10.

Ken Lucien Write up

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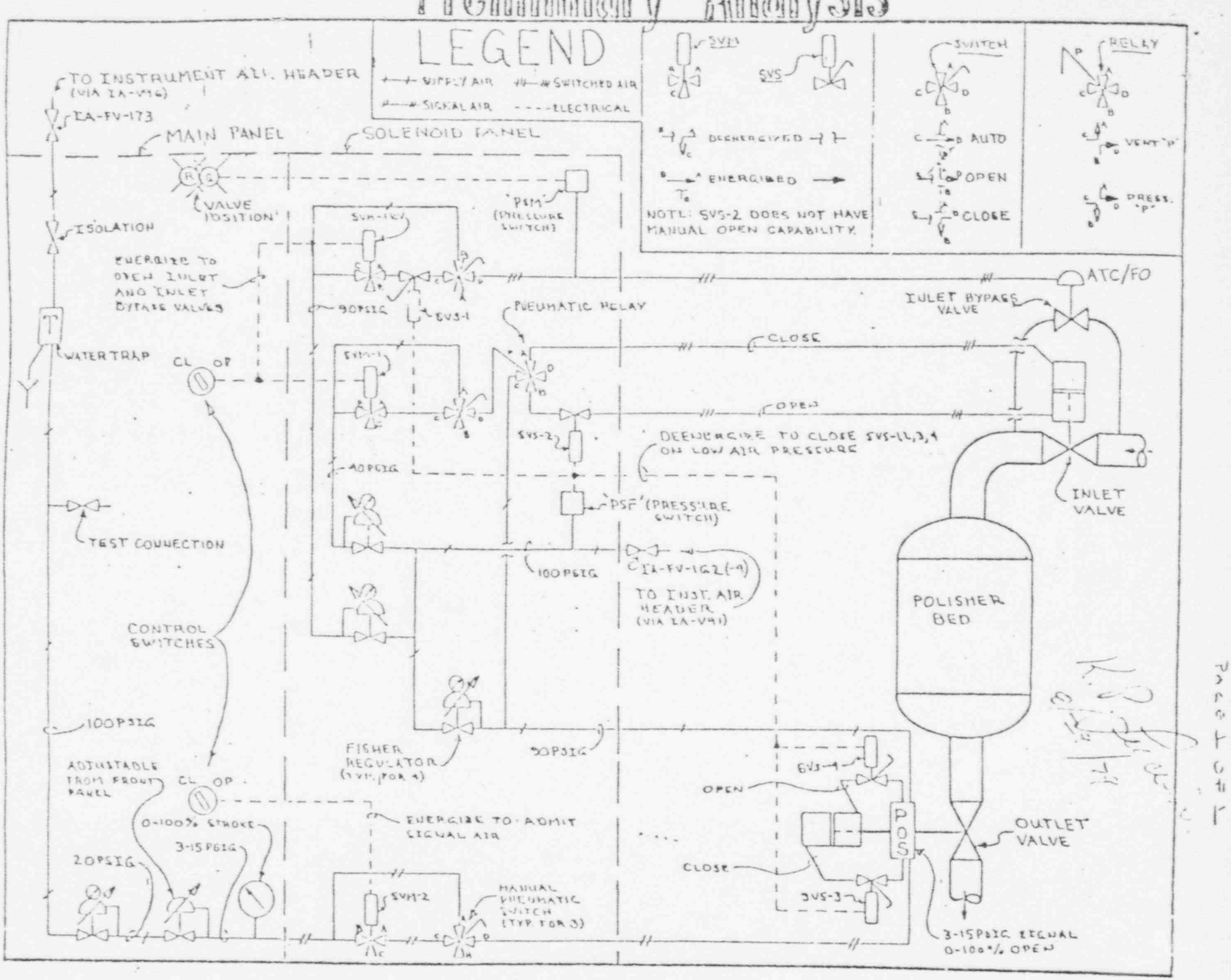
Preliminary Analysis



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Preliminary Analysis

To assist the reader in a technical understanding of the control loops selected for study, those that determine the positions of the process inlet and outlet control valves, a sketch of the various pertinent devices (Attachment B-1) has been prepared to consolidate the major configurations displayed on four plant drawings:

A) Main Enclosure Tubing Diagram, L*A Water Conditioning (L*A) drawing number D-4779, Revision C, (Burns and Roe (B&R) file number 15-00-0526);

B) Solenoid Enclosure Tubing Diagram, L*A dwg # D-3941, Revision B, (B&R file # 15-00-0302)

c) Polisher Control Wiring Diagram, L*A dwg. # D-3836, Revision D, (B&R file # 15-00-0217); and

D) Polisher Process Flow Diagram, L*A dwg. # D-4519, Revision F, (B&R file # 15-00-0405).

