease.

ENCLOSURES

For Complete Description See Page 5.

ALL ENCLOSURES HAVE VISIBLE ON/OFF OPERATION

GENERAL PURPOSE—NEMA 1
TYPES DA, DAF, DS, DSF, DR, DRF:
Bottom pressure connection 1/4" NPT. Dimensions drawing No. 10008. Shipping weight 4 lbs.

WATERTIGHT-DUSTTIGHT—NEMA 3S and 4
TYPES DAW, DRW, DSW:
Bottom pressure connection 1/4" NPT. Dimensions drawing No. 1062. Shipping weight 6 lbs.

WEATHER RESISTANT-RAINTIGHT—NEMA 3R
TYPES N3-DAW, N3-DRW, N3-DSW:
Bottom pressure connection 1/4" NPT. Dimensions drawing No. 1062. Shipping weight 6 lbs.

EXPLOSION-PROOF—Class 1, Group C & D, NEMA 7, Class 2, Group E, F, G, NEMA 9.
TYPES DAH, DSH, DRH, DAHF, DSHF, DRHF.
Bottom pressure connection 1/2" male thread with 1/4" female thread. Shipping weight 8 lbs. (For Other Enclosures See Page 14).

ACCESSORIES and SPECIAL FEATURES

FM **FACTORY MUTUAL APPROVED CONTROLS** - add letter "F" to all prefixes. EXAMPLE DAF, DSF, DAHF, DSHF etc. See page 14

See next page for operating ranges, differentials and electrical ratings.

8

1850

jamesbury

BULLETIN 262

LIMIT SWITCHES FOR MANUAL VALVES

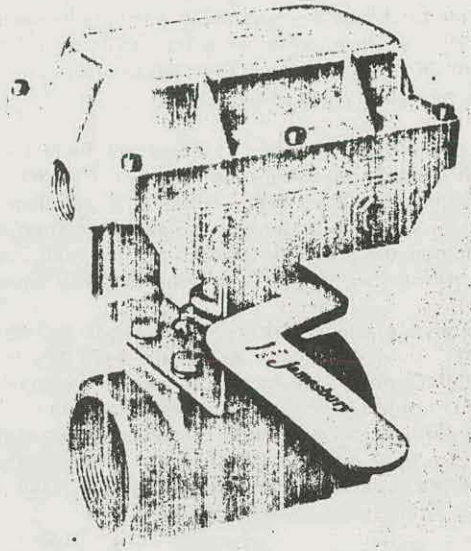
VP1 OR VTD

Limit switches can be furnished on manually operated Jamesbury 1/4"-6" ball valves whenever indication of the position of the valve is required at a remote location from the valve. Applications for these limit switches include the control of signaling devices, panel lights, supervisory conditions, or sequencing operations.

The switches are contained in a compact die cast housing which is rigidly mounted onto the valve. The limit switch assembly is UL listed, filling NEMA 4, 7, and 9 specifications for combined watertight and explosion-proof design. In addition, this design protects the switches from corrosion and prevents their settings from being accidently changed.

Units are available with either two single-pole double-throw (SPDT) or two double-pole double-throw (DPDT) switches. The SPDT switches are designed to break one contact while another contact is made. DPDT switches simultaneously break and make two independent circuits. Unless otherwise specified, these units are adjusted at the factory so that one of the two switches is actuated when the valve is fully open, and the other switch when the valve is closed.

