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The safety related design information contained in this document has been reviewed and satisfies (where applicable) the items contained on checklist(s) ___, ___, and ___ of the Quality Assurance of Design Manual. This review is so certified.

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MECHANICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION REPORT

V-PAK-481

FOR

HIGH PRESSURE SAFETY INJECTION PUMPS

FOR

ARIZONA NUCLEAR POWER PROJECT
PALO VERDES UNITS 1, 2 AND 3

PREPARED BY R. E. Haller DATE 1/9/84
R. E. HALLER, COGNIZANT ENGINEER

APPROVED BY T. E. Fitzsimmons DATE 1/12/84
T. E. FITZSIMMONS, QUAL. SUPERVISOR

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COMBUSTION ENGINEERING, INC.
WINDSOR, CT

Issued 1-12-84

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1.0 SCOPE

This document provides the environmental qualification for the High Pressure Safety Injection pumps installed at the Arizona Nuclear Power Project, Palo Verde Units 1, 2 and 3.

2.0 ASSIGNMENT OF RESPONSIBILITY

Combustion Engineering shall be responsible for conducting this investigation into the environmental qualification of the equipment covered by this report. The methodology utilized will be in accordance with the guidance of References 3.1, 3.2, 3.3, and 3.4.

3.0 APPLICABLE REFERENCES

The following references apply to this investigation:

3.1 IEEE 627-1980, Design Qualification of Safety Systems Equipment Used in Nuclear Power Generating Stations

3.2 IEEE 323-1974, Qualifying Class 1E Equipment for Nuclear Generating Stations.

3.3 C-E Quality Assurance of Design Manual.

3.4 V-PAK-467, Procedure for the Environmental Qualification of Mechanical Equipment for ANPP Palo Verde Units 1, 2 and 3.

3.5 C-E letter V-PSD-1006 dated June 18, 1982, ANPP, TVA, WPPSS, NUREG 0588 Qualification Parameters for Safeguard Systems.

3.6 Ingersoll-Rand letter dated December 6, 1983, Safeguard Pumps, Non-Metallic Materials Mechanical Equipment Environmental Qualification.

3.7 Ingersoll-Rand Instruction Manual for Centrifugal Pumps, 4 x 11 CA-8 High Pressure Safety Injection Pumps.

3.8 C-E System 80 CESSAR FSAR.

3.9 Bechtel letter B/CE-E-43422 dated January 21, 1983, Environmental Qualification Parameters.

3.10 C-E Specification SYS80-PE-410, Rev. 03, Specification for Standard Plant for Safeguard Pumps for System 80 Standard Design.

3.11 C-E Specification 14273-PE-410, Rev. 02, Project Specification for Safeguard Pumps for ANPP Units 1, 2, 3, 4 and 5.

3.12 Wyle Report 26364 dated December 31, 1981, Nuclear Environmental Evaluation Report of Valve Packing and Gaskets used in Anchor Darling and Dresser Valves for Bechtel Power Corporation ANPP PVNGS Units 1, 2 and 3.

3.13 Wyle Report 26365 dated December 16, 1981, Aging Analysis of Non-Metallic Components in Ingersoll-Rand Centrifugal Pumps for Bechtel Power Corporation for use in PVNGS Units 1, 2 and 3.

3.14 Ingersoll-Rand letter dated December 9, 1983, 4 x 11CA-8 Stage HPSI Pump.

3.15 C-E Program 14273-PE-5734, Rev. 01, Environmental Qualification Program for Safety Related Electric Solenoid Operated Pneumatic Pilot Valves on Nuclear Service Valves for ANPP Units 1, 2 and 3.

3.16 Dura Seal Manual, Guide to Modern Mechanical Sealing, 6th Edition.

3.17 Research Report 1209-A dated October 20, 1976, The Testing of Dura Seals in 2.5% Borated Water for Nuclear Power Plant Services.

3.18 "Selecting Elastomeric Seals for Nuclear Service" by R. Barbarin in Power Engineering dated December 1977.

3.19 V-PAK-483 dated December 16, 1983, Lubrication of HPSI Pump - MEQ.

3.20 TDM-83-290 dated December 16, 1983, Shell Turbo 68 Oil Lubrication of the Ingersoll-Rand HPSI Pump.

4.0 QUALIFICATION

4.1 Equipment Description

The High Pressure Safety Injection (HPSI) pump is an eight stage centrifugal pump manufactured by Ingersoll-Rand Company.

The basic parts of the pump are the rotating assembly and the casing that encloses it. Liquid enters in the center of the first stage impeller and, as the impeller rotates the liquid moves through the impeller vanes to the rim. A centrifugal force is thus imparted on the liquid and that force is converted to an increase in pressure. Each succeeding stage incrementally increases the pressure. The HPSI pumps have a double suction to the first stage and an internal single suction for the remaining seven stages.

