WESTINGHOUSE CLASS 3

Westinghouse Energy Systems

Westinghouse Energy Systems

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FACILITY DESCRIPTION REPORT
AP600 AUTOMATIC DEPRESSURIZATION SYSTEM
PHASE B1 TESTS

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1.0 INTRODUCTION

The AP600 safety systems are predominantly passive and rely upon the natural forces of gravity, natural circulation, convection, evaporation, and condensation instead of ac power supplies and motor-driven components. Within this framework, the AP600 employs an automatic depressurization system (ADS). The ADS ensures that the reactor coolant system (RCS) is depressurized so that long-term gravity injection is initiated and maintained for passive reflood and core cooling. During emergency conditions, the ADS valves discharge steam and saturated water from the pressurizer into the in-containment refueling water storage tank (IRWST) through spargers located underwater. Two separate ADS flow paths extend from the pressurizer to the IRWST in the AP600 plant. Each ADS flow path has three stages, 1, 2, and 3; the flow paths open sequentially to provide a controlled depressurization of the reactor coolant system.

Previously, the AP600 ADS Phase A tests generated data to evaluate the hydraulic behavior of the sparger under various steam flow rates. Pressure pulses from the discharge of steam into the quench tank, simulating the IRWST, were measured. The results were used for defining the dynamic forcing functions generated by steam condensation and for developing and verifying analytical models that will determine dynamic loads expected to be imposed on the AP600 IRWST during sparger operation.

The Phase B ADS tests were full-sized simulations of one of the two AP600 ADS flow paths from the pressurizer and included: a portion of the piping upstream of the ADS valves, the ADS valve/piping package, and piping through the sparger. The Phase B tests and the Phase A tests were performed at ENEA's VAPORE test facility in Casaccia, Italy; the AP600 ADS test program is part of a joint technical agreement between Westinghouse, ENEA, and SOPREN/Ansaldo.

The Phase B test program was performed in two parts, B1 and B2:

- Phase B1 - The overall system performance was tested with the ADS valves (or simulated valves) fully open. For these tests, flow was initiated by valves located upstream of the simulated AP600 ADS piping and valve package.

- Phase B2 - This portion of the test program is currently being performed. The B2 Phase is designed to demonstrate ADS valve operability as part of a test program outside of Design Certification.

This report gives a description of the facility used in the ADS Phase B1 testing program. (A facility description for Phase B2 testing will be presented later in an addendum to this report.) The report provides details of the test facility components, including layout, dimensions, materials, hydraulic characteristics, instrumentation, and data acquisition equipment. Information regarding Phase B1 test operation is provided in the test specification, Reference 1.

2.0 ADS PHASE B1 TEST DESCRIPTION

2.1 Test Method

The ADS Phase B1 tests were system performance tests on a full-sized replica of one of the two AP600 ADS pressurizer to IRWST flow paths. The tests were conducted with the ADS valves fully open and involved blowdown of either pressurized saturated water or pressurized saturated steam from a steam/water supply tank through the ADS valve/piping package to a sparger in a quench tank at atmospheric pressure.

Blowdowns with saturated water from the supply tank were performed using a discharge line from the bottom of the supply tank. The blowdown flow rate and the fluid quality (two-phase steam/water) at the valve/piping package were controlled by presetting the throttle valve in the line to a partially open position and adjusting the supply tank initial pressure and temperature. The supply tank initial conditions and throttle valve positions were selected to obtain flow conditions at the inlet of the ADS piping/valve package that simulated expected AP600 plant conditions.

Blowdowns with steam from the supply tank were performed using a discharge line from the top of the supply tank. Discharged steam flowed through a separator to ensure the removal of any water carried over from the top of the supply tank during the blowdown. In this way, only high-quality steam was supplied to the ADS piping/valve package in these tests.

Each ADS stage in the AP600 plant has two valves in series. In the Phase B1 ADS tests, however, only one of two valves was installed in each stage of the simulated ADS piping valve package. The missing valve in each stage was simulated by an orifice in some tests (series 100 and 200 tests), or by a full piping bore spacer in the 300-series tests. The orifices were sized to simulate the resistance and flow area of a fully open ADS valve.

In summary, the configuration was:

- ADS stage 1
  - 4-in. gate valve with 8.0 in.^{2} flow area simulated by orifice, or 4-in. full bore (minimum resistance) gate valve simulated by spacer
  - 4-in. globe valve installed
- ADS stages 2 & 3
  - 8-in. gate valve installed
  - 8-in. globe valve with 20.9 in.^{2} effective area simulated by orifice, or 8-in. full bore (minimum resistance) gate valve simulated by spacer.

The overall objectives and requirements of the Phase B1 testing program are defined in the test specification, Reference 1. Testing was conducted in accordance with applicable requirements of

ANSI/ASME NQA-1, 1986 as defined in Section 10, "Quality Assurance Requirements," of Reference 1, and the ENEA QA Plan for the tests, Reference 2.

2.2 Test Facility Requirements

For the Phase B1 tests, the capabilities required of the VAPORE test facility were:

- To provide an isolable source of saturated water at pressures and temperatures typical of the AP600 reactor conditions so as to achieve (or conservatively bound) prototypic volumetric and mass flowrates through the ADS. In the AP600 plant, the initial steam flow from the pressurizer will be followed by low quality steam or flashing saturated water.

- To provide a quench tank that contains water, in which the sparger is mounted, to simulate the AP600 IRWST arrangement.

- Piping and supports designed to ensure acceptable piping and valve thermal and dynamic stresses during ADS testing.

- To allow purging of air from the discharge piping using steam in order to minimize sparger air clearing loads if test full flow conditions are initiated over a shorter than prototypic time.

- To provide adequate space for the ADS valves, piping, and required supports and instrumentation so that the test can be constructed and operated with efficiency and safety.

- To provide appropriate instrumentation and data acquisition system (DAS) that can sample at about 1000 samples per second in order to record pressure pulses that have dominant frequencies as high as 100 Hz.

- To utilize the existing 16-in., Schedule-80 discharge line into the quench tank. The pipe must be routed so as to be level or sloping downward to the quench tank and must not contain any loop seals.

- To utiliz the existing ENEA vacuum breakers in the 16-in. discharge piping to prevent water from ris ıg into the discharge piping when flow to the ADS sparger is terminated.

3.0 TEST FACILITY DESCRIPTION

3.1 Principal Components

Most of the major Phase B1 test facility components are the same as those used in the Phase A test program (Reference 8), including the steam/water supply tank, steam moisture separator, steam supply header, main discharge pipe, quench tank, and sparger (Figure 3-1). Other components, such as the demineralized water tank, water chemical treatment system, surge pump, electric heaters, pool heating system, water supply system, sump and drainage system, are also retained. However, Phase B1 test requirements dictated various modifications to the existing facility. The significant modifications are illustrated in Figure 3-2 and are described in Table 3-1. A schematic piping and instrumentation diagram for the facility is provided in Figure 3-3.

Full details of the components that influence the tests are provided in subsequent sections. Engineering drawings are provided in Appendix A.

3.2 Steam/Water Supply Tank

The steam/water supply tank also referred to as the accumulator or pressurizer is the source of pressurized, heated water or steam for the blowdowns conducted in the tests. It is a vertically oriented cylinder with hemispherical ends made from low alloy steel. All the internal surfaces have stainless steel cladding. The steam/water supply tank volume is 1412.6 $ft.^3$ (40 m^3); including the support skirt, the overall height is 42.11 ft. (12.835 m). Internal electric heaters are inserted through the bottom head, and there are two main outlets: a 10-in. diameter steam outlet at the top, and a central 14-in. diameter water outlet from the bottom. The external surface is insulated by 5.91-in. (150-mm) thick fiberglass pads. Principal dimensions and characteristics are listed in Table 3-2. The accumulator is shown in drawing A-1 of Appendix A.

3.3 Piping

Steam Supply Line

A steam line runs from the supply tank's top outlet, via an isolation valve (VI-1.1) and a control valve (VR-1.1), to the steam moisture separator. Valve VI-1.1 is a hydraulically operated wedge gate type with a closing time of less than 0.5 seconds and an opening time of about 30 seconds. The steam line is 10-in. Schedule 160 up to the control valve and 12-in. Schedule 160 from the control valve outlet to the steam moisture separator. The line is carbon steel with a stainless steel lining. It is insulated externally with 4.72-in. (120-mm) thick fiberglass pads. Principal dimensions and characteristics are listed in Table 3-2. The steam line is shown in drawing A-2 of Appendix A.

Steam Moisture Separator

The separator is essentially a spherical tank. Inside the tank there is a "mist eliminator" that consists of packed, stainless steel lamellar sheets in a "chevron" arrangement. The separator is installed to remove moisture from the steam and is specified to achieve an exit steam quality of 95 percent. The tank's volume is 173 $ft.^3$ (4.9 m^3). It is made from carbon steel, is clad internally with stainless steel, and is insulated with 150-mm (5.91-in.) thick fiberglass pads. Principal dimensions and characteristics are listed in Table 3-2.

Steam Collector

At the steam outlet from the separator, there is a 12-in. ASME venturi-type flowmeter. Immediately downstream of the flowmeter is a large header, 25.07-ft. (7.6-m) long. The header is fabricated from 16-in., Schedule-160 and 24-in., Schedule-160 carbon steel with a stainless steel lining. On its 16-in. section are four 8-in. flanged tee connections, one of which is blanked. The three open tee connections are commoned into a 12-in., Schedule-160 carbon steel manifold that terminates with a flange located near the saturated water supply line. The steam collector assembly comprises the flowmeter, header, and manifold and is insulated with 4.72-in. (120-mm) thick fiberglass pads. Principal dimensions and characteristics are listed in Table 3-2. The header is shown in drawing A-3 and the manifold in drawings A-4 and A-5 of Appendix A.

Saturated Water Supply Line

A 12-in., Schedule-160 saturated water supply line runs from the steam/water supply tank's bottom outlet, via two gate valves, to a 12-in. flanged connection near the 12-in. steam manifold flange. A 14-in. by 12-in. reducer is fitted to the tank outlet. The line is stainless steel from the tank to the first gate valve and carbon steel thereafter. The line is insulated with 2.36-in. (60-mm) thick rock wool. Principal dimensions and characteristics are listed in Table 3-2. The line is shown in drawings A-4 and A-5 of Appendix A. Details of the gate valves, designated VLI-1 and VLI-2, are provided in Section 3.4.

ADS Valve Package Inlet Piping

The ADS valve inlet piping runs from the 12-in. flanged connections on the steam manifold or saturated water line to the ADS valve/piping package. Only one connection – steam or saturated water – can be made at a time: an interchangeable, 90-degree elbow spool piece is provided for this purpose. The inlet piping transitions to 14-in. and incorporates a prototypic loop seal just upstream of the valve/piping package. The loop seal's function is to ensure that the ADS valves and seats are always wetted (by condensate). This is important in the Phase B2 tests. The 12-in. and 14-in. piping is Schedule-160 carbon steel. It is insulated by 2.36-in. (60-mm) thick rock wool. Principal dimensions and characteristics are listed in Table 3-2. The piping is shown in drawings A-4 and A-5 of Appendix A.

ADS Valve Package Discharge Piping

The ADS valve package exhausts into a 16-in., Schedule-80 carbon steel discharge header. The header has two 10-in. flanged tee-connections, each of which is connected to a transition pipe containing a bellows section and a 90-degree elbow. The elbows connect to the tee connections on the header of the line running to the sparger and quench tank.

The quench tank line (16-in., Schedule-80 carbon steel throughout) runs, sloping downwards, for a distance of around 100 ft. to the sparger inlet above the quench tank. Two vacuum breaker valves are fitted near the quench tank to prevent quench tank water from being drawn up when flow stops.

All of this valve package discharge piping is uninsulated. Principal dimensions and characteristics are listed in Table 3-2. The ADS valve package discharge header and bellows sections are shown in drawings A-4 and A-5 of Appendix A, and the quench tank inlet line is shown in drawing A-6 of Appendix A.

3.4 Saturated Water Flow Control Valves

Two 12-in. gate valves, designated VLI-1 and VLI-2, are installed in the saturated supply water line for the purposes of initiating and controlling the saturated water blowdown flows (see Section 3.3). The upstream valve, VLI-1, is an Edward wedge-type gate valve; VLI-2 is an Atwood and Morrill (A&M) parallel disc gate valve. The valves are fitted with fast-operating motor actuators that give opening and closing times of about 30 seconds. The valves are insulated to the same specification as the remainder of the saturated water supply line.

VLI-2 is pre-set to a specified flow area for each saturated water blowdown test in order to achieve desired mass flow rate and steam quality conditions. It is opened to the necessary position before flow is initiated; VLI-1 is then opened (fully) to begin the blowdown. The blowdown is terminated by closing VLI-2.

The specifications of these valves are summarized in Table 3-2 and are detailed in References 3 and 4. Because VLI-2 is used to set test initial conditions, it has been subject to special testing and analysis to determine its flow characteristics (Reference 5). These characteristics are shown in Figures 3-4 (flow area versus valve opening) and 3-5 (friction factor K versus valve opening). (K is defined as:

$$K = \frac{17.2\ d^4\ \Delta P}{Q^2}$$

where:

d	=	connecting pipe internal diameter (in.)
ΔP	=	pressure drop across valve (psi)
Q	=	mass flow rate through valves (lbm/sec)

Valve opening was measured by the distance from the valve body to the anti-rotation bar on the stem, and was recorded for each test.

3.5 ADS Valve Package

The ADS valve/piping package comprises a prototypic matrix or cluster of three parallel flow paths—stages 1, 2, and 3—between the inlet and discharge piping described in Section 3.3.

Stage 1 is 4 in. throughout, with a spool piece (to allow later installation of a gate valve) and an Anchor Darling globe valve (VAD-1) downstream. There is a provision for fitting an orifice at the spool piece to simulate the resistance of the missing gate valve; when it is not fitted, a full bore spacer is inserted.

Stage 2 is 8 in. throughout, with an Anchor Darling parallel disc gate valve (VAD-2) and a spool piece (with provision for fitting an orifice to simulate the resistance of the missing 8-in. globe valve, or a full bore spacer) downstream.

Stage 3 is 8 in. throughout, with a Westinghouse gate valve (VAD-3) and a spool piece (with provision for fitting an orifice to simulate the resistance of the missing 8-in. globe valve, or a full bore spacer) downstream.

The stages are connected to the inlet and discharge piping with reducers and tees. The piping is carbon steel (Schedule 160 on the inlet side and Schedule 80 on the discharge side), while the valve bodies are stainless steel. The valve package is uninsulated.

Principal dimensions and characteristics of the valve package including valve and orifice specifications are given in Table 3-2. Detailed valve specifications may be accessed in References 6 and 7. The valve package is shown in drawings A-4 and A-5 of Appendix A. The orifices are shown in Figures 3-6 and 3-7.

3.6 Sparger and Quench Tank

The function of the sparger and quench tank is to condense the steam exhausting from the test facility.
[

][a,c] Except for the inlet pipe size (14-in. Schedule 80), its design is prototypic of the AP600 plant sparger.

The quench tank is a large, concrete cylindrical water tank, built below ground level. The tank has a steel cover that prevents excessive water vapor loss when the quench tank water is hot. The cover has "doors," which are opened during blowdowns to allow the vapor generated by quenching to vent. A water heating system allows tests to be conducted with the tank water at saturated conditions (212°F). The tank's internal diameter is 23.3 ft., giving a water volume of 9460 $ft.^3$ when filled to its normal depth of 22.2 ft.

The sparger and quench tank are shown in drawings A-7, A-8, and A-9 of Appendix A.

3.7 Instrumentation

The test facility instrumentation for Phase B1 was developed in collaboration between ENEA, Ansaldo and Westinghouse. Phase B1 instrumentation was based on the previous Phase A ADS test program, with extensive additions and changes.

The following is a description of instrumentation locations for the Phase B1 tests. A list of all instrumentation is given in Table 3-3. Figures 3-3, 3-8, 3-9, 3-10, and 3-11 schematically illustrate the location of the piping, quench tank, and sparger instrumentation.

3.7.1 Temperature Instrumentation

The temperature of the steam and/or water throughout the ADS test facility is measured by thermocouples. In general, the thermocouples are located in pipe tappings and are positioned so that they protrude into the flow stream by about 0.5 in. The measurements include:

- The temperature in the quench tank line upstream and downstream of the 90-degree elbow above the sparger (TE-01 & TE-02)

- The steam/water temperature in the vertical pipe runs in the quench tank just upstream of the sparger (TE-03) and one location in the sparger body (TE-06)

- The steam/water temperature at six locations in sparger arm A (TE-7 to TE-12) and at two locations in the bottom of each of the sparger arms B, C, and D (TE-13 to TE-18)

- The quench tank water temperature at four elevations on racks A, B, and C, in twelve locations throughout the tank (TE-19 to TE-30)

- The temperature in the 12-in. saturated water supply line from the pressurizer, upstream of valve VLI-1 (TE-1W)

- Temperature upstream and downstream of valve VLI-1 (TE-2W & TE-3W)

- Temperature upstream and downstream of VLI-2 (TE-4W & TE-5W)

- Temperature in 14-in. ADS valve package inlet piping (TE-6W)

- Temperature upstream and downstream of stage 1 spool piece (TE-7W & TE-8W)

- Temperature downstream of VAD-1 (TE-9W)

- Temperature upstream and downstream of VAD-2 (TE-10W & TE-11W)

- Temperature downstream of stage 2 spool piece (TE-12W)

- Temperature upstream and downstream of VAD-3 (TE-13W & TE-14W)

- Temperature downstream of stage 3 spool piece (TE-15W)

- Temperature in ADS valve package discharge header (TE-16W)

3.7.2 Steam/Water Supply Tank Inventory Instrumentation

The steam/water supply tank water level (LT-01) is used to establish proper tank inventory during tank heatup prior to test initiation. During tests, the mass inventory is also measured using LT-lB; the change in mass inventory is used to determine the mass flow rate in the saturated water blowdown tests.

3.7.3 Flow Instrumentation

A venturi-type flow meter (FT-15B) is used for measuring the steam flow rate downstream of the moisture separator. The venturi delta-P and associated compensating temperature and pressure signals are monitored.

3.7.4 Pressure Instrumentation

The pressure in the steam/water supply tank, the steam and saturated water supply lines, ADS valve package, sparger, and within the quench tank are measured. The locations for these pressure measurements are specified below:

- Steam/water supply tank initial pressure and pressure versus time during the blowdown (PT-04)
- The steam pressure just downstream of the moisture separator (at the steam venturi) and in the steam collector header (PT-61A & PT-10)
- The steam pressure in the header of the 16-in. quench tank line (PT-61B)
- Pressure measurements at approximately one-half of the length of the quench tank line, and pressure measurements in the quench tank line just upstream of the 90-degree pipe bend above the water surface of the quench tank (PT-18 & PE-21)
- A vacuum gage is installed in the quench tank line just outside the quench tank near PE-21 (PE-22)
- Pressure measurement at the 90-degree elbow above the sparger (PE-1)
- The steam/water pressure in the sparger body (PE-2)
- Pressure at three positions inside sparger arm A (PE-3 to PE-5) and a single pressure measurement in each of the three remaining sparger arms B, C, and D (PE-6 to PE-8)
- Twelve pressure measurements are made within the quench tank. These pressure measurements are made at two radial positions, one extending from sparger arm A and one radial position between two adjacent arms A and B. Each radial position consists of one pressure measurement at the bottom of the tank at the sparger arm radius, three pressure measurements spaced between the sparger arm radius and the tank wall at the arm elevation, and two pressure measurements at the tank wall spaced at higher elevations. (PE-9 to PE-20)
- The pressure in the 12-in. water discharge from the steam/water supply tank, upstream of valve VLI-1 (PT-1W)
- Pressure upstream and downstream of valve VLI-1 (PE-2W & PE-3W)
- Pressure upstream and downstream of VLI-2 (PT-4W & PE-5W)
- Pressure in 14-in. water supply piping for ADS loop (PT-6W)

- Pressure upstream and downstream of stage 1 spool piece (PE-7W & PE-8W)
- Pressure downstream of VAD-1 (PE-9W)
- Pressure upstream and downstream of VAD-2 (PT-10W & PE-11W)
- Pressure downstream of stage 2 spool piece (PE-12W)
- Pressure upstream and downstream of VAD-3 (PE-13W & PE-14W)
- Pressure downstream of stage 3 spool piece (PE-15W)
- Pressure in ADS loop discharge header (PE-16W)
- Pressure in valve body and bonnet for VLI-1 (PE-17W & PE-18W)
- Pressure in valve body and bonnet for VLI-2 (PE-19W & PE-20W)
- Pressure in valve body and bonnet for VAD-2 (PE-21W & PE-22W)
- Pressure in valve body and bonnet for VAD-3 (PE-23W & PE-24W)

3.7.5 Accelerometers

Three accelerometers are mounted on a 90-degree elbow above the sparger. The location of these accelerometers is shown in Figure 3-8. (YE-1 to YE-3)

3.7.6 Strain Gages

- Two sets of axial and horizontal (circumferential) strain gages were placed '0 degrees apart on the sparger pedestal (XE-1 to XE-4)
- Four axial strain gages are mounted at 90-degree intervals on sparger arms A and B, as close to the sparger body as possible (XE-6 to XE-12)
- Four axial strain gages are mounted on the ADS loop piping at the 90-degree elbow, downstream of VAD-2 (XE-13 to XE-16)
- Four axial strain gages are mounted on the ADS loop piping at the 90-degree elbow, downstream of VAD-3 (XE-17 to XE-20)

- One axial strain gage is mounted to two of the support columns (one on each column) for the ADS loop piping structural platform to measure the strain on the support columns (XE-21 to XE-22)

- Eight axial strain gages are mounted on the ADS loop piping at the tee downstream of Stage 3 spool piece at the ADS discharge header (XE-29 to XE-36)

3.7.7 Piping Position

Two LVDTs are mounted near the water discharge nozzle under the pressurizer to measure the axial and vertical motion during the transient (ZT-6 to ZT-7). These instruments are used for facility protection only.