It must be noted that this sketch depicts only those devices pertinent to the discussion. Since there are eight (essentially identical) solenoid panels, only one is shown. Likewise

NOT SHOWN ARE OTHER CONTROL CIRCUITS THAT ARE CONSIDERED INCAPABLE OF EXERTING CATASTROPHIC INFLUENCE ON THE PROCESS FLOW, AND OTHER CIRCUITS FOR RECORDING PROCESS PARAMETERS.

B2.0 SYSTEM DESCRIPTION

B2.1 DESIGNED SYSTEM OPERATION

REFERRING TO ATTACHMENT B-1, THREE MAJOR ELECTRO-PNEUMATIC INSTRUMENT LOOPS FOR THE INLET BYPASS, INLET, AND OUTLET CONTROL VALVES ARE DEPICTED. BEFORE EXPLAINING THE OPERATION OF EACH OF THESE LOOPS IN DETAIL, IT IS APPROPRIATE TO DISCUSS INSTRUMENT AIR DISTRIBUTION AND OTHER CIRCUIT COMMONALITIES.

THE MAIN CONTROL PANEL (PANEL 304) RECEIVES NOMINAL 100PSIG INSTRUMENT AIR FROM THE TURBINE BUILDING AIR HEADER VIA ROOT VALVE IA-V96 AND EX-PANEL ISOLATION VALVE IA-FV-173. THE AIRLINE ENTERS THE TOP OF THE PANEL AND

Preliminary Analysis

VALVE, A WATER TRAP, AND CONTINUES TO TWO REGULATORS (ONE SHOWN) WHICH SUPPLY ALL PANEL PNEUMATIC REQUIREMENTS. THE REDUCED AIR IS SUPPLIED TO EIGHT PRESSURE REGULATORS (ONE SHOWN), THE PURPOSE OF WHICH IS TO SUPPLY ADJUSTABLE AIR SIGNALS TO THE OUTLET VALVE POSITIONERS AND THUS CONTROL VALVE POSITIONS.

THE SOLENOID PANEL (ONE OF EIGHT SHOWN) RECEIVES NOMINAL 100PSIG AIR FROM THE MAIN HEADER VIA ROOT VALVE IA-V91 AND EX-PANEL ISOLATION VALVE IA-FV162. THE AIR SUPPLY PRESSURE IS MONITORED BY THE PSF PRESSURE SWITCH AND CONTINUES ON TO THREE REGULATORS WHICH REDUCE THE MAIN AIR SUPPLY TO THE PRESSURES INDICATED FOR USE IN THE PNEUMATIC VALVE CIRCUITS. (THE PRESSURES INDICATED ARE FROM OBSERVATION AND HAVE NOT BEEN VERIFIED TO BE IN ACCORDANCE WITH DESIGN. IT IS SUSPECTED THAT THE PRESSURES ARE EET SIGNIFICANTLY HIGHER THAN REQUIRED. FOR EXAMPLE,

BENCH STROKED SHUT WITH 30PSIG. ROUGH CALCULATIONS SHOW THAT A 40PSIG SUPPLY WOULD BE ADEQUATE TO SHUT THE VALVE AGAINST A POLISHER SKID DESIGN PRESSURE OF 200PSIG. ALSO THE L&A TUBING DRAWING CALLS FOR 20PSIG TO THE INLET VALVE CONTROL SOLENOID, SVM-1.)