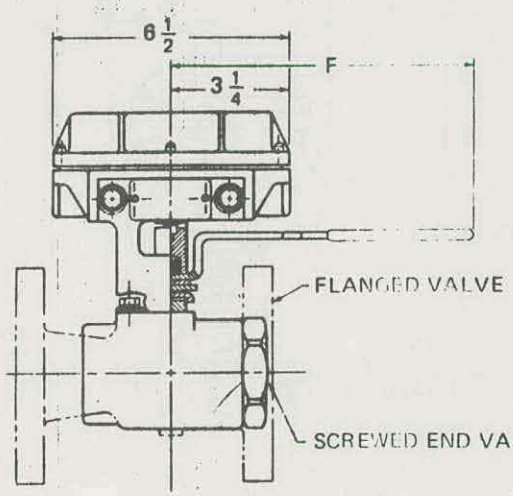
NOTE: Refer to the ball valve section of this catalog for complete valve-limit switch assemblies (supervisory cocks) that carry Factory Mutual approval.

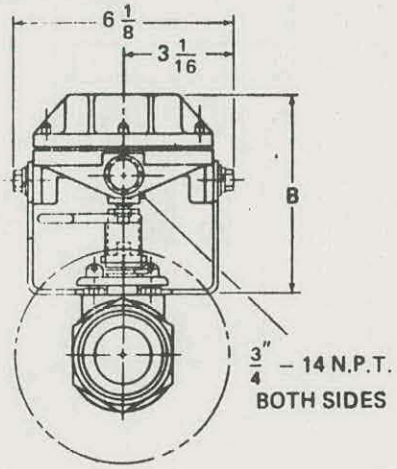


Designations of these units and switch ratings are:

		RATINGS IN AMPERES			
Switches	Designation	125V AC	250V AC	125V DC	250V DC
Two SPDT	32EX4B	20	20	0.3	0.15
Two DPDT	34EX4B	10	10	0.3	0.15

VALVE SIZE	APPROX. DIMS. (Inches)	
	B	F
1/4"-3/4"	5-3/16	8-5/16
1"-2"	5-1/2	8-5/16
3"-4"	7-3/4	14-1/2
6"	17	22-1/2





jamesbury

BULLETIN 262

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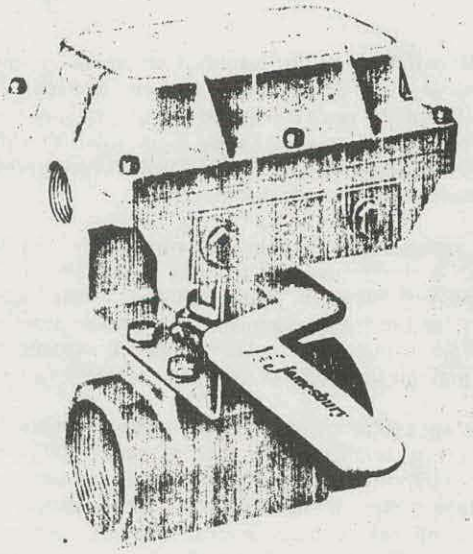
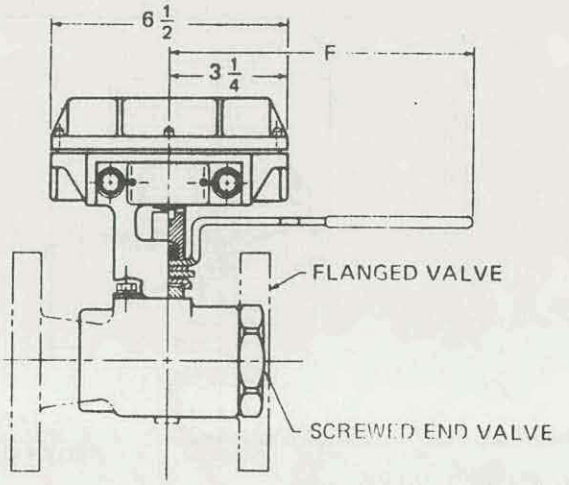
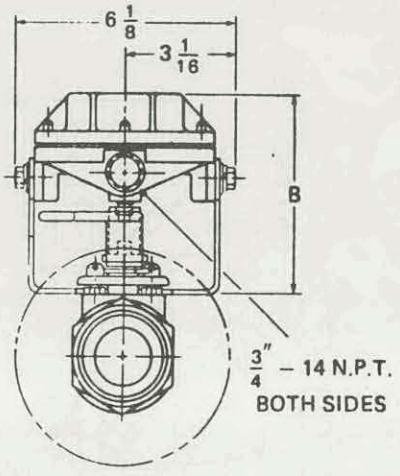