3.7.8 Valve Parameters

Each of the saturated water flow control valves VLI-1 and VLI-2 is equipped with a set of sensors that is part of the MOVATS valve monitoring system. The sensors measure:

- actuator motor current and power
- valve stem torque and thrust
- valve stem position
- "open" and "closed" limit switch state
- spring pack displacement

3.8 Data Acquisition System

For the Phase B1 tests, three separate data acquisition systems (DAS) were used: one for the quench tank temperatures, one for the valve data, and one for the remaining pressurizer, piping, and quench tank data. Figure 3-12 shows a schematic of the DASs. The three systems are referred to as the IBM system, the MOVATS system, and the Prosig system respectively. All three systems are PC-based digital DASs. A trigger signal from the main control room was used to start these three systems simultaneously, just seconds prior to the start of the transient.

Descriptions of the three DASs used are as follows:

- A schematic of the flow diagram for the IBM system used to record the quench tank temperatures during tests is shown in Figure 3-13. This schematic shows the DAS and signal conditioners (Euromisure INOR Model SE5000) used to condition the thermocouple data prior to recording. This DAS consists of a 30-channel, 12-bit analog-to-digital converter and an IBM-XT PC. This system records the data from the thermocouples in the quench tank at a rate of 4 samples per second (sps).

- A schematic of the flow diagram for the MOVATS system used to record the characteristics of the valve performance is shown in Figure 3-14. The DAS is a standard 12-channel, 3500-series signal conditioning unit and Dolch 486/33MHz PC supplied by ITI MOVATS. This system recorded valve torque/thrust, position, coil current, limit switch state (open/close), motor power and current, and upstream/downstream pressures. These data are recorded at a rate of 1000 sps.

- A schematic of the flow diagram for the Prosig system used to record data from the pressurizer, downstream piping, sparger, and quench tank is shown in Figure 3-15. Some of these signals are conditioned prior to the Prosig DAS. The DAS consists of a 136-channel, high-speed digital DAS manufactured by Prosig. This system consists of signal conditioners, filters, amplifiers, and 14-bit analog-to-digital converters housed in several units. A Viglen 486/33MHz PC is used to record the data from the Prosig DAS units. The data are recorded at a rate of 1000 sps.

Prior to start of the Phase B1 tests, these systems were setup and a functional/validation checkout was performed. The data acquisition hardware was found to be accurate within ±4%.

3.9 Control and Safety Systems

A programmable logic control system running on a Hewlett Packard PC is used for plant control. The system is used to control the supply tank pressure/temperature (by switching the heaters on and off) prior to test initiation and to control the operation of valves and DAS during the tests. The control sequence for the saturated water blowdown tests is shown in Figure 3-16.

The supply tank level is monitored and manually controlled so that the level is typically ≤ 60 percent prior to steam blowdowns and ≤ 80 percent prior to saturated water blowdowns.

During blowdown, heater operation and feedwater addition to the supply tank are terminated.

The test facility safety system consists of two spring-loaded safety valves mounted on top of the supply tank. These valves are set to open at a pressure of 2785 psig (192 barg).

If pressure reaches 2683 psig (185 barg), power to the heater rods is electronically cut off. When the supply tank level reaches less than 9.2 ft. (2.8 m), differential pressure cells cut off power input to the heater rods. Override functions provide two alarms. One alerts the operator when pressure reaches 2741 psig (189 barg), and the other alerts the operator when level reaches 7.2 ft. (2.2 m).

TABLE 3-1
PRINCIPAL MODIFICATIONS TO VAPORE FACILITY FOR ADS PHASE B1

Modification	Purpose
Addition of a 12-in. line, with two isolation valves, from the bottom of the supply tank to the ADS valve/piping package	Supply the ADS valve package with saturated water up to 2300 psig. Expected saturated water flowrate up to about 500 kg/s (1100 lb/s).
Addition of a new steam collector downstream of moisture separator	To ensure the proper steam feed to the ADS valve package
Addition of the prototype ADS piping and valves	Simulation of stage 1, 2, and 3 valve arrangement
Addition of new discharge collector at ADS loop outlet	To connect the existing discharge line and the ADS loop
Installation of high pressure bellows and structural verification of the existing discharge line	To ensure integrity during test conditions
Addition of a quencher stand to elevate the sparger to 14.5 ft. above the bottom of the quench tank	To enhance test simulation of the actual plant component arrangement
Addition of an interchangeable spool piece to provide the ADS loop with saturated water or saturated steam	To avoid mechanical stress since due to thermal expansion since only one of the two feed lines will be utilized at a time
Addition of new instrumentation (about 50 new instruments) and data acquisition systems	To ensure complete monitoring of the ADS Phase B1 test
Addition of new programmable logic control system	To allow control of additional equipment

TABLE 3-2 PRINCIPAL DIMENSIONS AND CHARACTERISTICS OF TEST FACILITY COMPONENTS	
Steam/Water Supply Tank	
Volume	1412.6 ft^3 (40 m^3)
Design Pressure	2860 psig (197 barg)[(1)]
Design Temperature	689°F (365°C)
Material: Wall Internal Cladding	Low alloy steel Austenitic stainless steel
Internal Diameter (nominal)	83.74 in. (2.127m)
Wall Thickness: Top Dome (min) Cylinder (min) Bottom Dome (min)	1.90 in. (48.3 mm) 3.82 in. (97 mm) 2.74 in. (69.6 mm)
Cladding Thickness (min)	0.13 in. (3.2 mm)
Overall Height (including skirt)	42.11 ft. (12.835 m)
Outlets: Steam (top) Water (bottom)	10-in. nominal bore 14-in. nominal bore
Insulation: Type	Fiberglass pads (glass wool encased in zinc mesh for physical stability) of density 90-100 kg/m^3/aluminum sheet cover
Thickness	5.91 in. (150 mm)
Steam Line	
Design Pressure	2860 psig (197 barg)
Design Temperature	689°F (365°C)
Material Wall Lining	Carbon steel Austenitic stainless steel
Bore: Up to Control Valve VR-1.1 After Control Valve VR-1.1	10-in. Schedule 160 12-in. Schedule 160
Lining Thickness (nominal)	0.12 in. (3 mm)
Insulation: Type	Fiberglass pads (density 90-100 kg/m^3)/aluminum sheet cover
Thickness	4.72 in. (120 mm)

TABLE 3-2 (Cont.) PRINCIPAL DIMENSIONS AND CHARACTERISTICS OF TEST FACILITY COMPONENTS	
Separator	
Volume	173 ft.^{3} (4.9 m^3)
Design Pressure	2860 psig (197 barg)
Design Temperature	689°F (365°C)
Material: Wall Internal Cladding	Carbon steel Austenitic stainless steel
Internal Diameter	6.9 ft. (2.1 m)
Wall Thickness (minimum)	3.4 in. (86 mm)
Cladding Thickness (nominal)	0.12 in. (3 mm)
Insulation: Type Thickness	Fiberglass pads (density 90-100 kg/m^3)/aluminum sheet cover 5.91 in. (150 mm)
Steam Collector	
Design Pressure	2860 psig (197 barg)
Design Temperature	689°F (365°C)
Venturi Flowmeter: Throat Diameter β Ratio	7.72 in. (196.2 mm) 0.753
Header: Wall Material Lining Material Bore Lining Thickness (nominal)	Carbon steel Austenitic stainless steel 16-in. Schedule 160 & 24-in. Schedule 160 0.12 in. (3 mm)
Manifold: Material Bore	Carbon steel 8-in. Schedule 160 (branches) & 12-in. Schedule 160 (common pipe)
Insulation: Type Thickness	Fiberglass pads (density 90-100 kg/m^3)/aluminum sheet cover 4.72 in. (120 mm)
Saturated Water Line	
Material: Up to Gate Valve VLI-1 After Gate Valve VLI-1	Austenitic stainless steel Carbon steel
Bore	12-in. Schedule 160
Insulation: Type Thickness	Rock wool/aluminum sheet cover 2.36 in. (60 mm)

TABLE 3-2 (Cont.) PRINCIPAL DIMENSIONS AND CHARACTERISTICS OF TEST FACILITY COMPONENTS		
ADS Valve Package Inlet Piping		
Material		Carbon steel
Bore:	Upstream of Loop Seal	12-in. Schedule 160
	Loop Seal and Upstream of Valve Cluster	14-in. Schedule 160
Insulation:	Type	Rock wool/aluminum sheet cover
	Thickness	2.36 in. (60-mm)
ADS Valve Package Discharge Piping		
Material		Carbon steel
Bore:	Valve Package Discharge Header	16-in. Schedule 80
	Two Transition/Bellows Sections	10-in. Schedule 80
	Quench Tank Line	16-in Schedule 80
Insulation		None
Valve VLI-1		
Size/Type		12-in. wedge type gate valve
Manufacturer		Edward
Model		Figure B12011 (WCC) DDIJWY (Class 1500)
Material:	Base	A216 Grade WCC
	Trim	A216 Grade WCC
Actuator		Limitorque SMB-3
Stem Travel Full Closed-Full Open		10.2 in.
Opening Time (to full open)		30 seconds max.
Full Open Flow Area		67.2 in.^{2} (manufacturer's data)
Full Open C_v		6850 (manufacturer's data)
Valve VLI-2		
Size/Type		12-in. parallel disc gate valve
Manufacturer		Atwood & Morrill
Model		12-in. class 1500 Dwg. #16654-0

TABLE 3-2 (Cont.) PRINCIPAL DIMENSIONS AND CHARACTERISTICS OF TEST FACILITY COMPONENTS	
Material Base Trim	A-216 grade WCB Stainless steel
Actuator	Limitorque SMB-3
Stem Travel Full Closed - Full Open	9.5 in.
Closing Time (from full open)	30 seconds max.
Full Open Flow Area	58.5 in.^{2} (manufacturer's data)
Full Open C_v	7150 (manufacturer's data)
ADS Valve Piping Package	
Stage 1 Pipe Bore	4-in. Schedule 160 (inlet side) 4-in. Schedule 80 (outlet side)
Pipe Material	Carbon steel
Orifice (for simulation of gate valve) Inside Diameter Profile Thickness β Ratio	 3.189-in. Parallel bore, square-edged, with two 0.118-in. radius notches to drain condensate 0.453 in. 0.927
Valve VAD-1: Type Manufacturer Model Material Actuator Full Open Flow Area Full Open C_v	 Globe Anchor Darling 4-in.-1707# linear plug Stainless steel (body) Limitorque SB-1-25 8.78 in.^{2} (manufacturer's data) 140 (manufacturer's data)
Stage 2 Pipe Bore	8-in. Schedule 160 (inlet side) 8-in. Schedule 80 (outlet side)
Pipe Material	Carbon steel
Valve VAD-2: Type Manufacturer Model Material Actuator Full Open Flow Area Full Open C_v	 Parallel disc gate valve Anchor Darling 8-in.-1707# Stainless steel (body) Limitorque SB-2-80 30.68 in.^{2} (manufacturer's data) 3275 (approx.) (manufacturer's data)

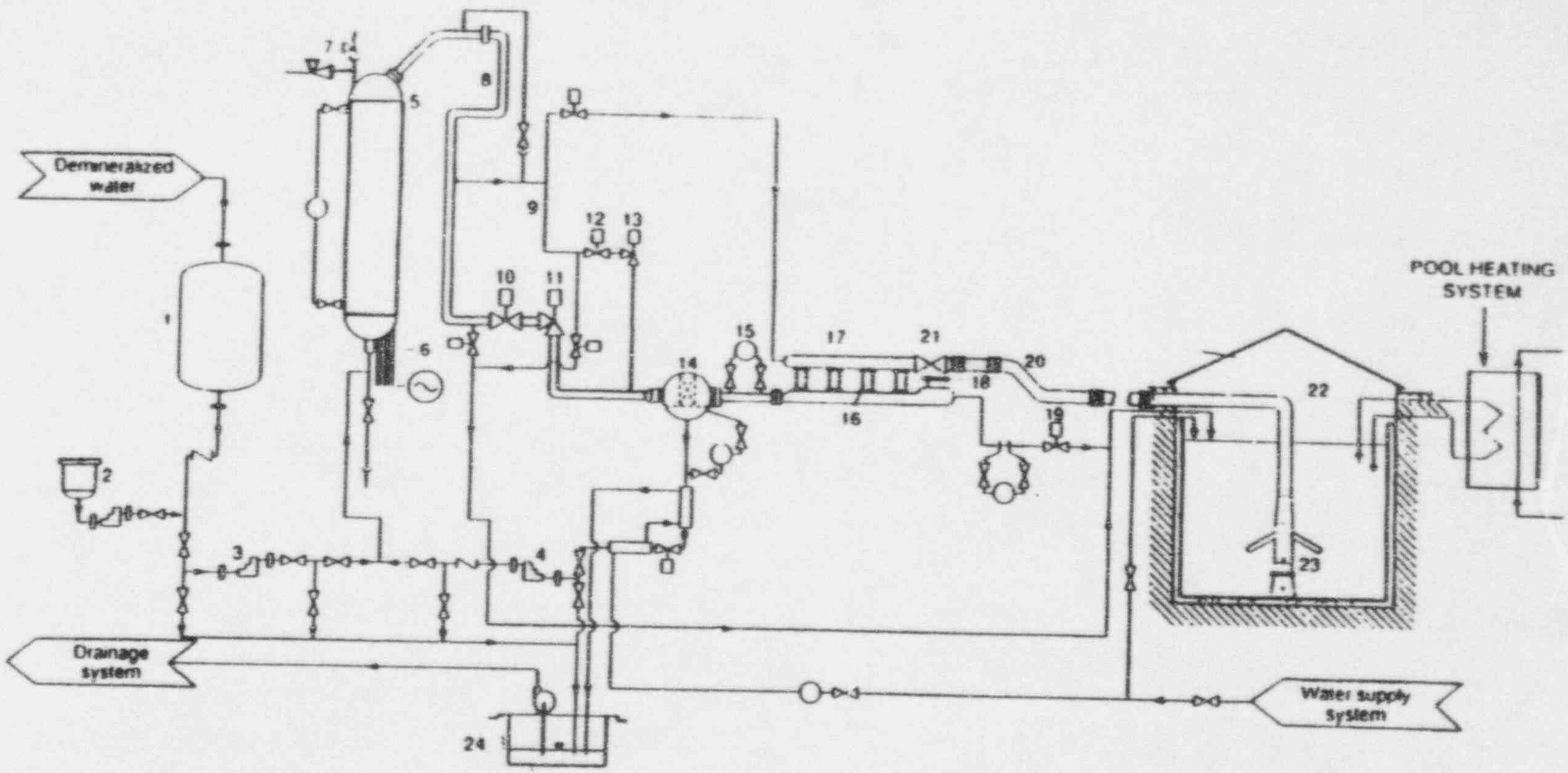
TABLE 3-2 (Cont.) PRINCIPAL DIMENSIONS AND CHARACTERISTICS OF TEST FACILITY COMPONENTS		
	Orifice (for simulation of globe valve) Inside Diameter Profile Thickness β Ratio	 5.161 in. Parallel bore, square-edged, with two drain holes at pipe wall position 0.379-in. 0.756
Stage 3	Pipe Bore	8-in. Schedule 160 (inlet side) 8-in. Schedule 80 (outlet side)
	Pipe Material	Carbon steel
	Valve VAD-2: Type Manufacturer Model Material Actuator Full Open Flow Area Full Open C_v	 Wedge-type gate valve Westinghouse 8-in.-Class 1725 dwg. #6437E31 Stainless steel Limitorque SB-3 28.8 in.^{2} (manufacturer's data) N/A
	Orifice (for simulation of globe valve) Inside Diameter Profile Thickness β Ratio	 5.161-in. Parallel bore, square-edged, with two drain holes at pipe wall position 0.630 in. 0.756

Note:
(1) Barg refers to bar gage. 1 barg = 10^5 pascals.

TABLE 3-3 LIST OF INSTRUMENTS				
Transducer I.D.	**Type of Transducer**	**Make/Model**	**Range**	**Specified Accuracy**
Quench Tank				
TE-01 to TE-30	Thermocouple (Type K)	Euromisure K01	32 - 572°F (0 - 300°C)	±4°F (±2.2°C)
XE-1 to XE-12	Strain Gage (120 ohms)	Eaton Ailtech SG-125-01	N/A	N/A
Piping Pressure				
PE2W - PE8W, PE11W, PE13W - PE15W, & PE17W - PE24W	Pressure (Piezoresistive)	Transinstruments BHL-4251	0 - 3625 psig (0 - 250 barg)	±0.2% of full scale
PE9W, PE12W, & PE16W	Pressure (Piezoresistive)	Transinstruments BHL-4251	0 - 2320 psig (0 - 160 barg)	±0.2% of full scale
DNP-01	Delta-P VLI-2	N/A	N/A	N/A
ADS Loop Piping Strains				
XE-13 to XE-36	Strain Gage (120 ohms)	KYOWA SKW-10057	N/A	N/A
Quench Tank Pressures				
PE-01	Pressure (Piezoresistive)	Transinstruments BHL-4225-86-4OMO	0 - 870 psig (0 - 60 barg)	±0.2% of full scale
PE-02	Pressure (Piezoresistive)	Transinstruments BHL-4225-86-4OMO	0 - 362.5 psig (0 - 25 barg)	±0.2% of full scale
PE-03 to PE-07	Pressure (Piezoresistive)	Transinstruments BHL-4225-86-4OMO	0 - 232 psig (0 - 16 barg)	±0.2% of full scale
PE-08	Pressure (Piezoresistive)	Transinstruments PROMAN C252230/2a	0 - 232 psig (0 - 16 barg)	±0.2% of full scale
PE-09 to PE-20	Pressure (Piezoresistive)	Transinstruments BHL-4240-86-4OMO	0 - 36 psig (0 - 2.5 barg)	±0.2% of full scale
Discharge Piping Before Sparger				
PE-21	Pressure (Piezoresistive)	Transinstruments BHL-4225	0 - 870 psig (0-60 barg)	±0.2% of full scale
PE-22	Pressure (Piezoresistive)	Hartmann-B ARK-210	0 - 36 psia (0 - 2.5 bar absolute)	±0.2% of full scale