The primary function of the HPSI pump per Reference 3.8 is to inject borated water into the Reactor Coolant System (RCS) if a break occurs in the RCS boundary. For small breaks, the RCS pressure remains high for a long period of time following the accident, and the HPSI pumps ensure that the injected flow is sufficient to mitigate a Loss-Of-Coolant-Accident (LOCA). The HPSI pumps are also used during the recirculation mode after a LOCA to maintain a borated water cover over the core for extended periods of time. For long term core cooling, the HPSI pumps are manually realigned for simultaneous hot and cold leg injection to insure flushing and ultimate subcooling of the core independent of break location. For small breaks, the HPSI pumps continue injecting into the RCS to provide makeup for spillage out the break while a normal cooldown is implemented.

During normal operation the high pressure safety injection pumps are isolated from the RCS by motor operated valves. During safety injection the HPSI pumps deliver water from the water storage tank to the RCS via the cold leg safety injection nozzles whenever RCS pressure falls below reactor coolant pump shutoff head. During the recirculation mode of operation, the pumps take suction from the containment sump.

Per Reference 3.5 HPSI pumps are normally on standby, ready to operate, and provide shutdown cooling at flow rates up to runout (4400 gpm) for one year. After one month of accident conditions normal fluid temperature will prevail.

4.2 System Operability Requirements

External Environment (Reference 3.9)

	Normal	Accident
Radiation	3.5×10^4 Rads	9.65×10^5 Rads
Temperature	104°F	104°F

Fluid Environment (References 3.8, 3.9, 3.11)

Radiation	----------	1×10^7 Rads
Temperature	120°F	300°F

4.3 Component Function and Failure Consequences

Per Reference 3.5, the HPSI pump must be capable of operating up to 9636 hours post accident at runout flow conditions in addition to operating 62 hours per year for testing plus 100 hours for preoperational testing.

Due to the redundancy designed into the system the safety functions can be accomplished with the failure of one HPSI pump during the injection mode or the recirculation mode of system operation.

4.4 Non-metallic Components

The non-metallic materials listed on Reference 3.6 are given below:

Part Number	Name	Non-Metallic Material
363B	Flexitallic Gasket	Asbestos
363C	Flexitallic Gasket	Asbestos
363H	Flexitallic Gasket	Asbestos
363E	Flexitallic Gasket	Asbestos
363D	Flexitallic Gasket	Asbestos
284	Gasket	Hydroil

429	Durametallic Seal	Carbon, EPT
	Bearing Lubricant	SAE 10 Motor Oil
	Trico Oiler	Glass Bottle, rubber gasket

4.5 Function and Failure Consequence of Non-Metallic Parts

Flexitallic gaskets are used between the discharge head and the barrel and between stages to retain pump discharge pressure. Flexitallic gasket failure will allow leakage between stages. A significant leakage between stages would reduce flow and head and could impact the performance of the safety function. The failure of Flexitallic gasket Part No. 363B would allow discharge of fluid to the atmosphere.

Hydroil gaskets are used as outboard cover gaskets for the bearing housing on each end of the pump shaft. A hydroil gasket failure will allow bearing oil to leak from the bearing housing. Since the pump must operate for one year after an accident loss of oil to the bearing through failure of the hydroil gasket cannot be tolerated.

Durametallic seals on both ends of the pump prevent the pump from leaking the borated water past the pump shaft into the atmosphere. Maximum allowable leakage is 50 cc/hr. per seal. Excessive leakage will increase the NPSH (required) and could cause cavition that could impact the performance of the safety function.

Bearing lubricating oil loss will lead to bearing failure which will cause the pump to be inoperative.

The Trico oiler provides a reservoir for oil and provides an indication of oil level. The rubber gasket provides sealing between the glass reservoir and the metallic base. Per Reference 3.6, the required oil level is below the glass reservoir, loss of the glass reservoir and rubber gasket does not affect required operability and can be excluded from the qualified life analysis.

4.6 Qualified Life

4.6.1 Flexitallic Gaskets

Flexitallic gaskets per Reference 3.12 do not exhibit any thermal or radiation aging effects due to the inherent stability of the metallic/mineral composition in comparison to the worst case environment.

Asbestos has historically been known for its resistance to heat effects and data indicates that there is no net change to asbestos to a radiation threshold of 3.96×10^{15} Rads.

4.6.2 Hydroil (Cellulose) Gaskets

4.6.2.1 Time/Temperature Effects

Qualified life based on Arrhenius methodology is a linear plot on semi-log coordinates and can be represented analytically as:

$$\log (\text{life}) = A + \frac{B}{T}$$

Where the temperature is expressed in °K and the constants A and B are determined from aging data.