Safety Evaluation

COMMON TO ALL THREE LOOPS IS A CIRCUIT DESIGNED TO COPE WITH TWO ANTICIPATED FAILURE MODES, LOSS OF INSTRUMENT AIR PRESSURE AND LOSS OF CONTROL POWER. THE PSF PRESSURE SWITCH OPENS ON LOW INSTRUMENT AIR PRESSURE AND CLOSES THE (FOUR) SVS SOLENOIDS TO PNEUMATICALLY LOCK THE MAIN PROCESS VALVES AND PREVENT THE AIR PRESSURE LOSS FROM ADVERSELY AFFECTING VALVE POSITION. THIS SWITCH SHOULD BE SET TO DROP OUT APPROXIMATELY 10 PSI GREATER THAN THE HIGHEST (NORMAL) REGULATOR SETTING. HOWEVER, PRE-TURNOVER CALIBRATION RESULTED IN MUCH LOWER SETTINGS, AS DISCUSSED IN SECTION B2.3. ON LOSS OF CONTROL

DEENERGIZE AND CLOSE TO PERFORM THE SAME FUNCTION. THIS IS NECESSARY BECAUSE THE SVM SOLENOIDS INTERPRET A LOSS OF CONTROL POWER TO BE A "CLOSE" COMMAND FROM THE MAIN PANEL CONTROL SWITCHES.

SVS-1, 3, AND 4 HAVE A "MANUAL OPERATE" CAPABILITY SO THAT THEY MAY BE ACTUATED BY HAND IN THE EVENT OF SOLENOID WINDING FAILURE. THIS OPERATION IS PERFORMED BY A SINGLE CLOCKWISE ROTATION OF A KNURLED SHAFT THAT PROTRUDES FROM THE VALVE BODY OPPOSITE THE WINDING ASSEMBLY. THIS MANUAL CAPABILITY CAN ALSO BE USED AS A "CLOSE OVERRIDE" FUNCTION TO PREVENT THE VALVE FROM CLOSING IN RESPONSE TO A LEGITIMATE SIGNAL (IE. DEENERGIZATION). SVS-2 DOES NOT HAVE THIS MANUAL CAPABILITY.

OPERATOR ACCESSIBLE PNEUMATIC SWITCHES ARE INSTALLED IN EACH VALVE CIRCUIT TO PROVIDE CERTAIN LOCAL OVERRIDE CAPABILITIES. THE AUTO POSITION ALLOWS NORMAL VALVE RESPONSE

Technical Analysis

CONTROL SWITCHES AND SVM SOLENOIDS. THE OPEN OR CLOSE POSITIONS OVERRIDE WHATEVER COMMANDS ARE PRESENT AT THE SVM SOLENOIDS.

SINCE THE SMALL SIZE OF THE PROCESS BYPASS PIPING PRECLUDES SIGNIFICANT EFFECT ON THE CONDENSATE FLOWRATE, THE INLET BYPASS VALVE CIRCUIT IS DISCUSSED HERE ONLY BECAUSE OF ITS INTERTIE WITH THE OTHER CIRCUITS VIA THE CONTROL SWITCH (WHICH ALSO OPERATES THE INLET VALVE) AND THE FAILURE PROVISION REPRESENTED BY SVS-1. MOVING THE CONTROL SWITCH TO OPEN ENERGIZES SVM-1BY THUS VENTING THE BYPASS VALVE ACTUATOR THROUGH THE PNEUMATIC SWITCH AND SVS-1. SINCE THE BYPASS VALVE IS "AIR TO CLOSE", VENTING THE ACTUATOR CAUSES THE VALVE TO OPEN. MOVING THE CONTROL SWITCH TO CLOSE DENERGIZES SVM-1BY AND ADMITS SUPPLY AIR THROUGH SVS-1, THE PNEUMATIC SWITCH, AND ON TO THE VALVE ACTUATOR TO CLOSE THE VALVE. UPON LOSS OF INSTRUMENT AIR OR CONTROL POWER

ENGINEERING ANALYSIS

DEPRESSURIZATION OF THE VALVE ACTUATOR, THUS HOLDING THE VALVE OPEN. THIS FUNCTION CAN BE OVERRIDEN WITH THE PNEUMATIC SWITCH EXCEPT IN THE CASE OF A TOTAL LOSS OF INSTRUMENT AIR PRESSURE.