TABLE 3-3 (Cont.) LIST OF INSTRUMENTS				
Transducer I.D.	Type of Transducer	Make/Model	Range	Specified Accuracy
Discharge Piping After Moisture Separator				
PT61A	Pressure (Piezoresistive)	Transinstruments BHL-4206-00-01MO	0 - 2320 psig (0 - 160 barg)	±0.5% of full scale
PT61B	Pressure (Piezoresistive)	Transinstruments BHL-4206-00-01MO	0 - 1450 psig (0 - 100 barg)	±0.5% of full scale
PT-18	Pressure (Piezoresistive)	Transinstruments BHL-4206-00	0 - 870 psig (0 - 60 barg)	±0.5% of full scale
PT-10	Pressure (Piezoresistive)	Transinstruments BHL-4206-00	0 - 2320 psig (0 - 160 barg)	±0.5% of full scale
FT-15	Venturi	Hydronics TH-DVA	0 - 507 psid (0 - 35 bard)	N/A
Pressurizer				
PT-04	Pressure (Piezoresistive)	Rosemount 1144-G6000-A22	0 - 2900 psig (0 - 200 barg)	±0.5% of full scale
LT-1	Delta-P Bellows Type	Rosemount 1511NPE22B1	0 - 32.8 ft (0 - 10 mH_2O) (level)	N/A
LT-1B	Delta-P Bellows Type	Rosemount 1511NPE22B1	0 - 79380 lb (0 - 36000 kg) (mass)	N/A
Discharge Piping				
PT1W, PT6W, & PT10W	Pressure (Piezoresistive)	Transinstruments 4600-BGC-2500-COUE	0 - 3625 psig (0 - 250 barg)	±0.5% of full scale
PT4W	Pressure (Piezoresistive)	Transinstruments BHL-4207-00	0 - 2320 psig (0 - 160 barg)	±0.5% of full scale
YE-01 to YE-03	Acceleration (Piezoelectric)	Endevco 7703A-100	100 g	N/A
TE1W to TE16W	Thermocouple (Type K)	Euromisure K01	32 - 572°F (0 - 300°C)	±4°F (±2.2°C)
Surge Line Displacement				
ZT-6 to ZT-7	Displacement (LVDT)	Monitran MTN/EGR010	± 0.4 in (± 10 mm)	N/A

TABLE 3-3 (Cont.) LIST OF INSTRUMENTS				
Transducer I.D.	**Type of Transducer**	**Make/Model**	**Range**	**Specified Accuracy**
MOVATS Transducers				
N/A	Torque/Thrust Cell (Strain Gage Type)	ITI MOVATS Type RF	0 - 200000 lbs thrust 0 - 6000 ft.-lbs. torque	±2% of reading ±0.5% of full scale
N/A	Current Probe (Clamp-On)	Fluke Y8100	0 - 200 amps dc	±6% of full scale
N/A	Displacement Probe	Pulsonic 2000	0 - 10 in.	±2.5% of reading



1- Demineralized water tank
2- Water chemical treatment
3- Surge pump
4- Condensate recirculation pump
5- Steam accumulator
6- Electric heaters
7- Safety/relief valve
8- Main steam line (10", sch 160)
9- Secondary steam line (3", sch 160)
10- Main stop valve (10")
11- Main control valve (10"x12")
12- Secondary stop valve (3")
13- Secondary control valve (3"x4")
14- Moisture separator
15- Nozzle flow meter
16- Test drum (16", sch 160)
17- Test sections (10" flanges)
18- 24" flange
19- Auxiliary control valve
20- Discharge line (16", sch 80)
21- Backpressure control valve
22- Water tank (Φ=8 m, h=10 m)
23- Sparger device
24- Facility sump

Figure 3-1 VAPORE Simplified Flow Diagram for Phase A Testing

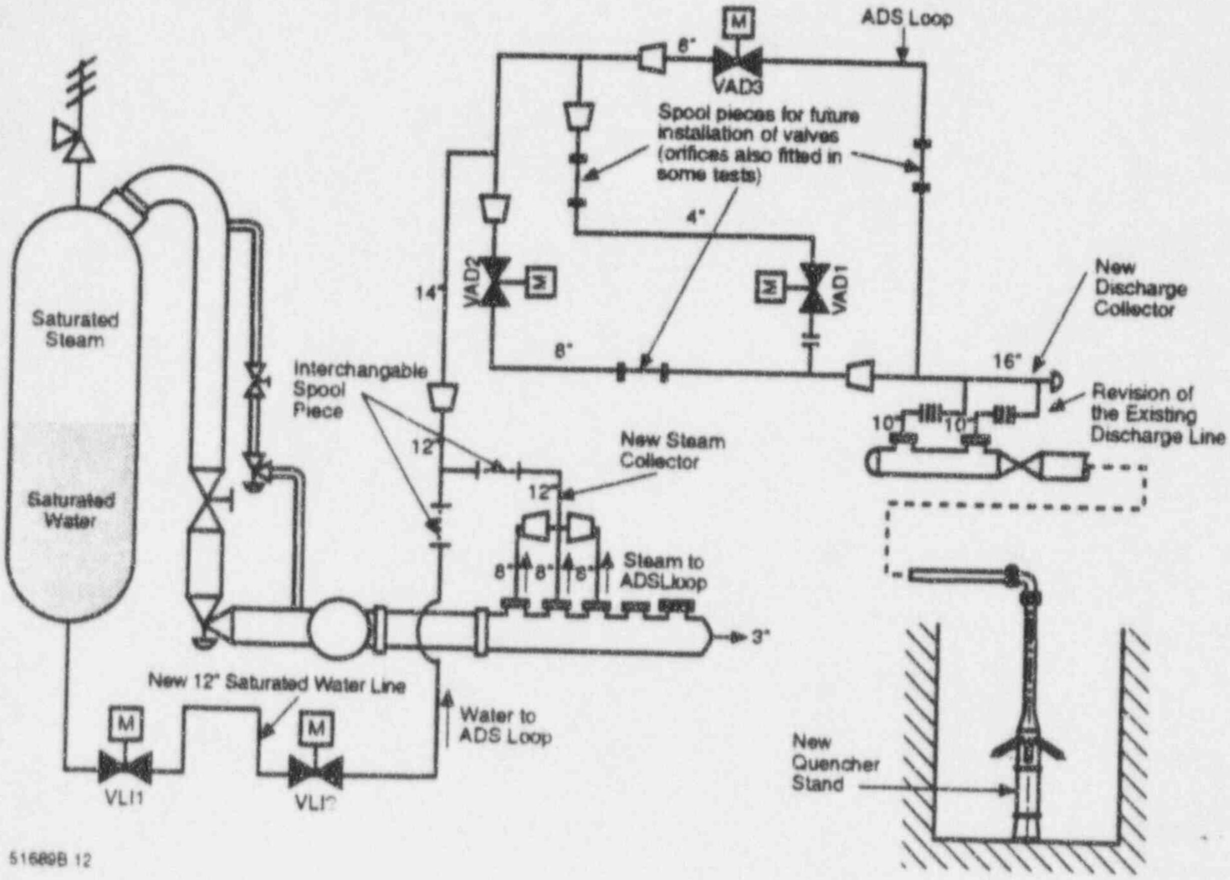
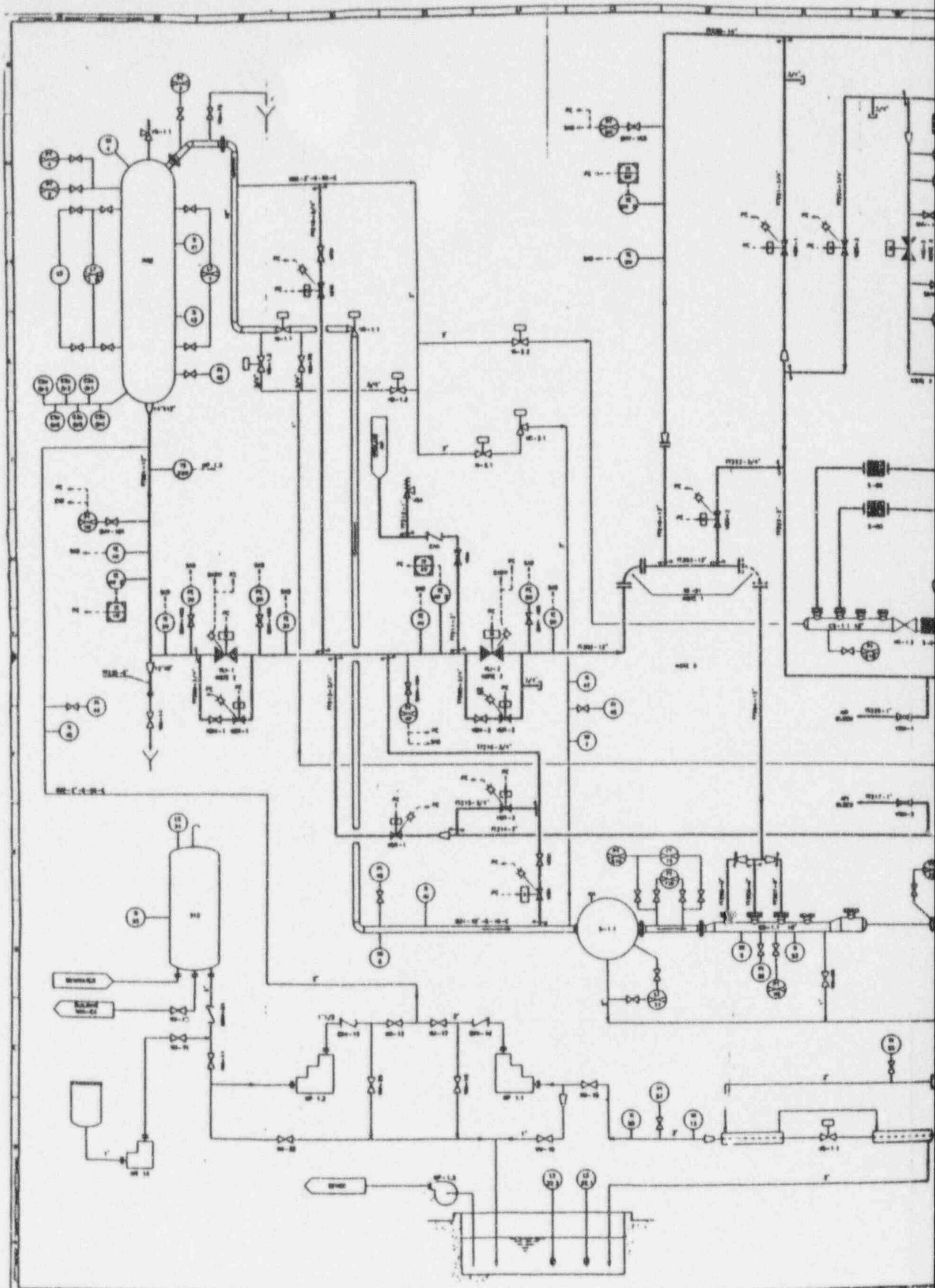


Figure 3-2 VAPORE Plant Main Modifications for Phase B1 Testing



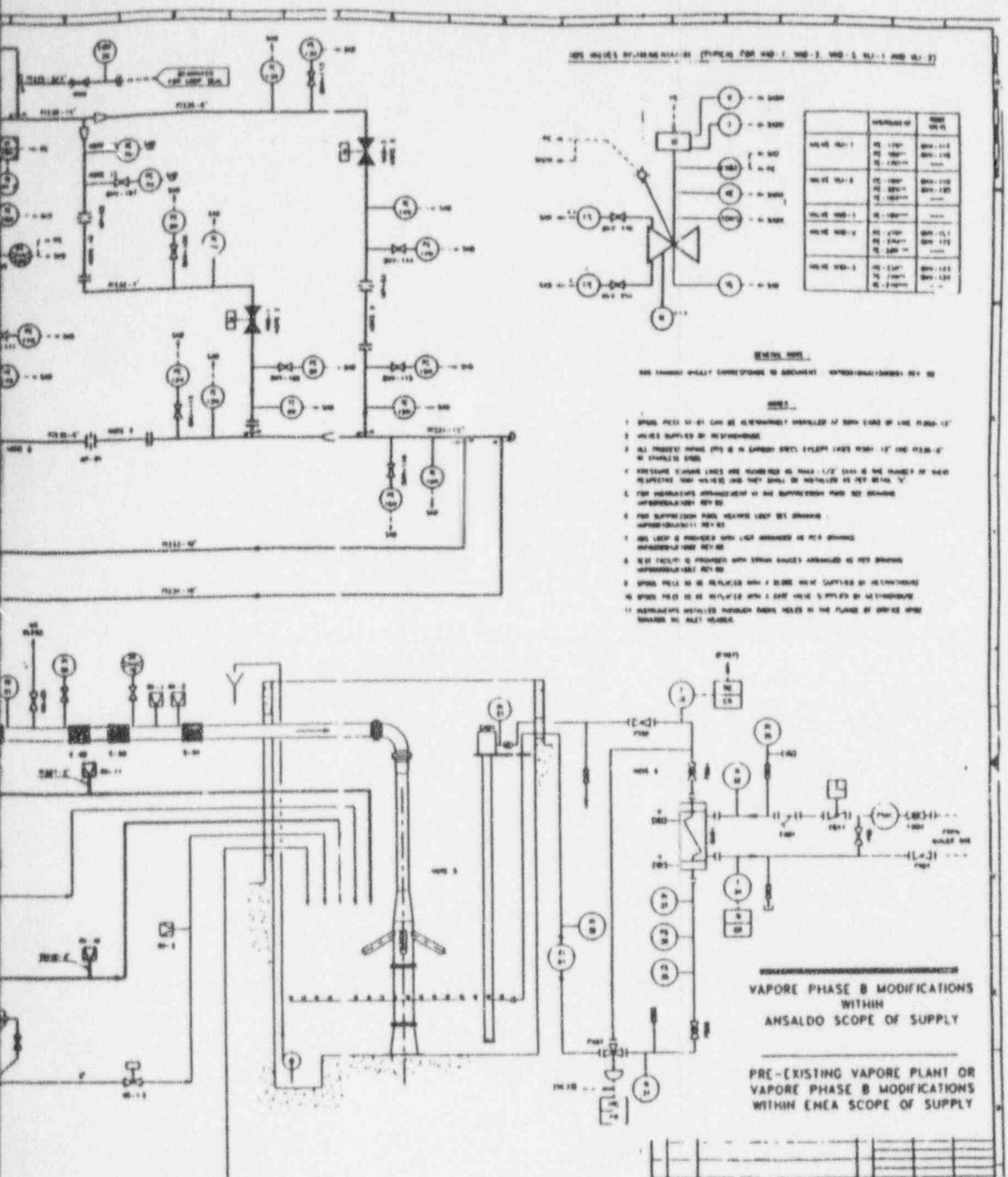


Figure 3-3

ADS Phase B1 Facility Description Report Piping and Instrumentation Diagram

9504050139-01

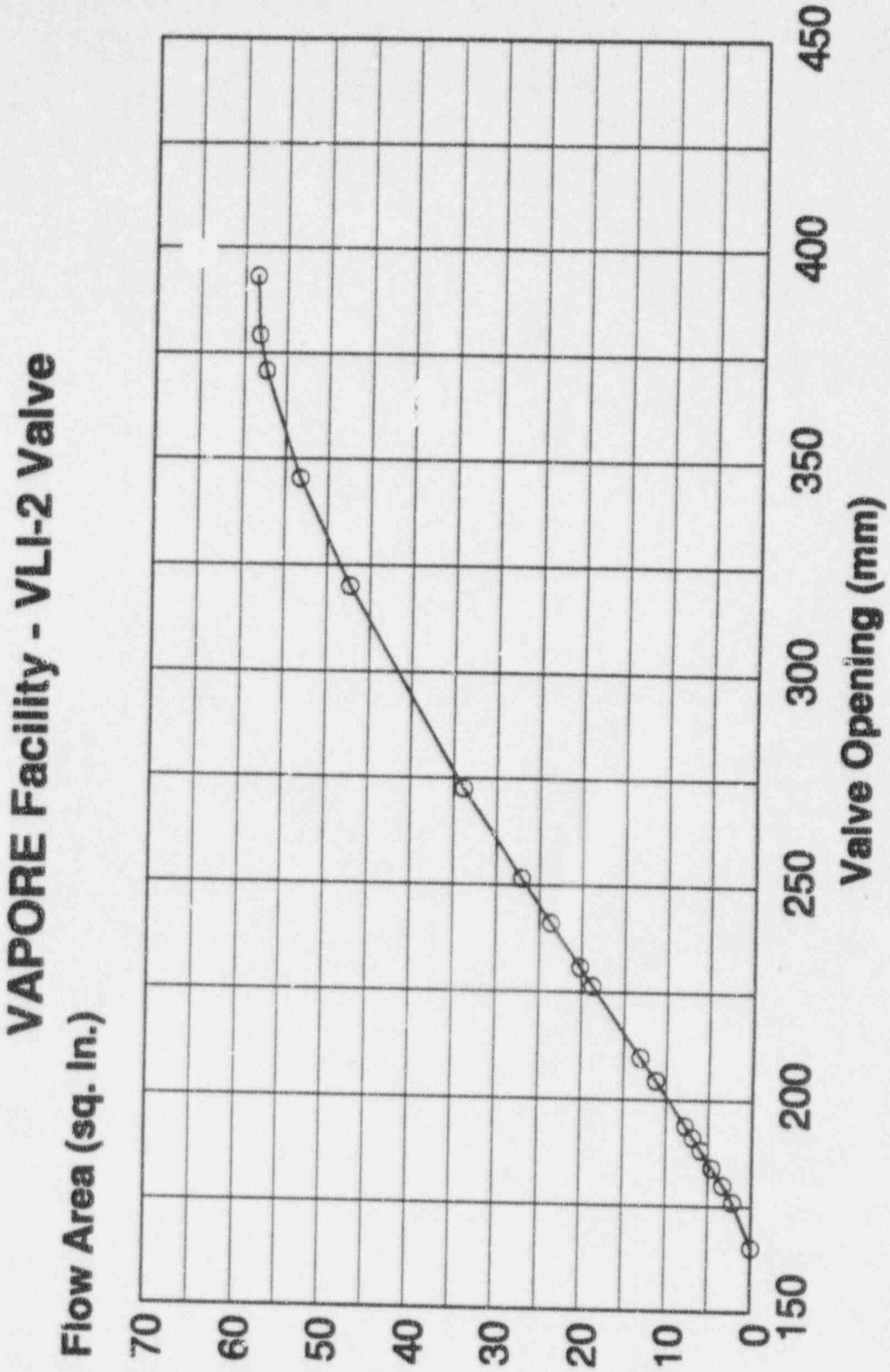
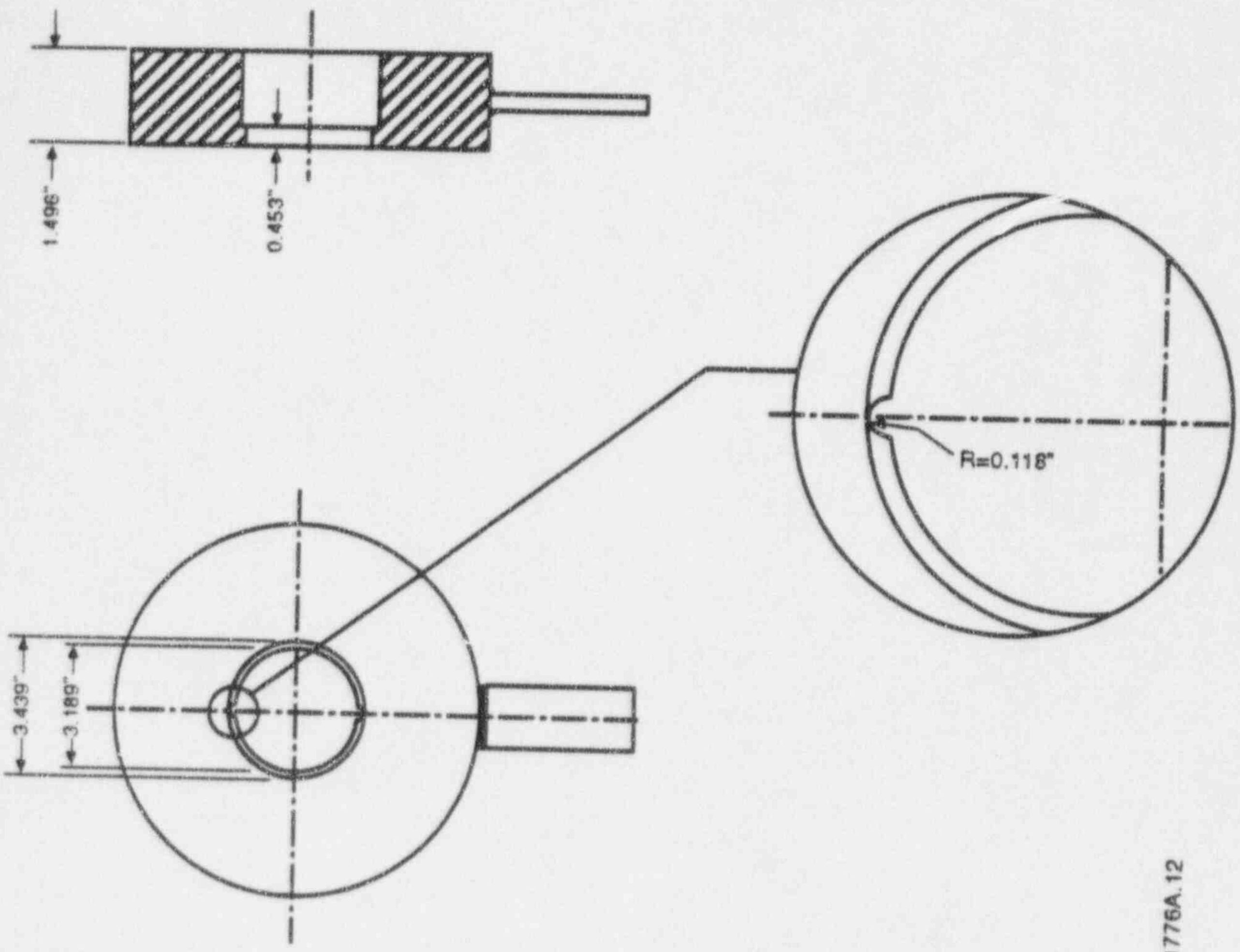