From aging data given in Reference 3.13, i.e.,

life = 204 years at T = 104°F
life = 1 year at T = 212°F

$$\log (\text{life}) = \frac{4494.116874}{T(°K)} - 8.1060666$$

Reference 3.13 indicates that bearing temperature during required accident conditions will not exceed 180°F. Since the cover gasket is in contact with the bearing oil reservoir it is assumed that it will be at the same temperature. Additionally, for conservatism, the temperature will be assumed to be 180°F. The qualified life is therefore:

$$\text{life}_{180°F} = 35{,}121 \text{ hrs.}$$

During normal operation and for time periods after the initial 30 day accident function, fluid temperature is defined as 120°F. it will be assumed for conservatism that this temperature will be the temperature of the gasket. The qualified life for this condition is:

$$\text{life}_{120°F} = 717{,}113 \text{ hrs.}$$

Based on operation parameters given in Reference 3.5 and applying a 10% time margin to accident functions:

	Required life (hrs)	Qualified life (hrs)
Accident function at 180°F	792	35,121
Accident function and normal operation at 120°F	11,424	717,113
Time while pump not operating at 104°F	347,820	1,787,040

To determine the impact of the varied operational parameters on qualified life, it can be assumed that the available life at a less severe operating condition is reduced by the percentage of life used at the higher operating condition, i.e.,

$QL2 - (\Sigma RL1/QL1) \times QL2 = AL2$

Where: QL2 = qualified life at temperature 2
RL1 = required life at temperature 1
QL1 = qualified life at temperature 1
AL2 = available life at temperature 2

This available life becomes the new qualified life to be applied to the next less severe condition.

$\text{available life}_{120°F} = 700{,}941$ hrs.

$\text{available life}_{104°F} = 1{,}717{,}615$ hrs.

Since the calculated available life, 1,717,615 hrs, is greater than the required life, 347,820 hrs, the hydroil gaskets are qualified for 40 years.

4.6.2.2 Radiation Effects

Per Reference 3.13, hydroil gaskets have a radiation threshold of 1×10^5 rads but can be utilized for doses of 1×10^6 rads and still maintain over 70% of their flexural and tensile strengths. At 1×10^7 rads original flexural and tensile strengths have degraded over 90%.

Since the gaskets are not in contact with the fluid the radiation dose that they will see will be the environmental normal and accident doses over a 40 year life. (1×10^6 rads). The gaskets can be considered qualified for 40 years.

4.6.3 Duranetallic Seals

4.6.3.1 Time/Temperature Effects

4.6.3.1.1 EPT (ethylene propylene terpolymer) O-rings

The qualified life can be determine from the results of thermal aging based on Arrhenius methodology. The qualified life can be determined using the Arrhenius equation.

$$t_2 = t_1 \exp\left[\frac{\phi}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)\right]$$

Where: t_2 = qualified life (hrs)
t_1 = aging life (hrs)
$\emptyset$ = activation energy (ev)
k = Boltzmans constant = 8.617×10^{-5} ev/°k
T_1 = aging temperature (°k)
T_2 = service temperature (°k)

From aging data given in Reference 3.15 and service conditions given in Section 4.2.

$life_{300°F}$ = 2390 hrs

$life_{120°F}$ = 7,363,347 hrs.

$life_{104°F}$ = 19,279,860 hrs.

Based on operation parameters given in Reference 3.5 and applying a 10% time margin to accident functions:

	Required life (hrs)	Qualified life (hrs)
Accident function at 300°F	792	2,390
Accident function and normal operation at 120°F	11,424	7,363,347
Time while pump not operating at 104°F	347,820	19,279,860

To determine the impact of varied operational parameters on qualified life, the available life can be determined as shown in section 4.6.2.1.

available $life_{120°F}$ = 4,923,275 hrs.

available $life_{104°F}$ = 12,846,148 hrs

Since the calculated available life, 12,846,148 hrs, is greater than the required life 347,820 hrs., the EPT O-rings are qualified for 40 years.

4.6.3.1.2 No. 5 Carbon Wear Ring

Per Reference 3.16, No. 5 carbon wear ring is a standard carbon graphite material with low porosity and high elastic modulus and does not exhibit any thermal aging effects at the temperature encountered during service.

Reference 3.17 indicates that the life of wear ring is a function of wear at a given service temperature, i.e., 3800 hrs. at 300°F and 40,400 hrs. at 150°F during continuous operation. From multiple cycling tests however, the wear rate increased 17 times over that encountered during continuous operation. Total allowable wear is 124 mills.