VALVE SIZE	APPROX. DIMS. (Inches)	
	B	F
1/4"-3/4"	5-3/16	8-5/16
1"-2"	5-1/2	8-5/16
3"-4"	7-3/4	14-1/2
6"	17	22-1/2





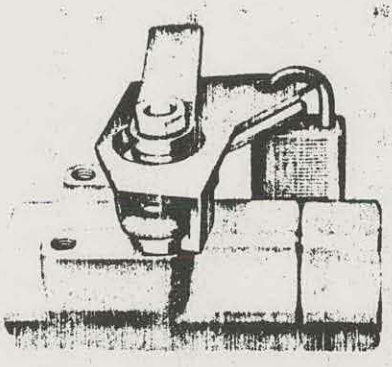
LOCKING DEVICES

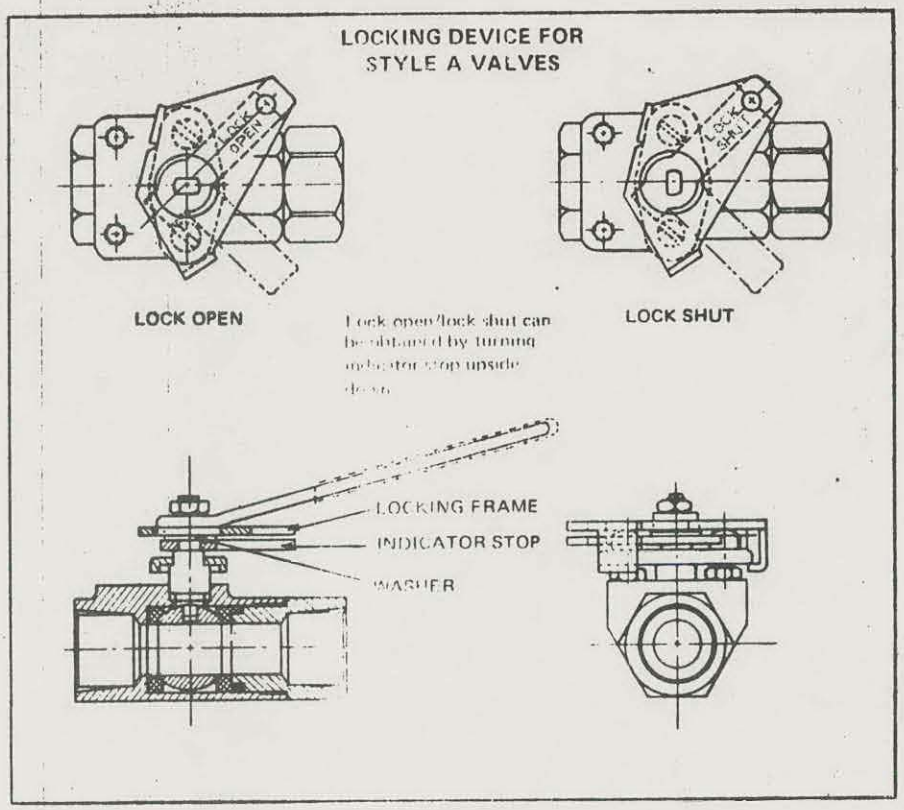
When safety measures are necessary for handling hazardous or valuable fluids, or are needed for applications covered by certain government regulations, reliable locking devices can be provided for securing Jamesbury "Double Seal" ball valves or holding them inoperative.

Readily removable when unlocked, these units are simple, unusually compact, and of light weight.