Figure 3-4 Valve VLI-2 Flow Area Characteristic

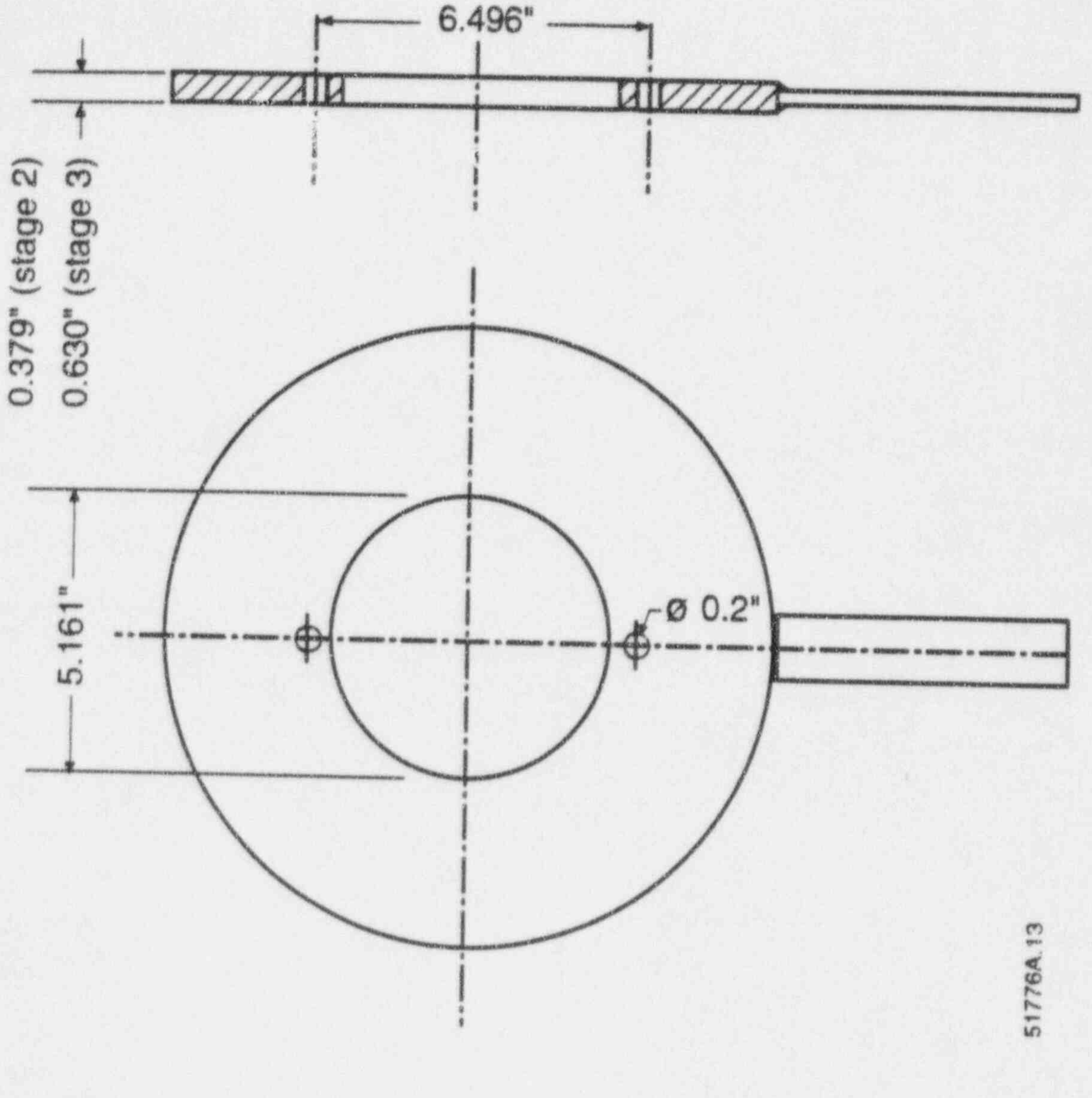
a,b

Figure 3-5 Valve VLI-2 Friction Factor Characteristic



NOTE: Bar attached to orifice plate is located at top of pipe when orifice is installed.

Figure 3-6 Orifice Simulating 4-in. Gate Valve (Stage 1)



NOTE: Bar attached to orifice plate is located at top of pipe when orifice is installed.

Figure 3-7 Orifices Simulating 8-in. Globe Valves (Stages 2 and 3)

a,c

Figure 3-8 Location of Sensors on Discharge Piping and in Quench Tank - Elevation View

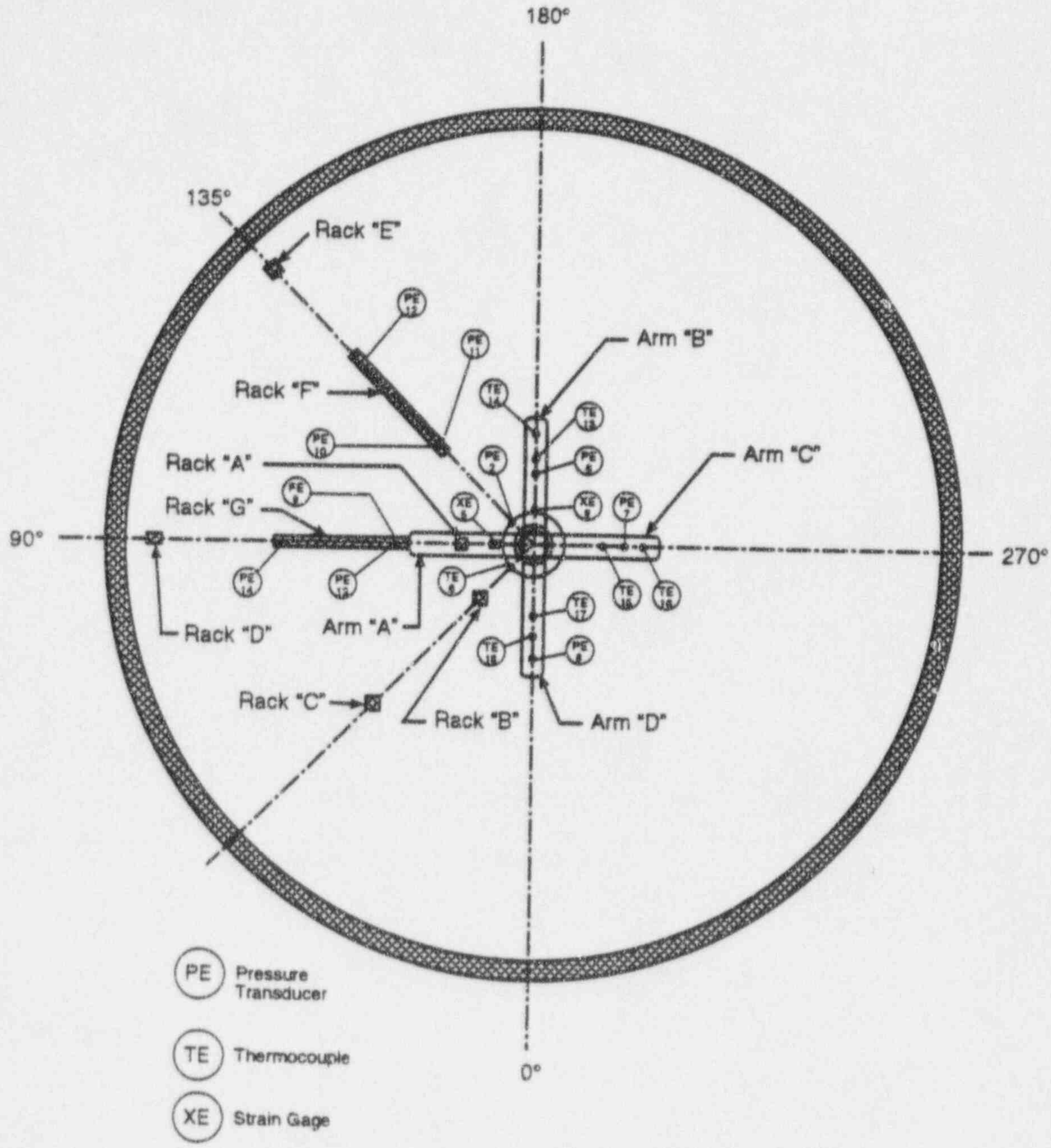


Figure 3-9 Location of Sensors in Quench Tank and on Sparger Arms - Plan View

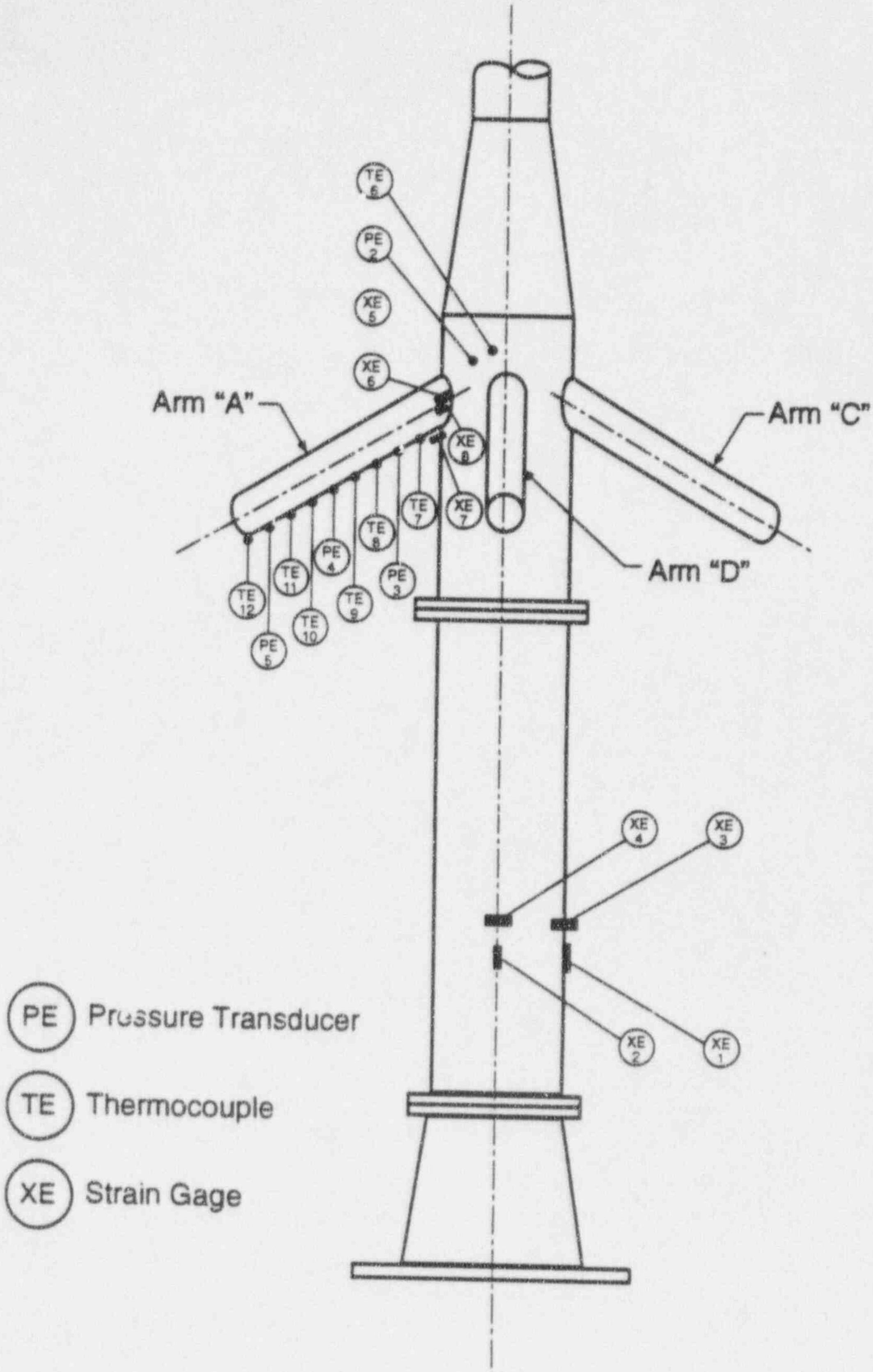


Figure 3-10 Location of Instrumentation on Sparger

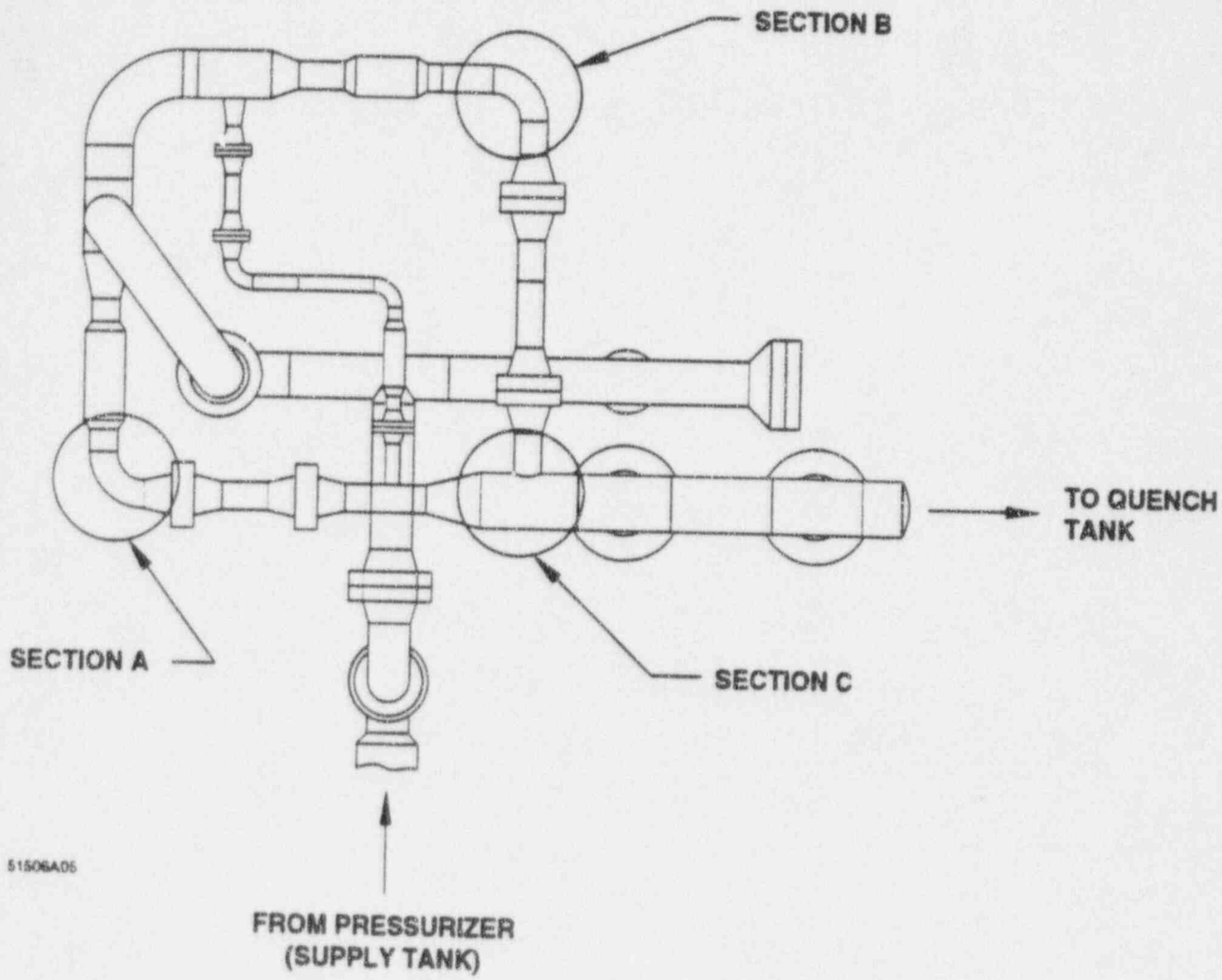
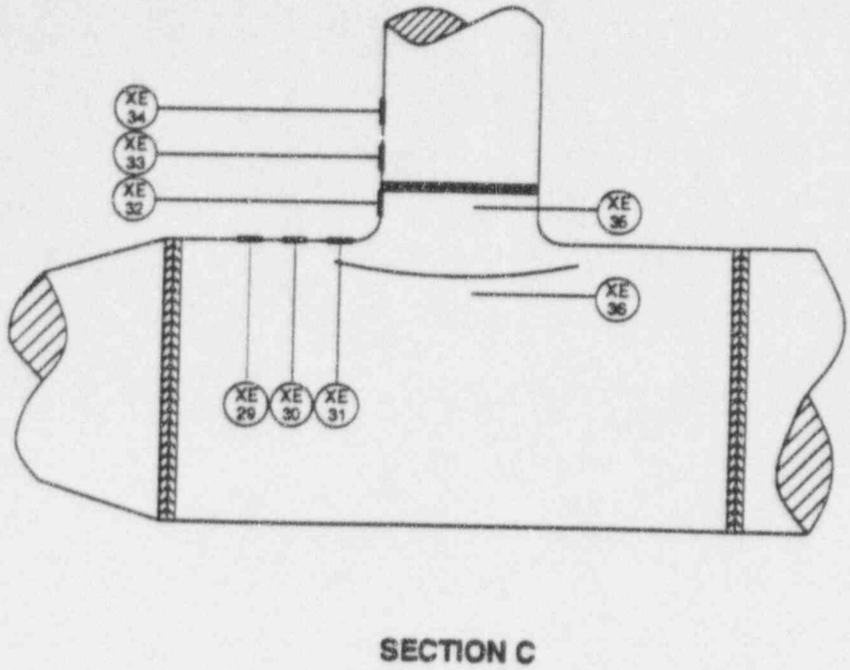
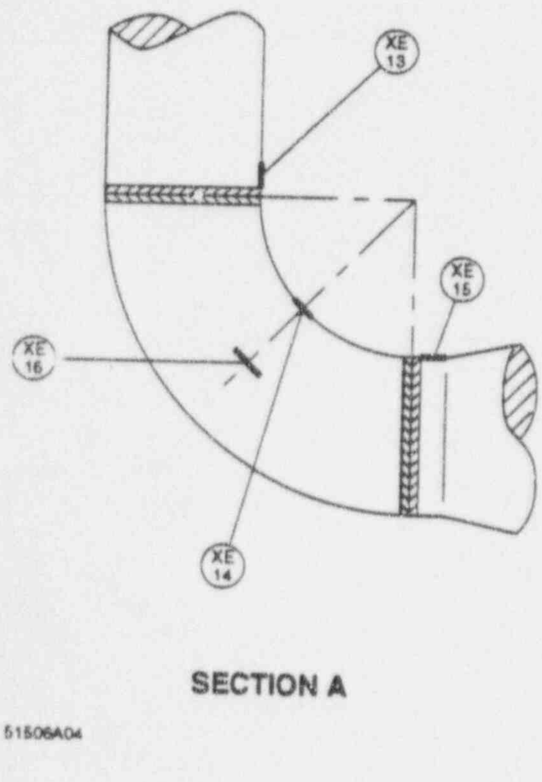


Figure 3-11 Location of Strain Gauges on ADS Piping Loop (Sheet 1 of 2)