PNEUMATIC ANALYSIS

THE INLET VALVE IS OPERATED BY THE SAME CONTROL SWITCH THROUGH A 1½ MINUTE TIME DELAY RELAY (NOT SHOWN). MOVING THE CONTROL SWITCH TO OPEN ENERGIZES SVM-1 AND ADMITS SUPPLY AIR THROUGH THE SOLENOID AND THE PNEUMATIC SWITCH TO THE PILOT PORT OF A PNEUMATIC RELAY. PRESSURIZING THE PILOT PORT ACTUATES THE RELAY AND ADMITS AIR TO THE "OPEN" SIDE OF THE INLET VALVE ACTUATOR AND VENTS AIR FROM THE "CLOSE" SIDE OF THE ACTUATOR, THUS OPENING THE VALVE. MOVING THE SWITCH TO THE CLOSE POSITION DEENERGIZES SVM-1 AND VENTS THE PILOT PORT OF THE RELAY VIA THE PNEUMATIC SWITCH. THE RELAY THEN ADMITS AIR TO THE "CLOSE" SIDE OF THE ACTUATOR AND VENTS AIR FROM THE "OPEN" SIDE,

OF INSTRUMENT AIR OR CONTROL POWER, SVS-2 CLOSES AND PREVENTS THE VENTING OF THE "OPEN" SIDE OF THE ACTUATOR. IN THE CASE OF LOSS OF CONTROL POWER, THE DEENERGIZATION OF SVM-1 WILL SHIFT THE PNEUMATIC RELAY AND ADMIT AIR TO THE "CLOSE" SIDE OF THE ACTUATOR. WHILE THIS MAY CAUSE THE VALVE TO "SAG" FROM ITS FULL OPEN POSITION, THE VALVE WILL NOT CLOSE UNTIL THE "OPEN" SIDE IS VENTED. WHILE THE PNEUMATIC SWITCH CAN REMOVE THE "SAG" IF CONTROL POWER IS LOST, IT IS INCAPABLE OF CLOSING THE VALVE IF EITHER FAILURE MODE IS PRESENT.

THE OUTLET VALVE OPERATES SOMEWHAT DIFFERENTLY IN THAT THE VALVE POSITION IS CAPABLE OF BEING REMOTELY CONTROLLED FROM THE MAIN PANEL. THIS ADJUSTMENT IS PROVIDED BY A BULKHEAD-MOUNTED REGULATOR, THE HANDWHEEL OF WHICH PROTRUDES THROUGH THE FRONT PANEL FACE TO THE APPROPRIATE LOCATION ON THE MIMIC BUS. ADJACENT TO THE REGULATOR

INFERS VALVE POSITION BY CONVERTING A 3-15PSIG SIGNAL TO A 0-100% DIAL READING. THIS SIGNAL IS PASSED ON TO SVM-2, AND, IF SVM-2 IS ENERGIZED BY AN "OPEN" COMMAND, ON THROUGH THE PNEUMATIC SWITCH TO THE POSITIONER FOR THE OUTLET VALVE. THE POSITIONER IS CALIBRATED FOR A 3-15PSIG INPUT AND A 0-100% VALVE STROKE (OPEN) OUTPUT. THE INPUT SIGNAL IS CONTINUOUSLY COMPARED WITH ACTUAL VALVE POSITION VIA A MECHANICAL FEEDBACK SPRING FROM THE ACTUATOR STEM, AND THE POSITIONER DIRECTS SUPPLY AIR TO THE ACTUATOR AS NECESSARY TO MOVE THE VALVE TO THE POSITION EQUIVALENT TO THE SIGNAL AIR PRESSURE. AS BEFORE, SVM-2 SIMPLY RESPONDS TO COMMANDS FROM THE MAIN PANEL, EXCEPT IN THIS CASE, SIGNAL AIR IS CONTROLLED INSTEAD OF SUPPLY AIR. DEENERGIZING SVM-2 VENTS THE SIGNAL AIR WHICH EFFECTIVELY TELLS THE POSITIONER TO CLOSE THE VALVE. UPON LOSS OF INSTRUMENT AIR OR CONTROL POWER, SVS-3 AND 4 DEENERGIZE AND

PRESSURE IS PRESENT IN THE ACTUATOR, THUS PREVENTING GROSS VALVE MOVEMENT UNTIL THE FAILURE IS RECTIFIED. THE PNEUMATIC SWITCH PROVIDES THE NORMAL OVERRIDE OF SUM-2, BUT IS INCAPABLE OF MOVING THE OUTLET VALVE IF EITHER FAILURE MODE IS PRESENT.