Standard designs permit locking the valve in either the closed or open position by means of a padlock or pin. Arrangements for designs to fit valve styles other than those shown below are available upon request. Standard locking devices available for Jamesbury valves are:

STYLE	SIZE	LOCKING DEVICE
A	1/4" – 3/4"	LD-1
A, A150F, AF30S, A300F	1" – 1-1/4"	LD-2
A, A150F, AF30S, A300F	1-1/2" – 2"	LD-3
A150F, AF30S, A300F	1/4" – 3/4"	LD-4





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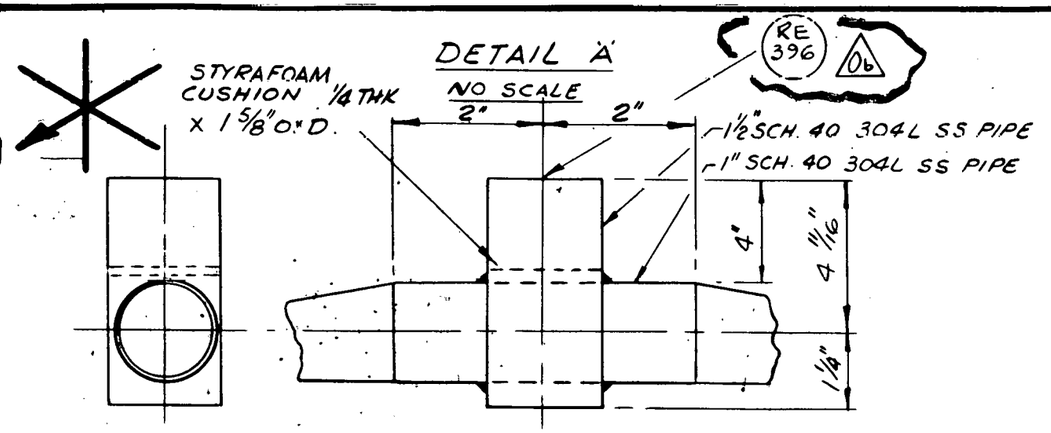
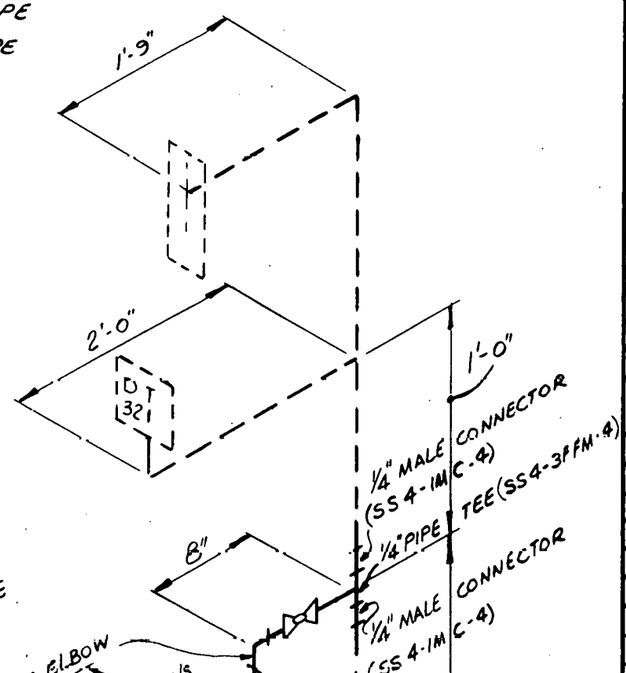




0b PM/PS TEST INSTALLATION #1

NOTE: 1. ALL VALVES, PIPE & FITTINGS TO BE STAINLESS STEEL
2. FITTINGS SHOWN ON THIS DWG ARE VOGT & TYLOK, APPROVED EQUALS MAY BE USED.