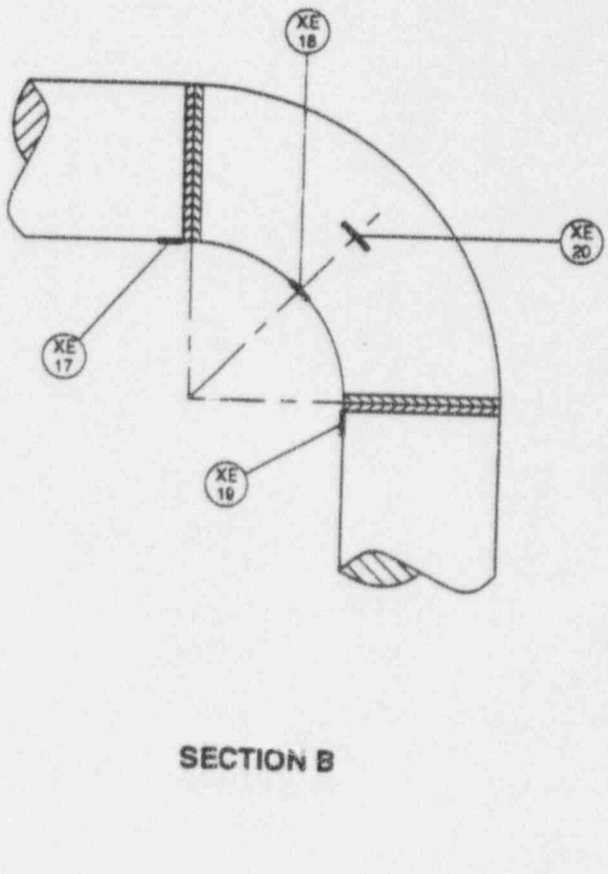


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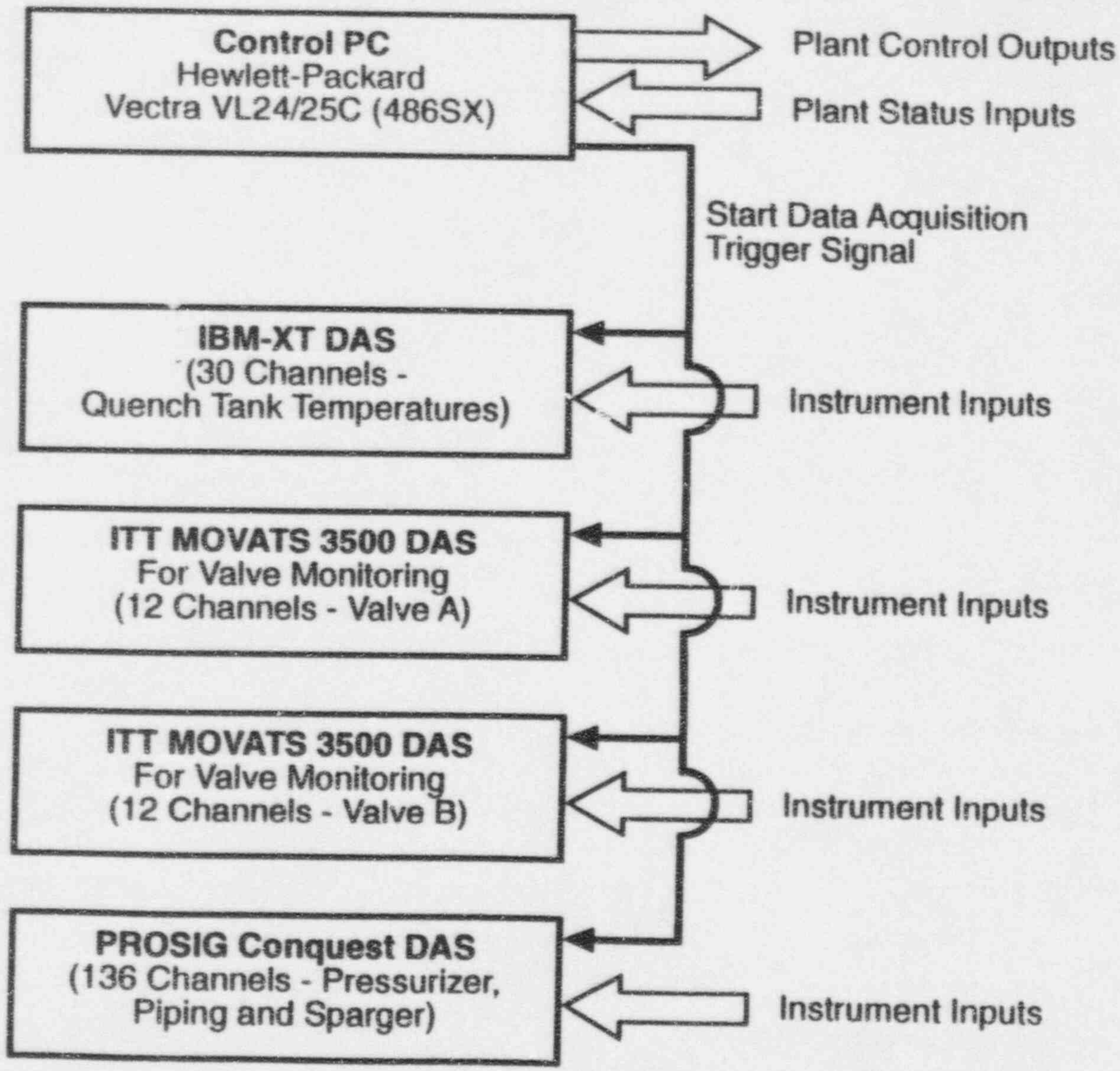
Figure 3-11 Location of Strain Gauges on ADS Piping Loop (Sheet 2 of 2)



51770A.1

Figure 3-12 VAPORE Facility Control and Data Acquisition System Computers

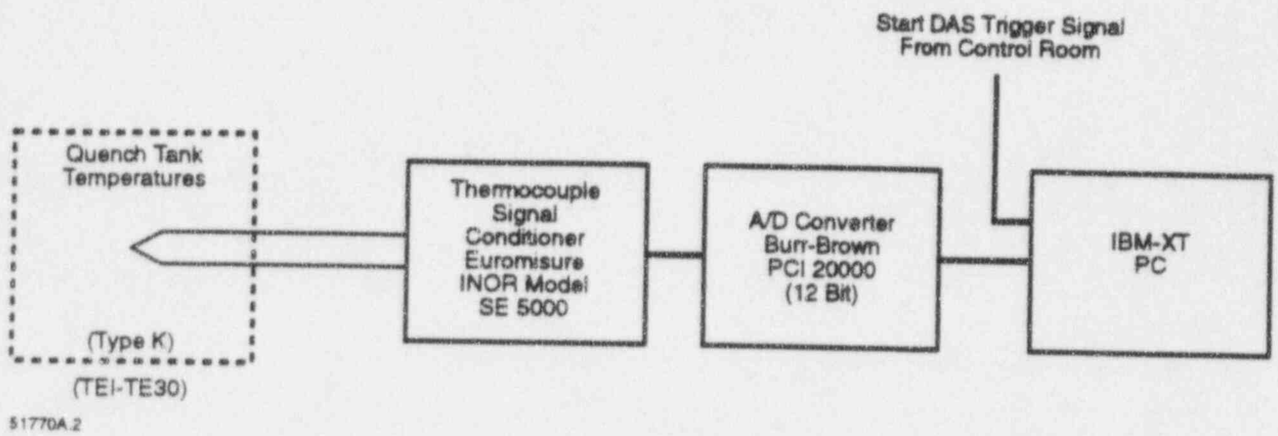


Figure 3-13 IBM Data Acquisition System Typical Instrumentation Arrangement

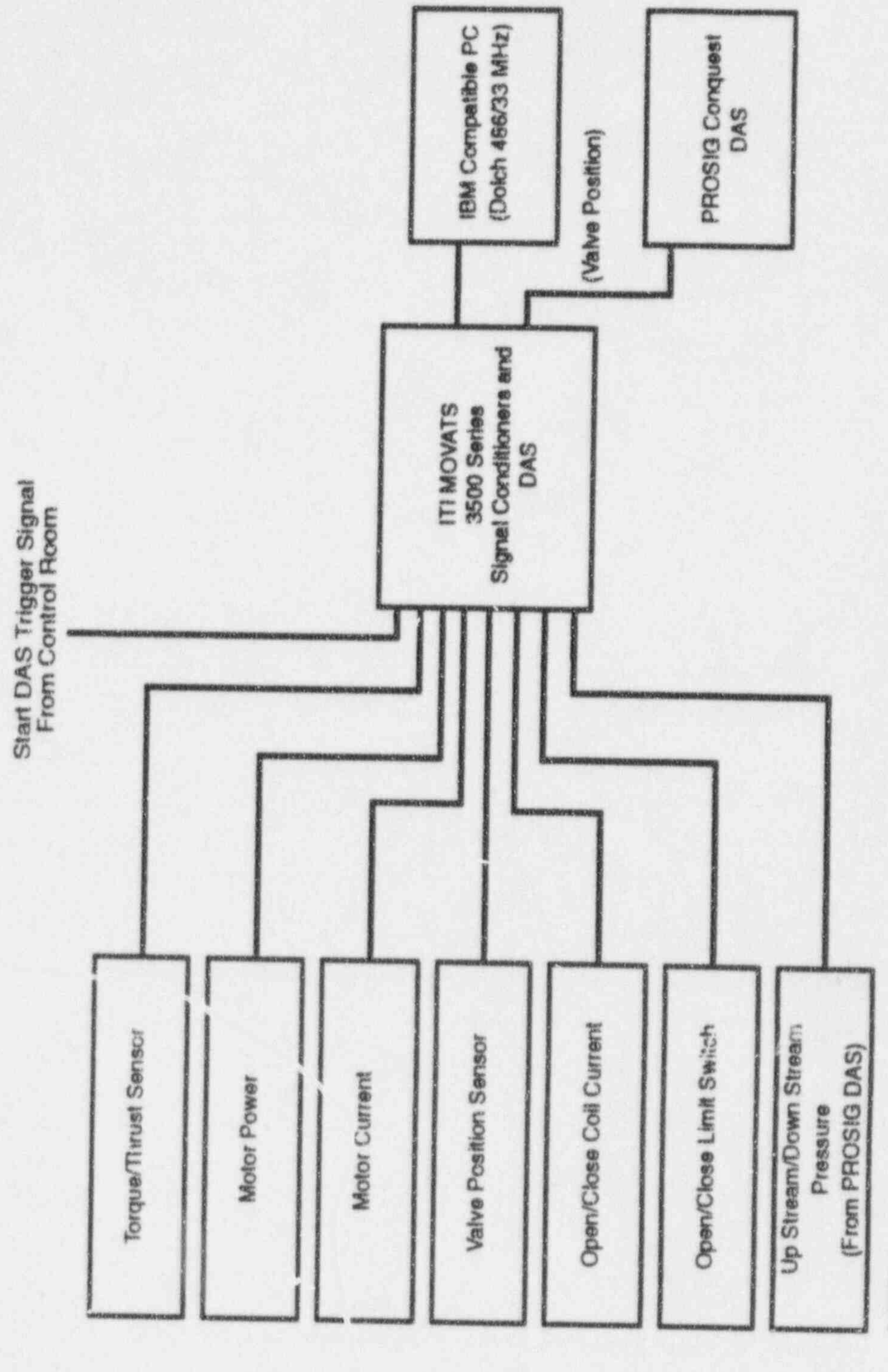


Figure 3-14 ITI MOVATS Data Acquisition System Typical Instrumentation Arrangement

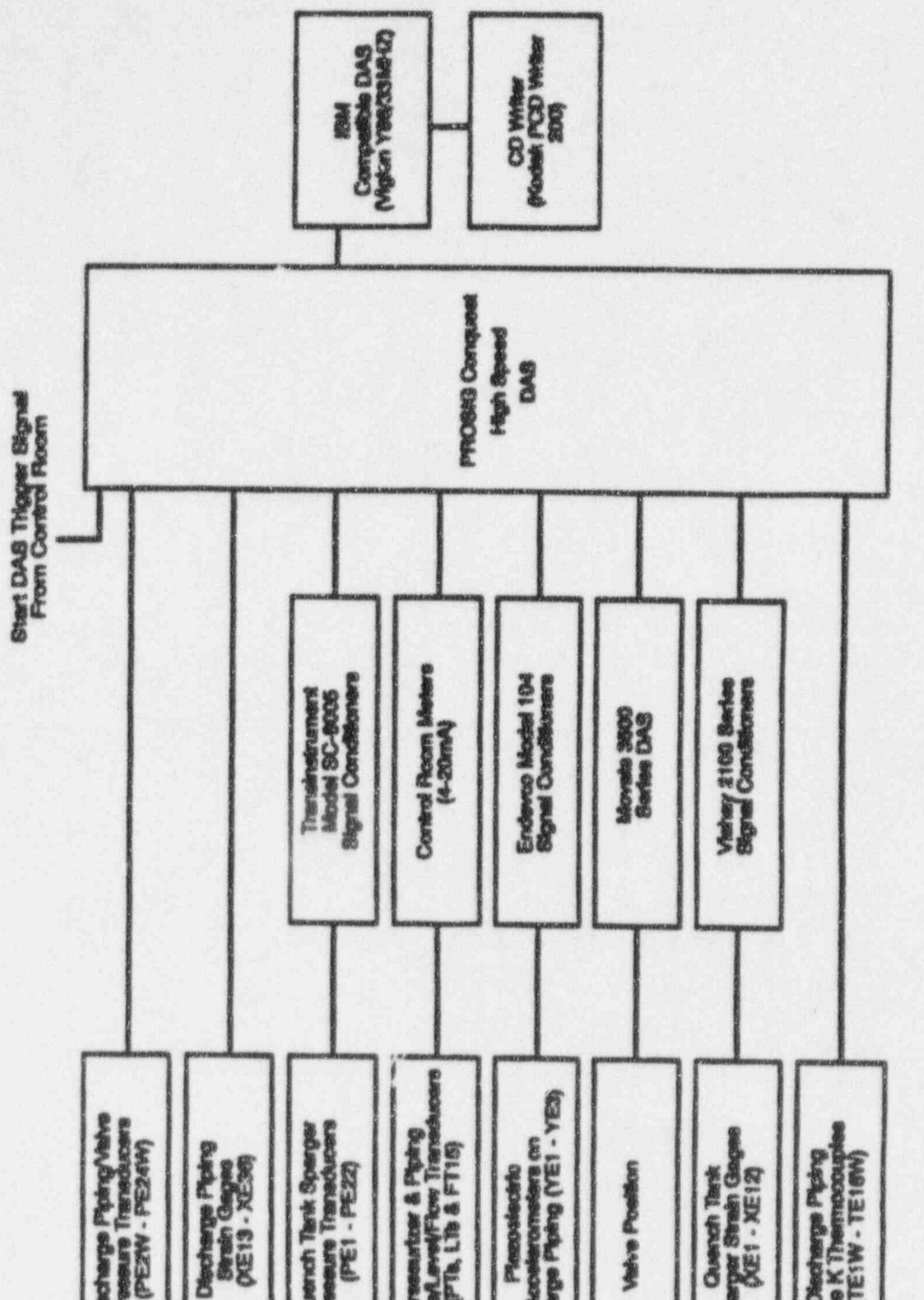


Figure 3-15 Prosig Data Acquisition System Typical Instrumentation Arrangement

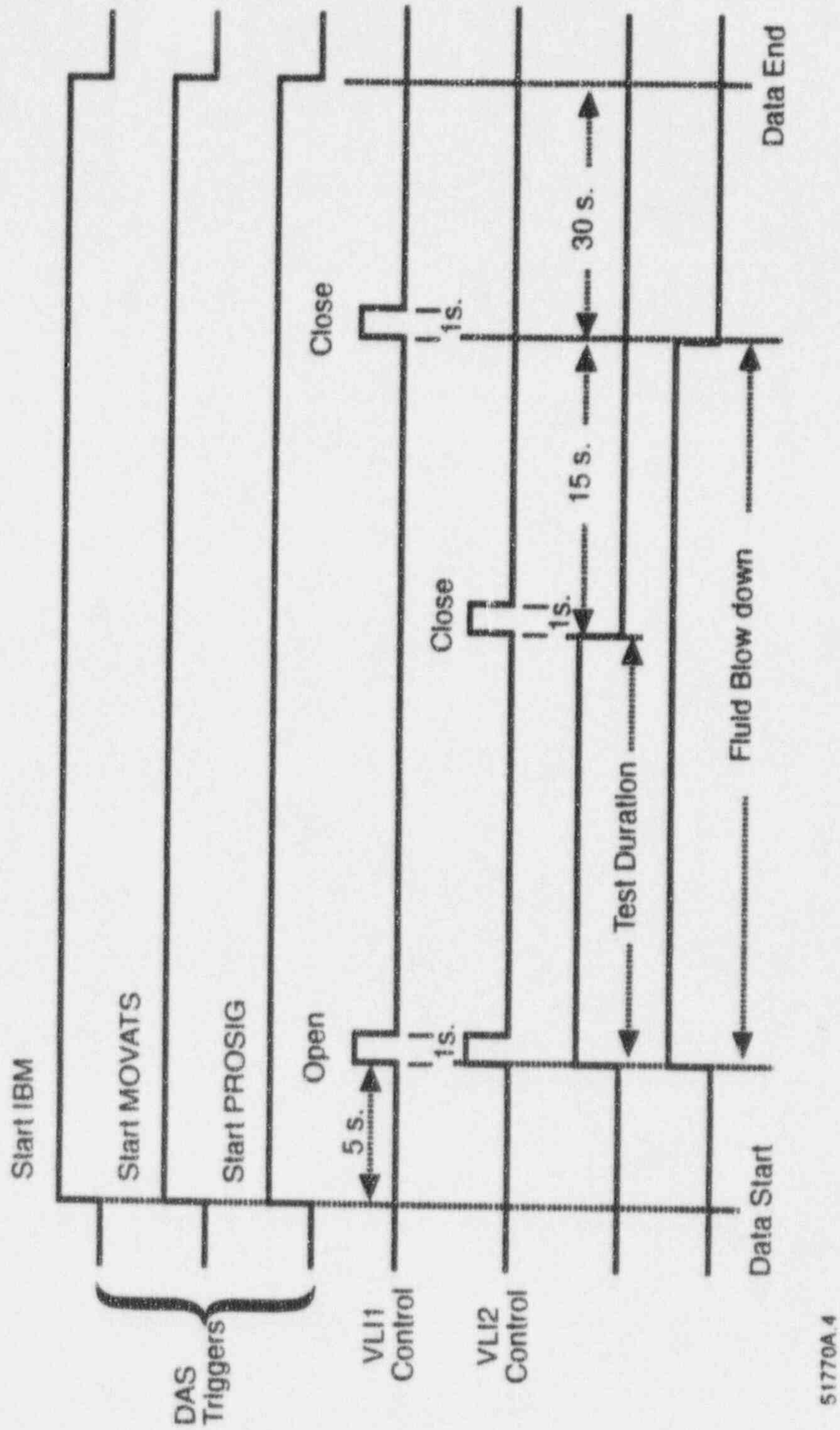


Figure 3-16 Control Sequence for Saturated Water Blowdowns

4.0 REFERENCES

1. Brockie, A.J., *AP600 Automatic Depressurization System Test Specification (Phase B1) Revision 2*, PXS-T1-P004, WCAP-14112 (Proprietary), February 1995.

2. *Quality Assurance Plan Description: AP600 Test Program Conducted at the VAPORE Plant in ENEA Casaccia (Phase B)*, RCS-T1H-001 (ENEA Document AP600-GQ9402).

3. *ADS Test Valves 12-in. Edward Valve Field Manual*, PV60-VTM-001 (Proprietary).

4. *ADS Test Valves Atwood & Morrill Valve Field Manual*, PV60-VTM-002 (Proprietary).

5. Peters, F. E., *Automatic Depressurization System Phase B1 Final Data Report*, RCS-T24-100, March 1995.

6. *ADS Test Valves* Anchor Darling Valve Field Manual, PV60-VTM-003 (Proprietary).

7. *ADS Test Valves Westinghouse Valve Field Manual*, PV60-VTM-004 (Proprietary).