THIS COMPLETES THE DESCRIPTION OF HOW THE SYSTEM SHOULD WORK. UNFORTUNATELY, SYSTEM ALTERATIONS HAVE INHIBITED CERTAIN DESIGN FEATURES, AS DISCUSSED IN THE NEXT SECTION.

B2.2 POLISTER MODIFICATIONS - NATURE AND EFFECTS

SEVERAL INSPECTIONS OF THE EQUIPMENT REVEALED MODIFICATIONS THAT HAD BEEN MADE TO ~~FOR~~ THE ORIGINAL DESIGN CONFIGURATION, THE NATURE OF WHICH ESSENTIALLY NEGATED THE SYSTEM CAPABILITY TO EXPERIENCE A LOSS OF INSTRUMENT AIR PRESSURE OR CONTROL POWER WITHOUT CATASTROPHIC EFFECTS ON THE PROCESS. SINCE SOME MODIFICATIONS WERE REDUNDANT AND SOME WERE COUNTER-PRODUCTIVE (INSOFAR

IT IS DIFFICULT TO RECONSTRUCT THE RATIONALE OR THE SEQUENCE THAT WAS EMPLOYED WHEN PLANNING THE CHANGES.

THE SPECIFIC NATURE AND EFFECTS OF THE VARIOUS ALTERATIONS ARE AS FOLLOWS:

A) THE SETPOINT ADJUSTMENTS FOR THE PSF PRESSURE SWITCHES FOR ALL BEDS EXCEPT #7 AND 8 HAVE BEEN REDUCED TO THE MINIMUM SETTING (APPROXIMATELY ZERO PSIG). THE SETTING OF THE CORRESPONDING ADJUSTMENTS FOR BEDS #7 AND 8 IS VISUALLY INDETERMINATE BUT IS PRESUMED TO BE LIKEWISE AT OR NEAR ZERO. BY ITSELF, THIS ALTERATION WOULD NOT AFFECT SYSTEM RESPONSE TO A LOSS OF CONTROL POWER, BUT WOULD NEGATE THE ABILITY TO COPE WITH A LOSS OF INSTRUMENT AIR BY FAILING TO DETECT THAT LOSS UNTIL PRESSURE HAD FALLEN BELOW THAT NECESSARY TO OVERCOME VALVE RESPONSE TO PROCESS HYDRAULIC FORCES.

B) THE

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TO THE PSF PRESSURE SWITCHES FOR ALL BEOS EXCEPT #3 AND 4 HAVE BEEN DISCONNECTED AT THE APPLICABLE SOLENOID PANELS. THE EFFECT OF THIS ALTERATION WOULD BE TO RENDER ALL BEOS, EXCEPTING #3 AND 4, INOPERABLE BECAUSE OF THE INABILITY TO PROPERLY POSITION THE OUTLET VALVES.

c) THE SVS-3 AND 4 SOLENOIDS FOR ALL EIGHT BEOS, AND THE SVS-1 SOLENOIDS FOR ALL BEOS EXCEPT #3 AND 7, HAVE BEEN MANUALLY ACTUATED RESULTING IN THE SOLENOIDS BEING CONTINUOUSLY HELD OPEN REGARDLESS OF THE STATUS OF THE WINDINGS. IN THE CASE OF SVS-3 AND 4, THIS WAS OBVIOUSLY NECESSARY TO COUNTERACT THE CONTINUOUSLY CLOSED CONDITION RESULTING FROM THE ALTERATIONS DESCRIBED IN THE PRECEDING PARAGRAPH. THIS ALTERATION, IN ITSELF, WOULD RENDER ALL EIGHT BEOS INCAPABLE OF COPING WITH EITHER LOSS OF AIR OR CONTROL POWER, AND IN EITHER CASE THE THE PROCESS FLOW WOULD BE

FAULT TREE ANALYSIS