MAT'L CODE NO.		IDENTIFICATION	QUANTITY BY SIZE 1/4"
L112HJGEJ	PIPE	SCH 40S A312 SMLS. 304L S/S	5'
	VALVES		
	FITTINGS	90° ELL	
		45° ELL	
		TEE	
		UNION	
		COUPLING	

		TYPE	RATING AND FACING/ENDS	QUANTITY BY SIZE
	FLANGES			
	GASKETS			

	QUANT.	SIZE	TYPE	BOLTS / JOINT
BOLTS				

	QUANT.	IDENTIFICATION
SPECIALS	6	1/4" BALL VALVES JAMESBURY S/S SCRD ENDS

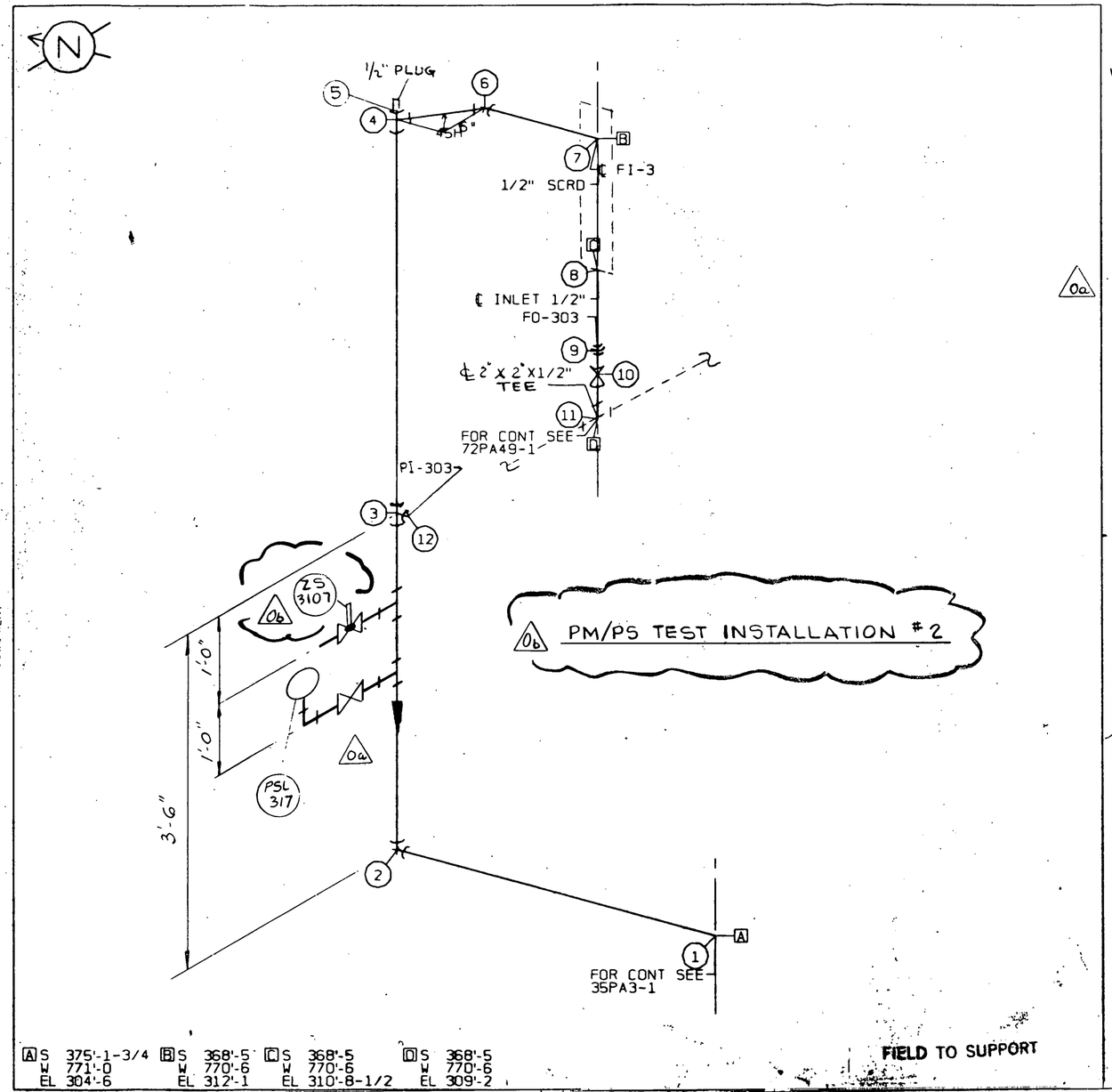
NOTES
1. REF. DWGS.: P&ID 3R-A-4 PIPING PLAN
2. MARK EACH PIPE DETAIL WITH FULL LINE NUMBER AT EACH END