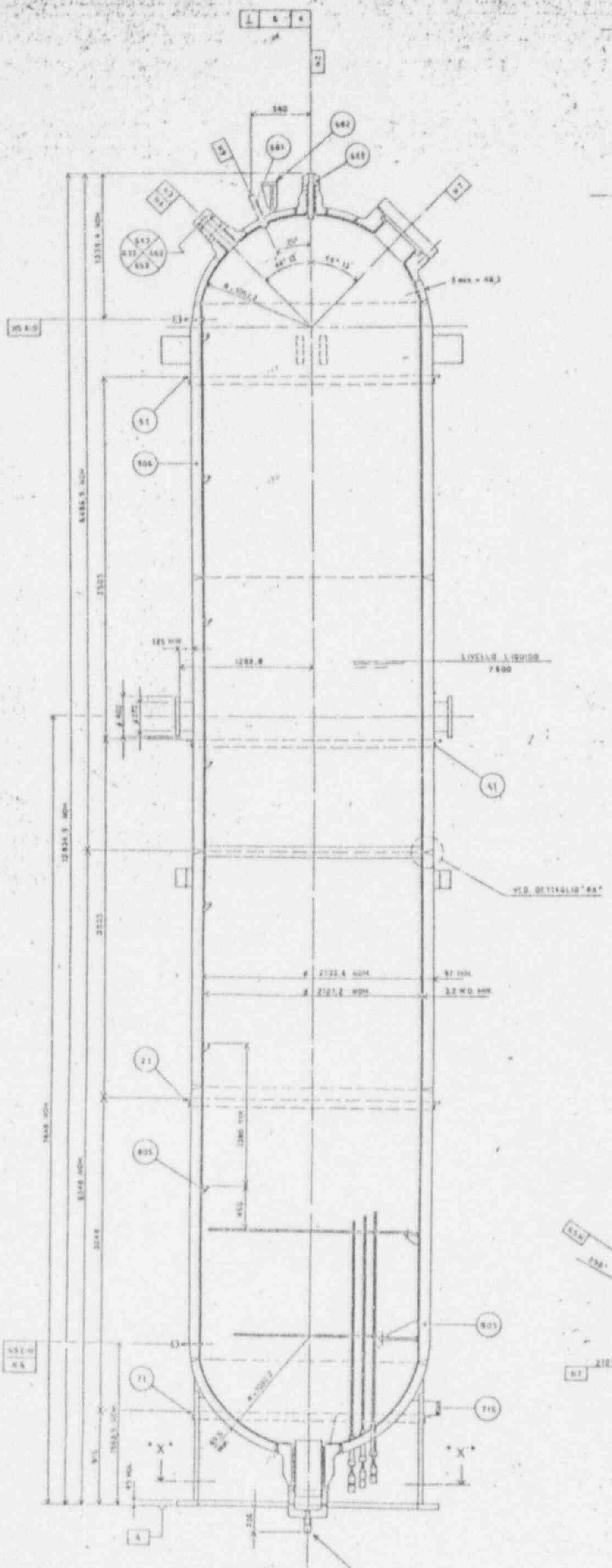
8. *VAPORE Facility Description Report - AP600 Automatic Depressurization System Phase A Test*, Revision 0, WCAP-14149 (Proprietary), August 1994.

APPENDIX A
VAPORE FACILITY DRAWINGS

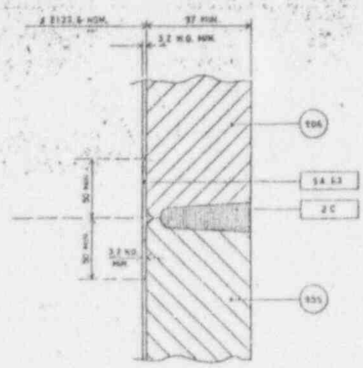
TABLE A-1
PHASE B-1 VAPORE FACILITY DRAWINGS

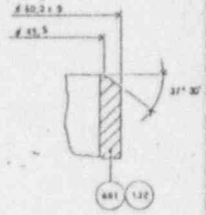
Drawing Ref	Title	Organization/Drawing No.	Revision	Date
A-1	Accumulator – assembly	ANSALDO 7.083.901	6	7 June 1985
A-2	Piping layout, lines 001-12 in.-G-10-C 001-10 in.-G-10-C	FBM 39698 sheet 1	3	29 May 1985
A-3	Test header	FBM 39700	3	1 June 1985
A-4[1]	Composite piping - loop ADS	ANSALDO VAP0001 DMBX2260001	0	20 May 1994
A-5[1]	Isometric main lines-loop ADS	ANSALDO VAP0001 DMLX 22500001	0	20 May 1994
A-6	Assembly of quench tank inlet line	FBM 39763	4	15 May 1986
A-7	Quench tank	ANSALDO VAP0001 DMYX0413	1	27 January 1992
A-8	Quench tank	ANSALDO VAP0001 DMYX0414	0	3 July 1991
A-9	Sparger	Vincent's Welding 074-91-1	0	22 April 1991

Note:
(1) These drawings are not included in the non-proprietary version of this document.

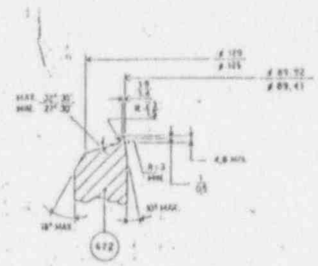


DETTAGLIO "PA"

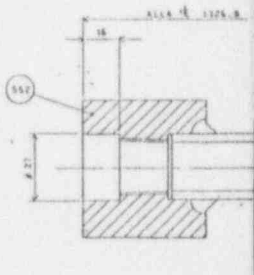




DETTAGLIO ATTACCHI
N1-N8, N9

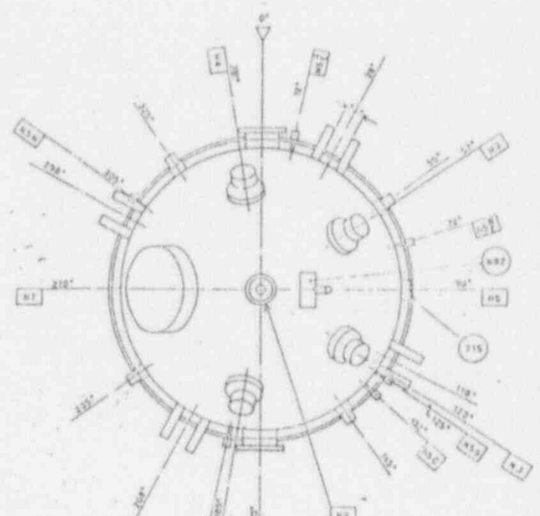


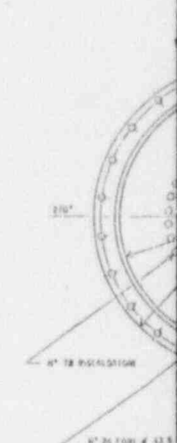
DETTAGLIO ATTACCO
N2



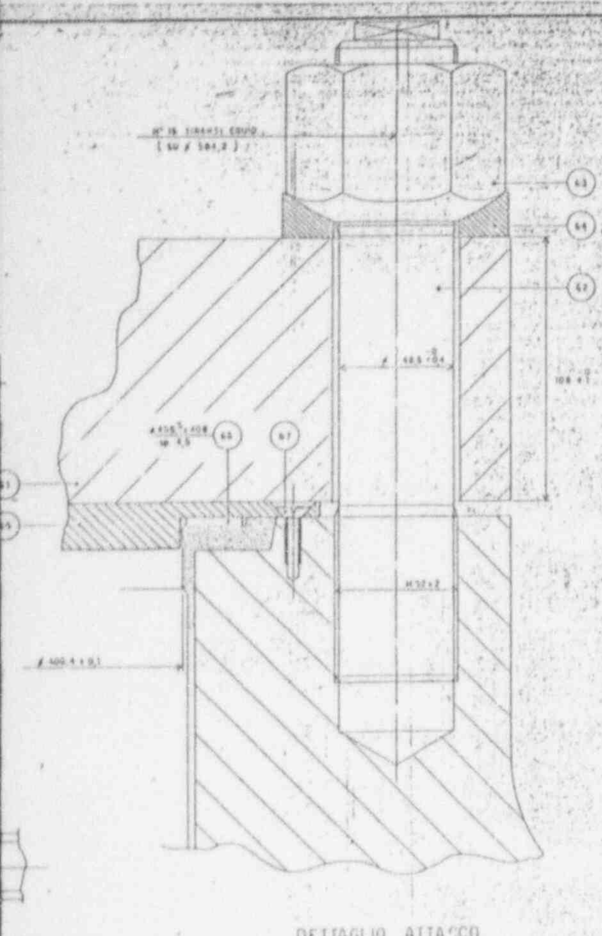
DETTAGLIO ATTAC
N5 A+H - N6

PIANTA DI ORIENTAMENTO

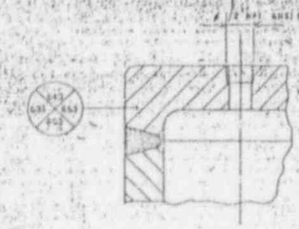




A-1



DETTAGLIO ATTACCO
N7



DETTAGLIO ATTACCHI
N3 - N4

CONDIZIONI DI PROGETTO	
CONDIZIONI LATO	CORPO
PRESSIONE DI PROVA IDRAULICA bar	246,2
PRESSIONE DI BOLLO bar	157
TEMPERATURA DI BOLLO °C	343
COLLAUDO MATERIALI	
SOVRASPESSORE DI CORROSIONE mm	0
TRATTAMENTO TERMICO	[illegible]
RX DEI GIUNTI SALD.	100 %
EFFICIENZA DELLE SALDATURE	
TALLONI DI SALDATURA	S1
FLUIDO	Acqua e Vapore
CAPACITÀ GEOMETRICA m^3	10
POTENZA ELETTR. RISCALD. kW	1,4
PESO A VUOTO Kg	20 430
PESO PIENO D'ACQUA Kg	110 430
CODICE ASME VIII	ISPEZIONE
N° pezzi 1	N° DI FABBRICA 7570

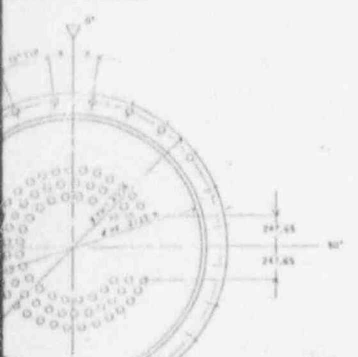
LISTA CONNESSIONI

Pos.	Pezzi	Dn	Pn	Tipo	SERVIZIO
N1	1	2"	SCH.160	B.W.	INGRESSO ACQUA
N2	1	4"		B.W.	BOCCH. STRUMENTAZIONE
N3	1	6"	(SCH 160)	(B.W.)	CONNESSIONE PSRVA
N4	1	6"	(SCH 160)	(B.W.)	CONNESSIONE PSRVA
N5 A-B	8	1"	SCH 160	S.W.	STRUMENTAZIONE
N6	1	1"	SCH 160	S.W.	PRESA CAMPIONE
N7	1	16"		PAD	PASSO D'UOMO
N8	1	2"	SCH 160	B.W.	DRENAGGIO
N9	1	2"	SCH 160	B.W.	VALVOLA SIC.

POS.	DENOMINAZIONE	PEZZI	MATERIALE	PESO	N° DIS.
910	ASSIEME GENERALE	1		—	7.083.901/1
692	STAFFA SUPPORTO VALVOLA DI SIC.	1			7.083.038
715	TARGA DI RICONOSCIMENTO	1			7.083.672
805	MENSOLA	21		20	7.082.028
65	INSERTO	1		24	7.083.087
906	ASSIEME COMPLESSO SUPERIORE	1		32 311	7.083.112
905	ASSIEME COMPLESSO INFERIORE	1		34 083	7.083.102
691	ATTACCO N9		SA 182 Gr F 316		
651/652 663/664	TAPPI ATTACCHI N3 - N4				
672	SAFE END - ATTACCO N7		SA 182 Gr F 316		
552	ATTACCHI N5 A - N, N6		SA 182 Gr F 316		
132	ATTACCHI N1 - N8		SA 182 Gr F 316		
67	VITE UNI 6109 - M6 x 16	3	8G		
66	GUARNIZIONE "SPIRAL WOUND TIPO R"	1	AISI 304-AMIANTO	—	
64	RONDELLA	16	—	10	7.083.028
63	DADO ESAGONALE	16	—	24	7.083.020
62	VITE A TIRANTE	16	—	68	7.083.027
61	COPERCHIO	1	—	280	7.083.025
71	ANELLO PORTA COIBENTE	1	—	62	7.083.161
41 51 21	ANELLO PORTA COIBENTE	3	—	198	7.083.019
ITEM	DESCRIPTION	QTY	MATERIAL	WEIGHT	DRAWING N°
POS.	DENOMINAZIONE	PEZZI	MATERIALE	PESO	N° DIS.

910

SEZIONE "X-X"



REV. 6 DATA 7-4-86
MODIFICATO MATERIALE POS. 552

REV. 5 DATA 6-6-85
MODIFICATO TABELLA DATI PROGETTO

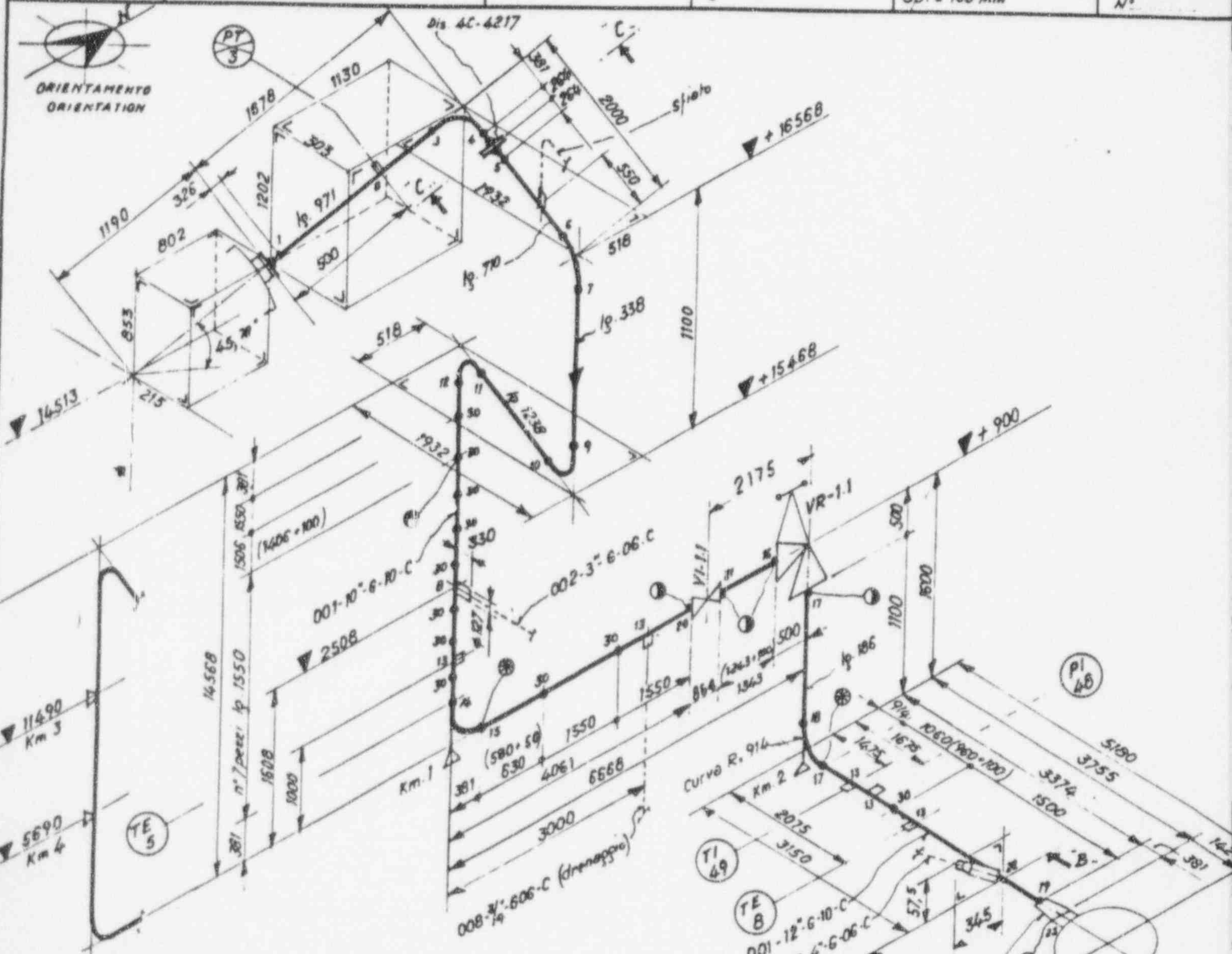
NOTE:

1) TUTTE LE LAVORAZIONI DI MACCHINA DEVONO AVERE GRADO DI FINITURA 250/ RMS.
2) DISTINTA VEDI VED. DIS. N° 7.083.901 FOGLIO N° 2
3) TABELLA PER SALDATURE VEDI DIS. N° 7.083.901 FOGLI N° 21-26
4) MATERIALE TIG: ACCIAIO INOX tp 308

ANSALDO COMPONENTI S.p.A.
RAGGRUPPAMENTO ANSALDO
ENEA
ACCUMULATORE DI PRESSIONE
ASSIEME
7.083.901

9504050139-02

ASSI DI RIFERIMENTO Reference axis	GIUNZIONE MEDIANTE SALDATURA DI TESTA Butt weld joint GIUNZIONE MEDIANTE SALDATURA A TASCA Socket weld joint GIUNZIONE MEDIANTE FILETTATURA Screwed joint GIUNZIONE MEDIANTE FLANGIATURA Flanged joint	SALDATURA IN OFFICINA Workshop welding SALDATURA IN CANTIERE Yard welding LA Lg. MINIMA DI AGGIUSTAGGIO PER SALDATURA IN CANTIERE Minimum fitting length for yard welding	QUOTA ASSE TUBAZIONE Pipe axis level SUPPORTO Support VERSO DEL FLUSSO Flow direction LIMITI DI FORNITURA Supply limits	PROVA IDRAULICA / Hydraulic test: SI ☒ NO ☐ COIBENTAZIONE / Insulation: SI ☒ NO ☐ SP. = 100 mm	ELENCO TUBAZION[I] Pipe list N° __ ELENCO SALDAT[URE] Welding list N° DS. 13/847 ELENCO SUPPOR[TI] Support list N°



NOTE:

- Tutta la tubazione è rivestita internamente per saldatura con AWS-309 spessore 3 mm.
- ⊛ saldatura in opera lasciare 100 mm di tubazione per aggiustaggio.

- FINITURA: Tutte … essere sabbie… con una man… GABBRO ZN 7…

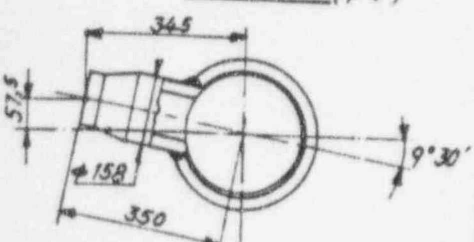
ANSTEC APERTURE CARD

Also Available on Aperture Card

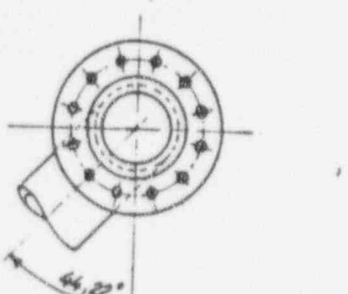
A-2

DESIGN PRESSURE	Barg	
ASSESSMENT TEMPERATURE	°C	
HYDR. PRESS.	Barg	
ERECTION WEIGHT	N	
WEIGHT FULL OF WATER	N	

SEZ. "B-B." (ϕ 4")



SEZ. "C-C."