EXHIBIT 3-1

ISSUE NO.	DESCRIPTION	DRN.	CHK	APPROVED	DATE
0b	ADDED LE-333 & CHNG TAG NOS. (30322 31466)	RNA	MLZ	JHM	HRK	1/15/79
0a	ISSUED FOR CONSTRUCTION	T-J	JTB	MLZ	MLM	9/15/78

ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
PROCESS MONITORING / PROCESS SURVEILLANCE

LOC. / PLANT/AREA	DESIGN ENGINEERING DEPARTMENT		
BSC-TPIG	AGNS	P.O. BOX 847 BARNWELL, S.C. 29812	
PROJECT NUMBER	PIPE LINE NUMBER	DRAWING NUMBER	ISSUE
30322 31466		5078-J-5001	0b



LIST OF MATERIAL

CODE	DESCRIPTION / SIZE	SHOP	FIELD
L13GA4COG	PIPE WELDED SCH 80 CS T-C GALV 1/2IN		20
L20BNOBA	GATE VLV 150 LB SCRD BRONZE B-T 1/2IN		2
L30F1AAMG	ELBOW 45 300 LB SCRD MI GALV 1/2IN		1
L30F1ABMG	ELBOW 90 300 LB SCRD MI GALV 1/2IN		1
L31F1ABMG	TEE 300 LB SCRD MI GALV 1/2IN		2
L34NA2JFG	STRT NIPPLE XS TBE CS GALV 1/2X 3 IN		1
L370ABWCG	PLUG BAR ETO CL THRD. 1/2 IN		1
L31F1ABMG	1/2" STR. TEE 300LB SCRD. MI. GALV.		2
L34NA2JFG	STRT. NIPPLE XS TBE. GALV. CS. 1/2" x 3"		4
L20BNOBA	1/2"-150LB. BR. THRD. GATE VALVE		1
L21DNOAC	1/2"-200LB BR. THRD. GLOBE VALVE		1
L30SAABC	1/2"-90° ELBOW		1

DIMENSIONAL INFORMATION

FROM	TO	DISTANCE	CUT LENGTH
1	2	8'-5 3/16"	
2	3	3'-6"	
3	4	4'-1"	
4	5	1 1/4"	
4	6	8 1/4"	
6	7	14 7/16"	
8	9	9 15/16"	
9	10	3"	
10	11	5 9/16"	
3	12	1 1/2"	

CUT LENGTHS FOR ALL SCRD/ S.W. AND 1½" & SMLR. B.W. LINES ARE ± 1".

REFERENCE

V=VERTICAL PT=INSTRU.
H=HORIZONTAL VT=VENT
M=MITER DR=DRAIN
THREADED END
BEVEL FOR WELD
PLAIN END
FIELD WELD
F BY FIELD

BOLT HOLES TO STRADDLE N/S-E/W ℄ UNLESS NOTED

INSULATE	
STEAM TRACE	
SHOP FABRICATE	
FIELD FABRICATE	X
HEAVY WALL	
ALLOY	
PRESS	
TEMP	
WGT-EMPTY	24
WGT-FULL	26

ASSEMBLIES

POINT	FITT	CODE	SIZE
12		L20BNOBA	1/2"
12		L34NA2JFG	1/2"X3"