UNITÀ Unit	QUANTITÀ Quantity	VALVOLE - Valves TIPO - Type	DN O.D.	GUARNIZIONI Gaskets	TIRANTI Stud bolts	DADI Nuts	MATERIALE Material	NORME O NUMERO Standard or drawing	NOTE Remarks
N°	1	VR. 1.1	10"/12"				A 182 - F11		N. PIGNONE
N°	1	VI - 1.1	10"				A 216 - WCB		CMI
N°	12				1 7/8" - 8UN × 370		A 193 - B7		
N°	24					1 7/8" - 8UN	A 194 - 2H		
N°	1			ϕ 286 × 324 sp. 4,5			Amianto/inox	ϕ 10" ANSI 1500 #	

ALTRI PEZZI - SPECIALS

N°	1	Bocchello ϕ 4"		
N°	1	Bocchello ϕ 3"	A 182 - F304	4C - 4169
N°	3	Manicotto - TE 5 ; TE 8 ; T 149	A 182 - F304	4C - 4170
N°	3	Manicotto - PT 3 ; PI 48 ; Drenaggio	A 182 - F304	4C - 4215 pos. 1-4-9
			A 182 - F304	4C - 4158 pos. 1-8

UNITÀ Unit	QUANTITÀ Quantity	TUBI Pipes	CURVE Elbows 45°	CURVE Elbows 90°	RIDUZIONI Reducers	PEZZI A T Tee	FLANGE Flanges DN	MANICOTTI Coupling DN			
Ml	2,7	ϕ 323,9 × 33,32							A 106 - B	Sch. 160	ϕ 12"
Ml	27,3	ϕ 273 × 28,58							A 106 - B	Sch. 160	ϕ 10"
N°	5			ϕ 10"					A 234 WPB	" "	L.P.
N°	1			ϕ 12"					A 234 WPB	" "	R. 914
N°	1				ϕ 12" × 10"				A 234 WPB	Sch. 160	R.C.
N°	1		Dis.	4C - 4217			10"		A 182 - F1	ANSI 1500	WN
N°	1		Dis.	4C - 4218			10"		A 182 - F1	SPECIAL	WN - RF
N°	1		Dis.	4C - 4216			16"/10"		A 182 - F1	SPECIAL	WN - RF
N°	1	Manicotto ϕ 1" lg. totale 150 mm. ANSI 6000 #							A 182 - F304	dis. 50109 pos. 6	

Supporti : Km 1 ÷ Km 4 - Dis. 4C-4243 fg. 1÷3

E.N.E.A. Casaccia

DIPARTIMENTO REATTORI TERMICI

IMPIANTO V.A.P.O.R.E

- CONTRATTO: N 36541 - Serie 3 - Registrato il 19-10-84 -

LINEA N°

001 - 12" - G - 10 - C

001 - 10" - G - 10 - C -

SCHEMA STRUMENTALE P & I D

N°. 39654 - TS

DISEGNI DI INSIEME Assembly drawings

N° 39658 - D1

Dis. F. Valentini Data 10-1-85

SPECIFICHE Specifications

Visto ___ Data ___

... le superfici esterne in C.S. dovranno ...te al grado SA 2½ e verniciate ... di zincante inorganico tipo ... spessore 75 μ -

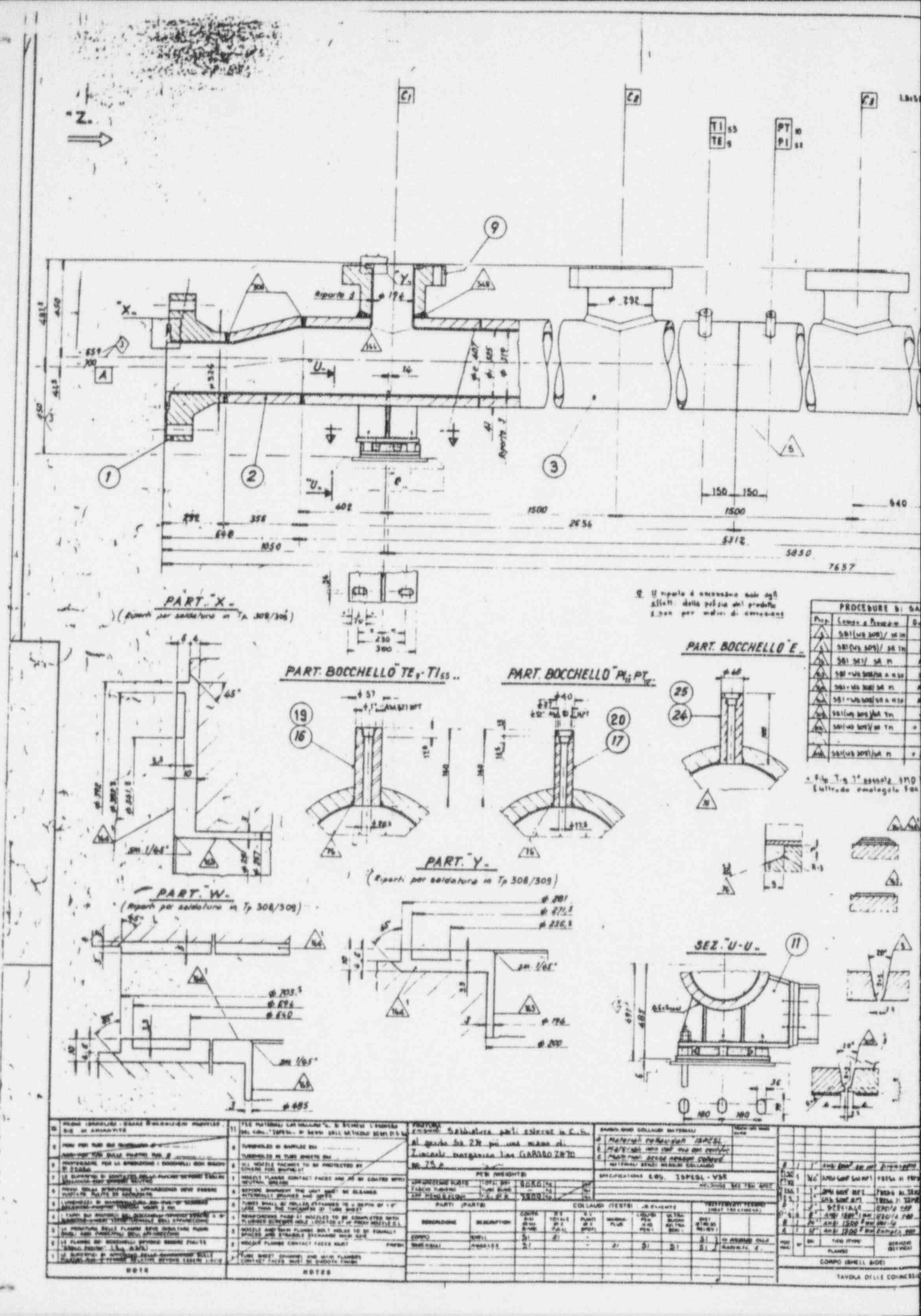
3	29-5-85	Aggiunto manicotto sfiato	
2	7-5-85	AGGIORNATO	
1	15-3-85	Revisionato	

FBM MILANO

Co. 8479

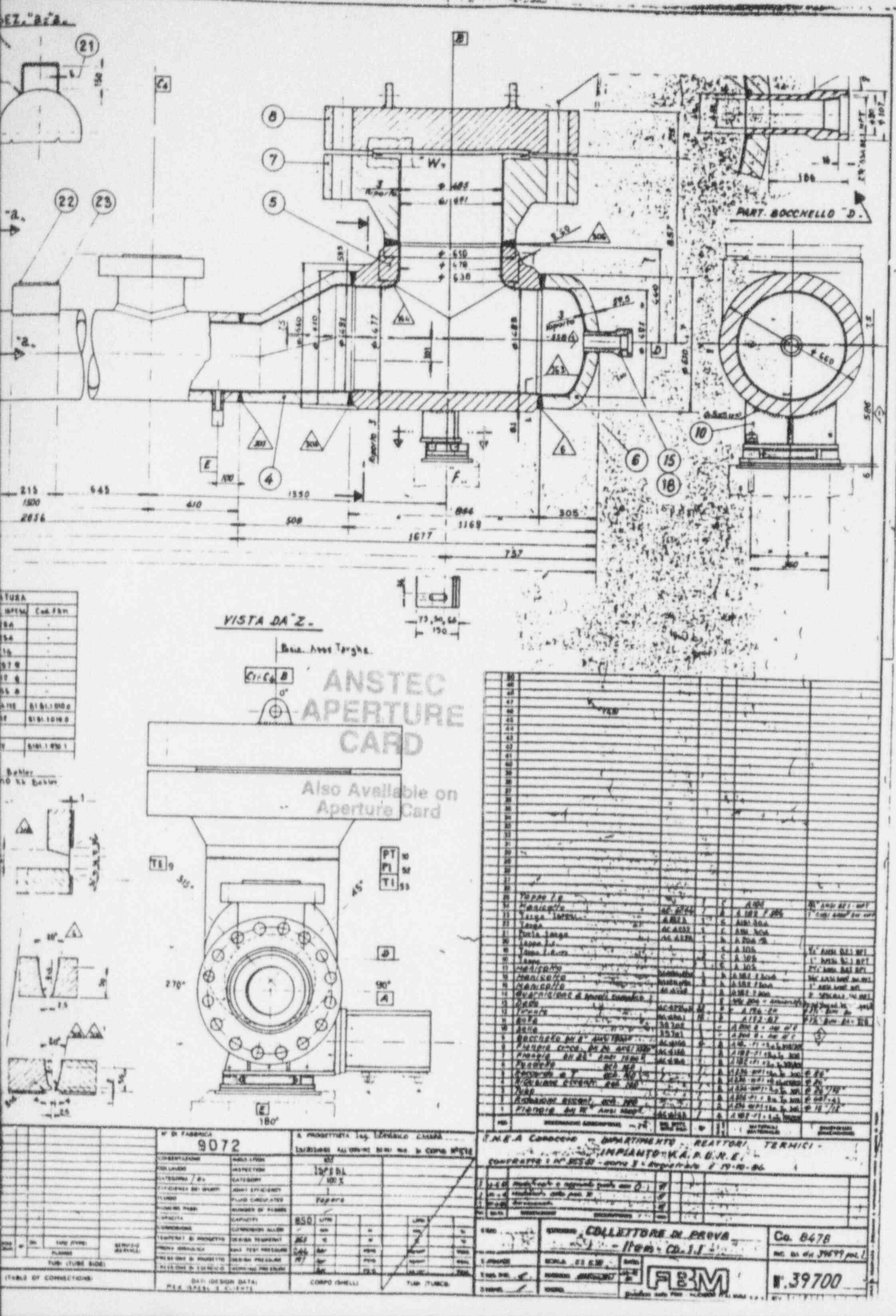
N° 39698

9504050139-03



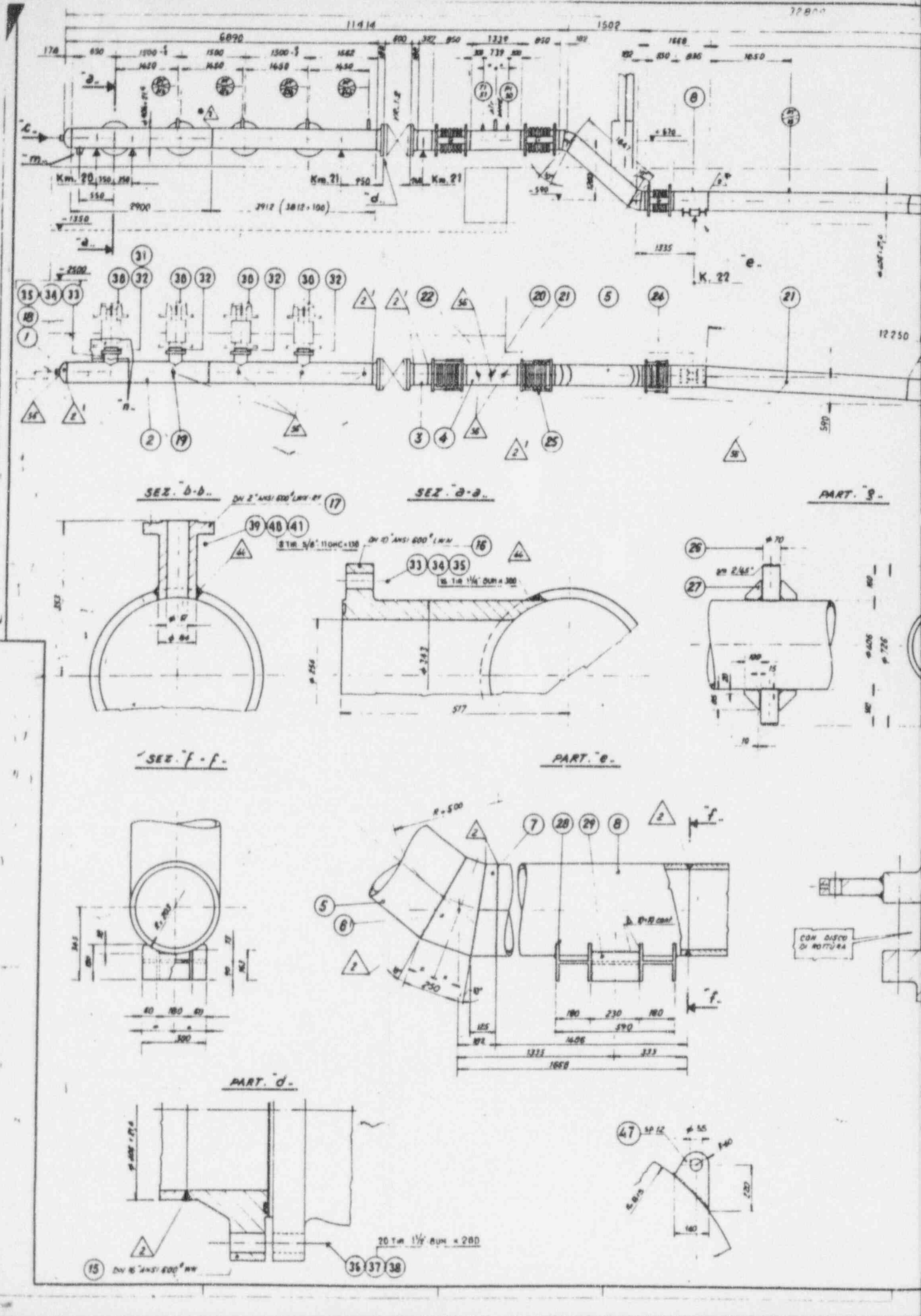
"Z"
C1
C2
C3
TI 55
TE 9
PT 10
PI 12
PART. "X"
(Riporti per saldatura in Tp 308/309)
PART. BOCCHELLO "TE9 - TI55"
PART. BOCCHELLO "PI12 PT10"
PART. BOCCHELLO "E"
PART. "Y"
(Riporti per saldatura in Tp 308/309)
PART. "W"
(Riporti per saldatura in Tp 308/309)
SEZ. "U-U"
PROCEDURE DI SA
1500
2656
5312
5850
7657
1050
SPECIFICATIONS ENG. ISPESL - VSR
PESI (WEIGHTS)
NOTE
NOTES
CORPO (SHELL SIDE)

A-3

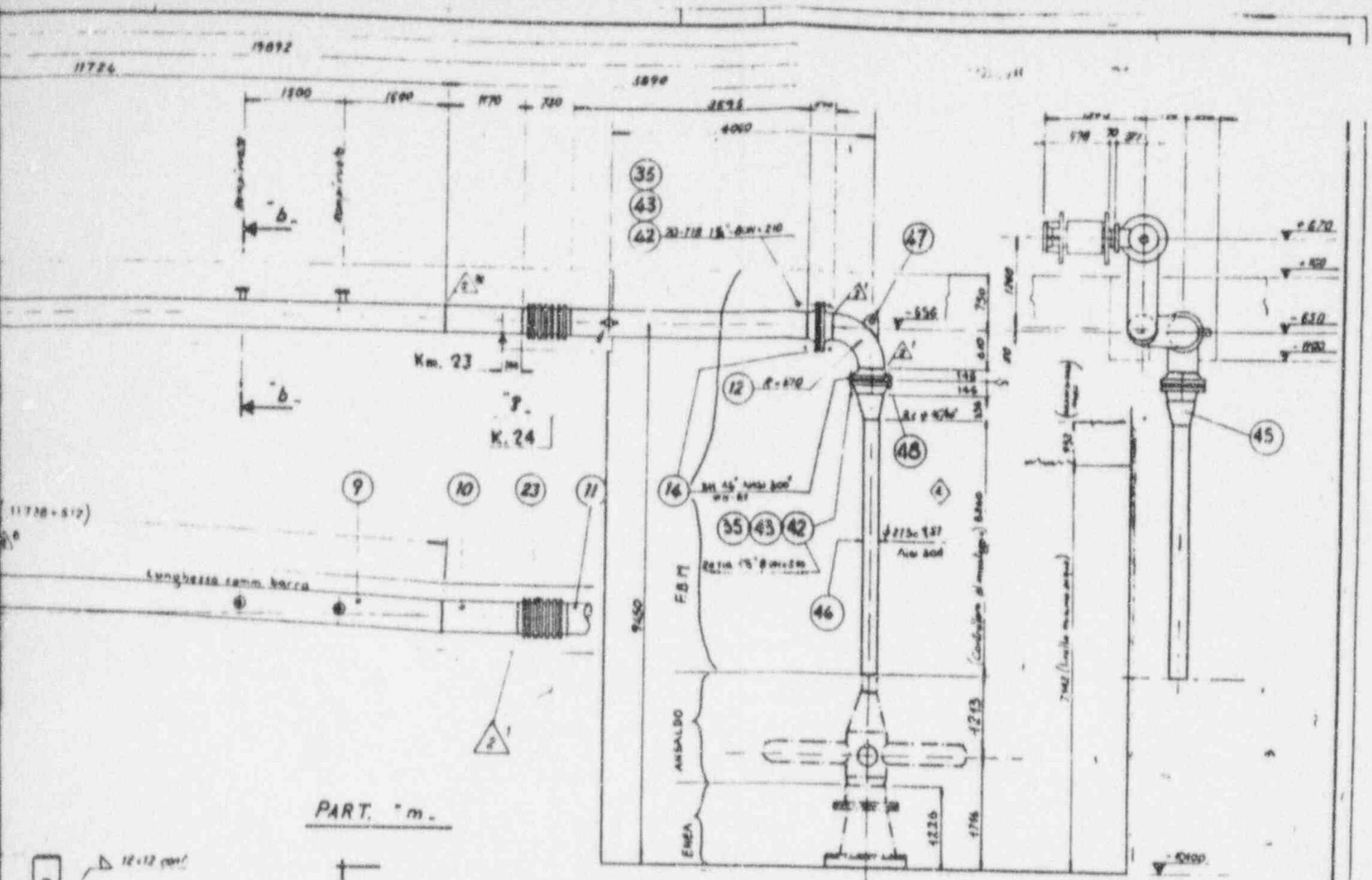


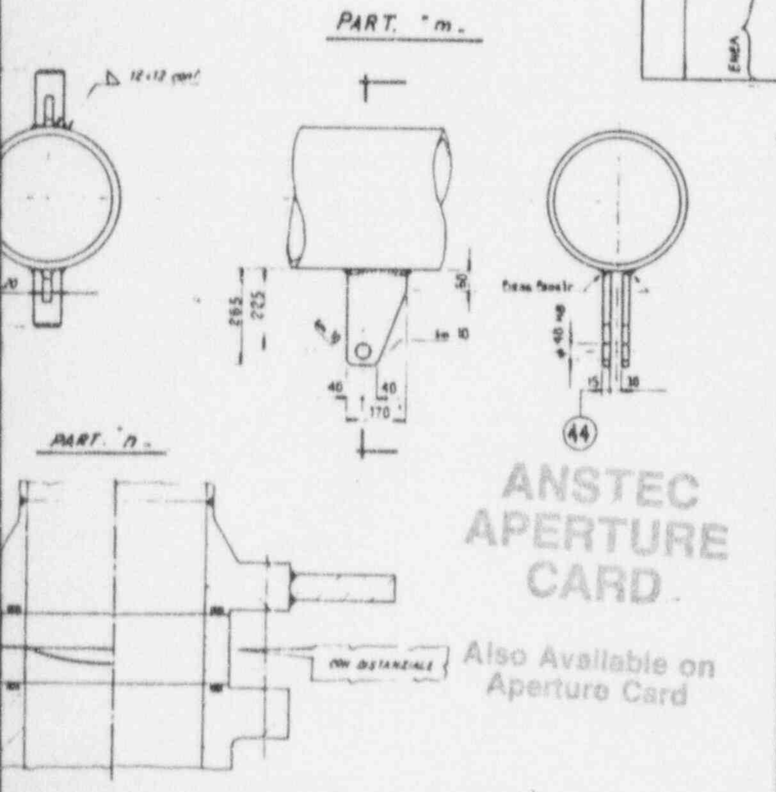
9504050139-04

Drawings A-4 and A-5 are not included in the non-proprietary version of this document.