LINE NO	SIZE	CLS.
35 PA 3X1	1/2	AB2U

REFERENCE DRAWING	REFERENCE EQUIPMENT
3R-A-4	TPIG

NOTES AND REVISIONS
1. REVISED FOR DEP 30322 31466 (0a)
2. CHNG. TAG No. PER DEP 30322 31466 (0b)

EXHIBIT 3-2

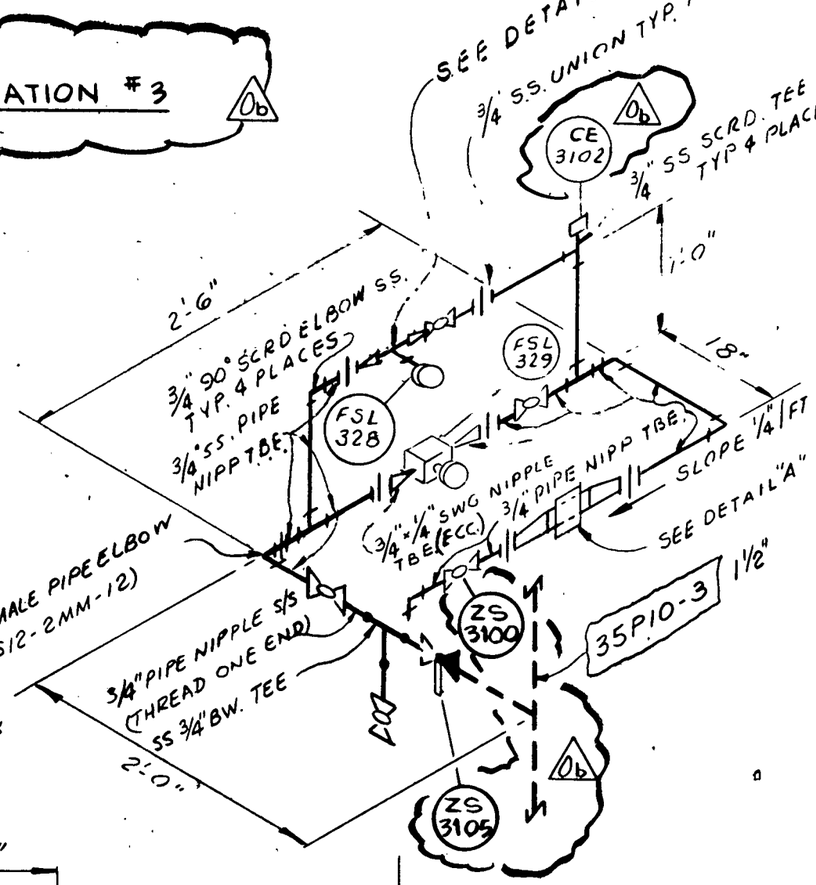
SUPP'T ENG			
STRESS ENG	MLM	N.K	
SUPERVISOR			
CHECKER			
BY	T.J	NA	
DATE	9/5/79	9/12/79	
REV NO.	0a	0b	2

BECHTEL SAN FRANCISCO

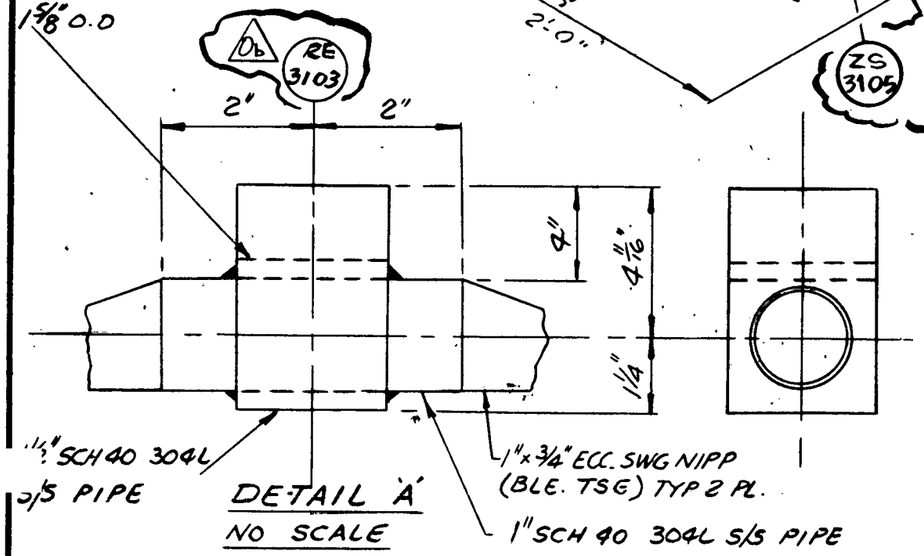
ALLIED-GULF NUCLEAR SERVICES

JOB NO.	PLT	AREA	BASE	ISOMETRIC NO.	REV.
30322	35	0	28	35 PA 3X1-3	0b

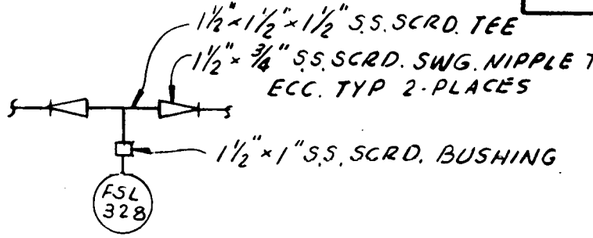
PM/PS TEST INSALLATION #3 (0b)



NOTE: 1. ALL VALVES PIPE & FITTINGS TO BE S/S
2. FITTINGS SHOWN ON THIS DWG. ARE VOGT & TYLOK, APPROVED EQUALS MAY BE USED.
3. FLUSH LINE TO SLOPE 1/4" PER 1'-0"



DETAIL "A"
NO SCALE



DETAIL "B"
NO SCALE

MAT'L CODE NO.		IDENTIFICATION	QUANTITY BY SIZE 3/4"
L112HIGEJ	PIPE	SCH. 40 A312 SMLS 304L S/S	2'-6"
	VALVES		
	FITTINGS	90° ELL	5
		45° ELL	
		TEE	3
		UNION	6
		COUPLING	1

		TYPE	RATING AND FACING/ENDS	QUANTITY BY SIZE
	FLANGES			
	GASKETS			

	QUANT.	SIZE	TYPE	BOLTS / JOINT
BOLTS				

	QUANT.	IDENTIFICATION
SPECIALS	5	3/4" BALL VALVES JAMESBURY S/S SCRD ENDS

NOTES
1. REF. DWGS.: P&ID 3R-A-4 PIPING PLAN
2. MARK EACH PIPE DETAIL WITH FULL LINE NUMBER AT EACH END

EXHIBIT 3-3

ISSUE NO.	DESCRIPTION	DRN	CHK	APPROVED	DATE
0b	ADDED 24-3100, CHNG. TAG NOS. (30322.31466)	N/A	JJ	JHM	11/8/76
0a	ISSUED FOR CONSTRUCTION	T.J.	JB	MM	10/6/76

ALLIED GENERAL NUCLEAR SERVICES
BARNWELL NUCLEAR FUEL PLANT
PROCESS MONITORING/PROCESS SURVEILLANCE

LOC./PLANT/AREA		PROJECT NUMBER	PIPE LINE NUMBER	DRAWING NUMBER	ISSUE
BSC-PPC PUMP NICHE	AGNS DESIGN ENGINEERING DEPARTMENT P.O. BOX 847 BARNWELL, S.C. 29812	30322 31466		507B-J-5002	0b