11414
1502
6890
SEZ. "b-b"
DN 2" ANSI 600# LWN-RF
SEZ. "a-a"
DN 10" ANSI 600# LWN
PART. "g"
SEZ. "f-f"
PART. "e"
R=500
CON DISCO DI ROTTURA
PART. "d"
20 TIR. 1 1/8" BUM = 280
DN 16" ANSI 600# WN





NOTE

- 2 SALDATURE DA FARSI IN CANTIERE
- TUTTE LE SUPERFICI IN ACCIAIO AL CARBONIO DOVRANNO ESSERE SABBIATE E VERNICIATE CON UNA MANO DI GABBRO ZN 70.
- CONTROLLO SALDATURE:
  GIUNTI DI TESTA 100 %
  BOCCHELLI MT
- K e Km = SUPPORTI

POS.	DESCRIZIONE	DIS.	N°	MATERIALE	DIMENSIONI
48	FLANGIA DN 16" ANSI 300#	1556/67	1	A105	WN-RF (B-381)
47	ORECCHIA		1	ACC. carb.	sp. 15
46	TUBO		1	AISI 304	φ 273×9,27 lg 4200
45	RIDUZIONE CONC.		1	A 234-WPB	φ 16"/10" sch 40
44	ORECCHIA		2	ACC. carb.	sp. 15
43	TIRANTE		40	A 193-B7	1⅛" - 8UN - 2A - 210
42	GUARNIZIONE SPIROTALLICA		2	AISI 304 + Amianto	DN 16" - 300#
41	DADO ES		32	A 194-2H	5/8" - 11UNC 2B
40	TIRANTE		16	A 193-B7	5/8" - 11UNC - 2A × 120
39	GUARNIZIONE SPIROTALLICA		2	AISI 304 + Amianto	DN 2" - 600#
38	DADO ES		80	A 194-2H	1⅛" - 8UN - 2B
37	TIRANTE		40	A 193-B7	1⅛" - 8UN - 2A × 200
36	GUARNIZIONE SPIROTALLICA		2	AISI 304 + Amianto	DN 10" - 600#
35	DADO ES		200	A 194-2H	1⅛" - 8UN - 2B
34	TIRANTE		64	A 193-B7	1⅛" - 8UN - 2A × 380
33	GUARNIZIONE SPIROTALLICA		8	AISI 304 + Amianto	DN 10" - 600#
32	DISTANZIALE	4C-6309	4	A 105	
31	DISCO DI ROTTURA	4C-6140	1	A 105	
30	DILATATORE	31707	4		
29	PROFILATO		1	ACC. car.	HE 100 B lg 290
28	PROFILATO		2	ACC. car.	HE 180 B lg 300
27	SQUADRETTO		4	ACC. car.	sp. 20
26	PERNO		2	Aq 70	φ 70 lg 180
25	COMPENSATORE (UNIFLEX)		2		Tipo HW - 600
24	COMPENSATORE (")		1		Tipo HW - 600
23	COMPENSATORE (")		1		Tipo AFW - 8 600
22	MEZZO MANICOTTO (TI)	30817 p. 6	1	A 105	φ 1" - 6000#
21	MEZZO MANICOTTO (PI - PT)	30821 p. 5	2	A 105	φ 3/4" - 6000#
20	MANICOTTO (Air blond)	30121 p. 6	1	A 105	φ 1" - 6000#
19	MANICOTTO - PT 61/62/63/64	4C-6150 p.	4	A 105	φ 3/4" - 6000#
18	MEZZO MANICOTTO SW-ASA B16.11	30121 p. 9	1	A 105	DN 2" serie 3000#
17	BOCCHELLO DN 2" ANSI 600#	4C-6285	2	A 105	LWN - RF
16	BOCCHELLO DN 10" ANSI 600#	4C-6284	4	A 105	LWN
15	FLANGIA DN 16" ANSI 300#	4C-6286	2	A 105	
14	FLANGIA DN 16" ANSI 300#	1556/67	3	A 105	WN - RF (B-364)
13					
12	CURVA A 90° L.R.		1	A 234-WPB	φ 16" sch 80
11	TUBO φ 16" sch 80		1	A 106-B	lg 5790
10	"		1	"	lg 830
9	"		1	"	lg 8758
8	TUBO φ 16" sch 80		1	"	lg 636
7	SETTORE DA TUBO φ 16" sch 80		2	"	
6	SETTORE DA TUBO φ 16" sch 80		2	"	
5	TUBO φ 16" sch 80		1	"	lg 8967
4	" "		1	"	lg 1337
3	" "		1	"	lg 312
2	TUBO φ 16" sch 80		1	A 106 B	
1	FONDELLO φ 16" sch 80		1	A 234-WPB	

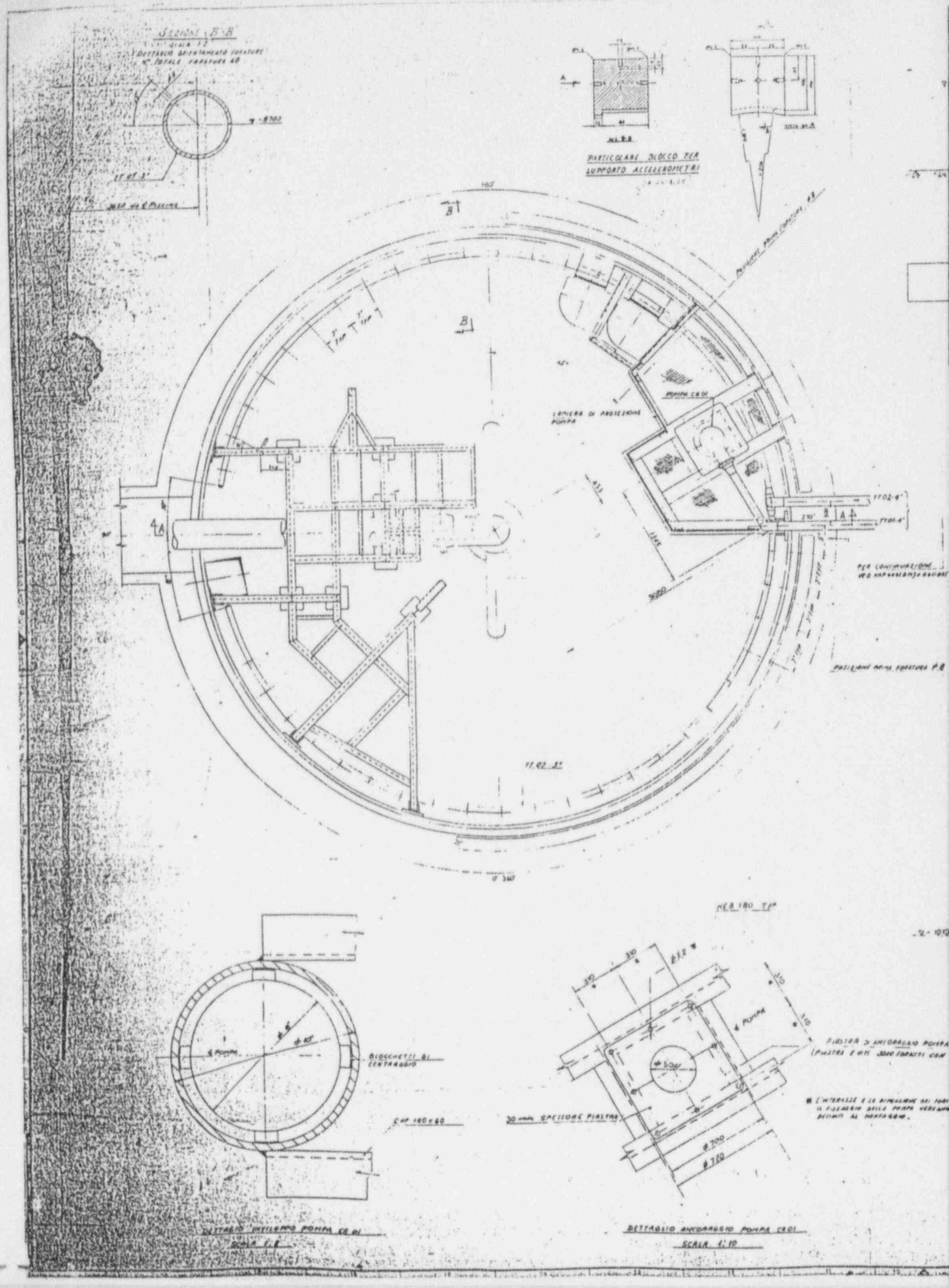
POS.	SPEC. DI SALDATURA	COD. F.B.M.	
2	344/NSR-TM	A4A4.0.020.1	● ▲
44	344/NSR-TM	A4A4.0.060.4	● ▲
36	3A4/NSR-M	A4A4.0.030.2	●
2'	3A4/NSR-TMA	—	A 107

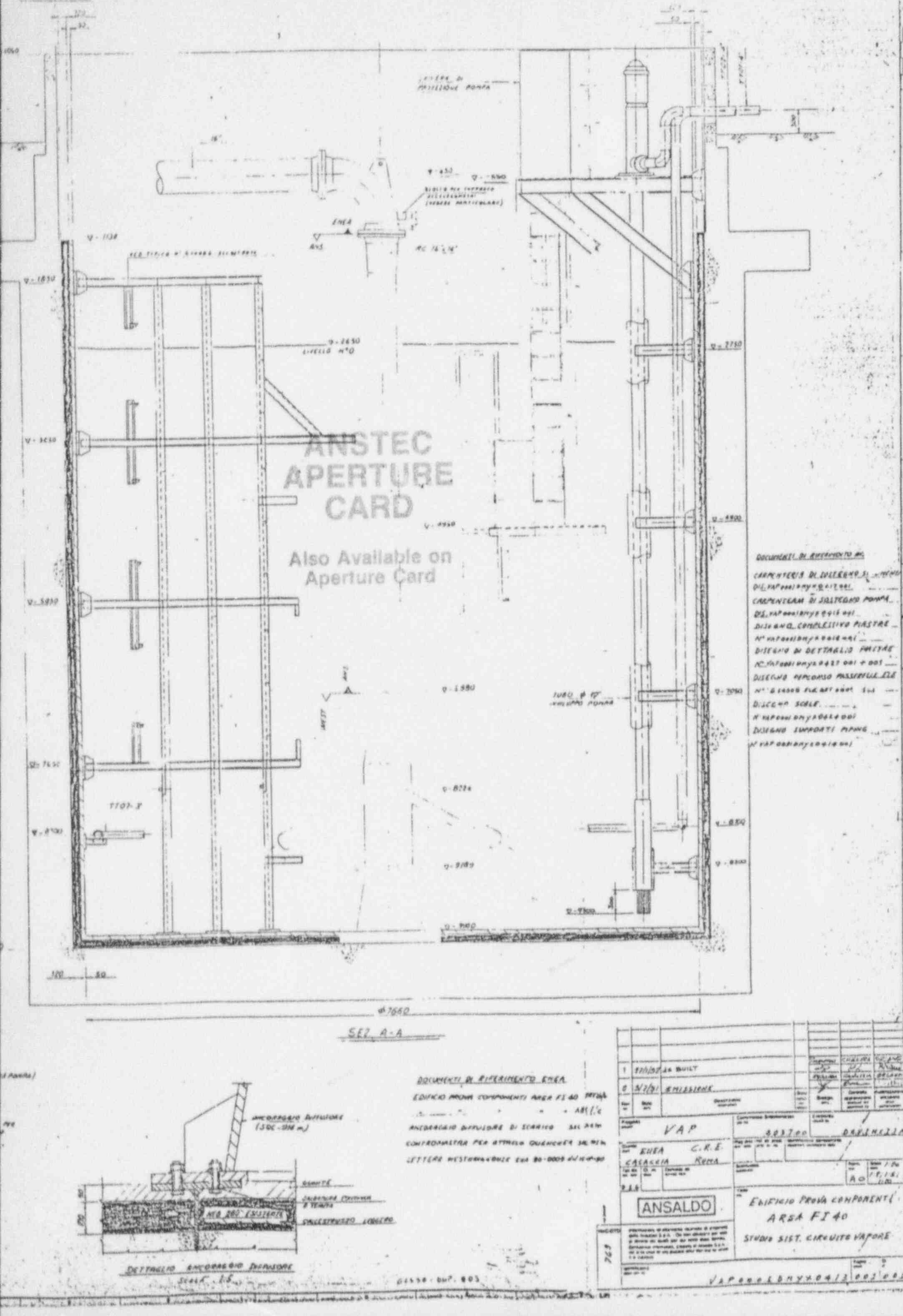
▲ . FILO TIG EML 5 10 Bohler.

● . ELETTRODO OMOLOGATO FOX EV 50 Bohler.

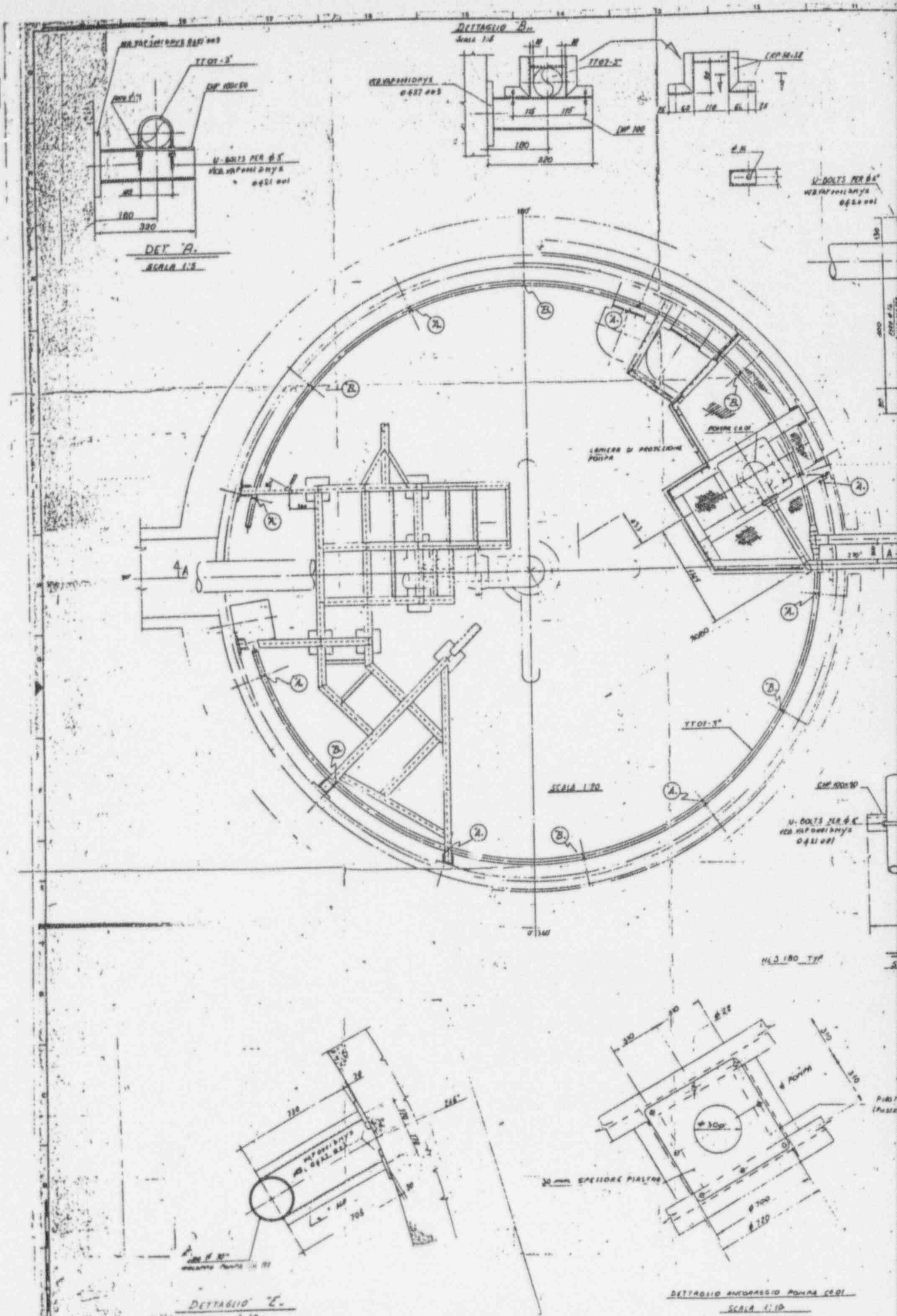
CERTEZZA DI QUALITÀ A. Q.	COMPLESSIVO "GRUPPO COLLETTORE DI SCARICO."							
Data	3	Eseguito note fabr. in arrivo						RIC. DA
Firma	2	Aggiornato enti-federal						
	0	Data indicata con						
APPROVATO DA	N.	DESCRIZIONE	VISTO	DATA				Co. 6480
Data	SCALA 1:10 1:5 1:50							
Firma	DISEGNATO	VISTO		FBM S.p.A. MILANO				N. 39763

9504050139-05


SEZIONE B-B
PARTICOLARE BLOCCO PER SUPPORTO ACCELEROMETRI
LAMIERA DI PROTEZIONE POMPA
PER CONTINUAZIONE
POSIZIONI PRIME FORATURE
HEB 180 TIP
FLANGIA DI ANCORAGGIO POMPA
BLOCCHETTI DI CENTRAGGIO
30 mm SPESSORE PIASTRA
DETTAGLIO INVILUPPO POMPA
SCALA 1:5
DETTAGLIO ANCORAGGIO POMPA
SCALA 1:10

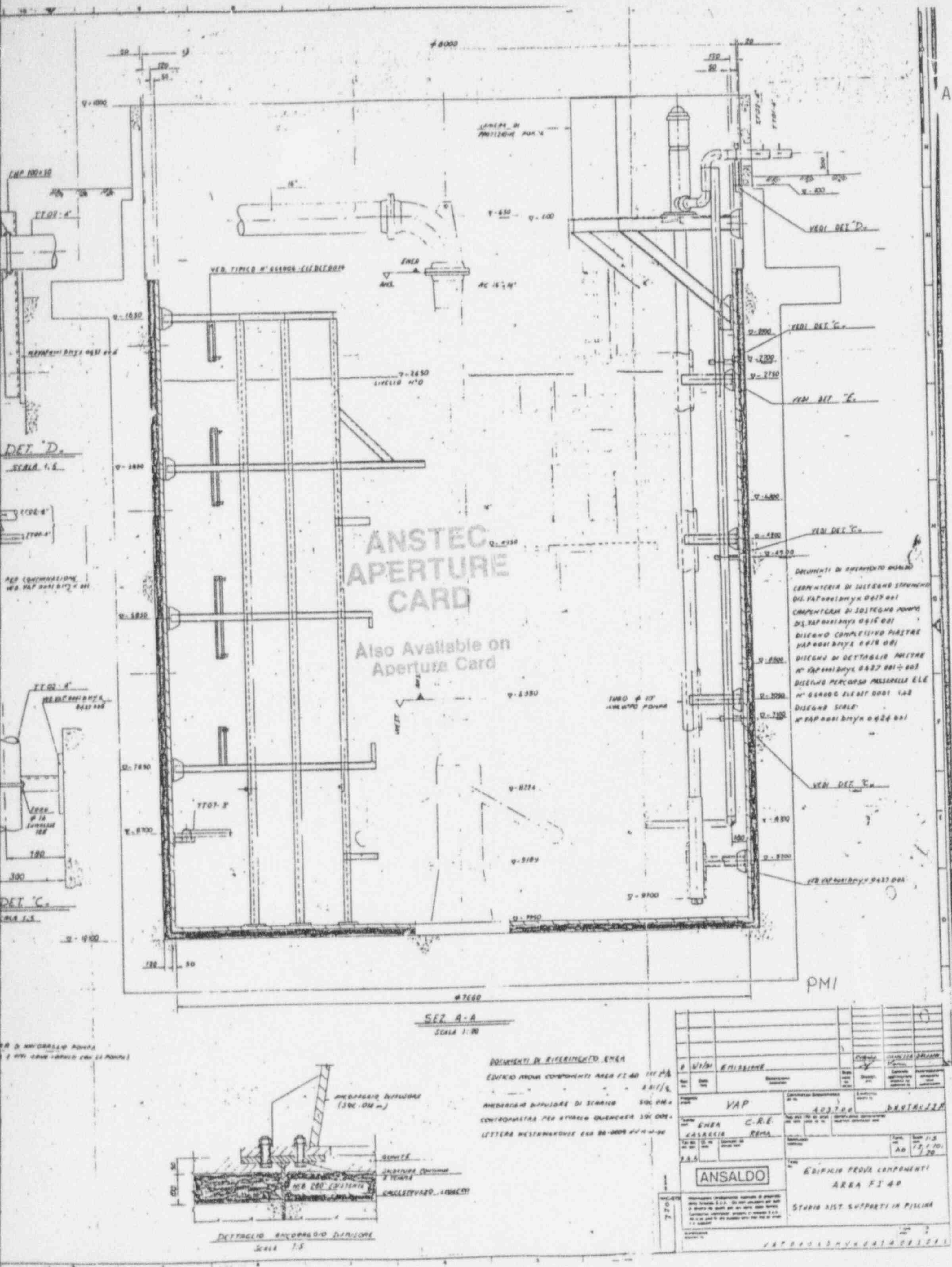


9504050139-06



DET. "A."
SCALA 1:5
DETTAGLIO "B."
U-BOLTS PER Ø 5"
SCALA 1:20
30 mm SPESSORE PIASTRA
DETTAGLIO "C."
SCALA 1:10
DETTAGLIO ANCORAGGIO POMPA C0.01
SCALA 1:10

A-8



9504050139-07

Drawing A-9 is not included in the non-proprietary version of this document.