Based on operation parameters given in Reference 3.5 and applying a 10% time margin to accident functions and always allowing for wear due to accident condition operation, the qualified life is:

	Required Life (hrs)	Wear Rate (Mills/hr)	Total Wear (Mills)
Accident condition at 300°F	792	.03274	25.93
Accident condition at 150°F	8844	.00299	26.44

Wear allowable for normal operation = 124-25.93-26.44 = 71.63 Mills

Utilizing a wear rate of .0525 mills/hr for normal operation, the qualified life is:

$$\frac{71.63}{.0525} = 1364 \text{ hrs.}$$

Since operation is 62 hours/year: $\frac{1364}{62}$ = 22 years

4.6.2.1 Radiation Effects

4.6.3.2.1 EPT (ethylene propylene terpolymer) O-rings

Per Reference 3.18 EPT has a radiation threshold of 1×10^7 rads andcan be considered qualified for 40 years.

4.6.3.2.2 No. 5 Carbon Wear Ring

Industry experience has shown that carbon is not radiation sensitive and can be considered to be qualified for 40 years.

4.6.4 SAE 10 Motor Oil

Oil is subject to gradual deterioration from use as well as contamination from moisture and dirt. In time the accumulation of sludge will cause premature bearing wear. Reference 3.7 indicates replacement after 3 months of operation.

An alternate lubricant, Shell Turbo 68, is utilized for the HPSI pump per Reference 3.19. The use of an alternate lubricant is allowed per Reference 3.7. Reference 3.20 indicates that the lubricant used can withstand the service conditions for which it is utilized.

4.7 Replacement and Maintenance

4.7.1 Flexitallic Gaskets

The Flexitallic gaskets are qualified for 40 years without replacement provided they are not disturbed. Replacement is required if they are removed during pump disassembly. No maintenance is required except as determined by normal surveillance.

4.7.2 Hydroil Gaskets

The Hydroil gaskets are qualified for 40 years without replacement provided they are not disturbed. Replacement is required if they are removed during pump disassembly or if an oil leak occurs. No maintenance is required except as determined by normal surveillance.

4.7.3 Durametallic Seals

The EPT O-rings are qualified for 40 years without replacement provided that they are not distrubed or that excessive leakage is not present due to boric acid crystalization. Replacement is required during any mechanical seal maintenance or if excessive leakage is found during routine surveillance.

The carbon wear rings require replacement every 22 years based on projected operation. If excessive leakage is found during routine surviellance, replacement would on a shorter interval.

4.7.4 Bearing Lubricating Oil

The lubricating oil should be replaced after 3 months of operation or at least once a year. Since 3 month replacement post-accident is impractical, the radiation resistance and temperature endurance of the oil has been evaluated and has been determined to be sufficient to sustain one year post-accident operation.

5.0 EQUIPMENT IDENTIFICATION

The equipment consists of the following:

High Pressure Safety Injection Pumps

Manufacturer:	Ingersoll Rand
Manufacturer Part No.:	4x11 CA-8 stage
Serial Numbers:	Unit 1 0776-14/15 Unit 2 0776-16/17 Unit 3 0776-18/19
Drawing No.	D-4X11-8CA500X1D, Rev. 5

DURAMETALLIC CORPORATION 2104 Factory Street Kalamazoo, Michigan 49001, U.S.A.

SECTION I

THE TESTING OF DURA SEALS IN 2.5% BORATED WATER FOR NUCLEAR POWER PLANT SERVICES

Ref: Durametallic Corporation
Research Report No. 1209-A
October 20, 1976

THE TESTING OF DURA SEALS IN 2.5% BORATED WATER

This report summarizes the testing accomplished by Durametallic Corporation on Dura Seals for use in Nuclear Power Plant pumps handling 2.5% borated water. The summarized data, shown in Table I-1, represents over 4,100 hours of testing, simulating the most severe and adverse conditions that such seals might be subjected to during plant emergency conditions. All the tests that were conducted assume no external cooling was available. Only bypass flushing was used to cool and lubricate the seal faces even under the severe conditions of high temperature with little pressure above the corresponding vapor pressure. All tests were completely successful with no failures encountered during the entire test program.

This series of tests is an update of the test program conducted by Durametallic Corporation in 1969. The 1969 report is still valid in that the basic conditions under which the seals are to operate have not changed appreciably since 1969. However, seal technology has progressed and present seal designs and materials may perform better and withstand more severe conditions with less wear. This latest series of tests show the projected wear life for each of the adverse conditions tested, including the condition of 150°F product temperature and 250 PSIG seal chamber pressure which was not in the 1969 test program. Of special significance are the moderate cycle and rapid cycle tests which severely test the ability of the seal to adapt to rapid changes in temperature and pressure and to determine whether or not boric acid will immobilize or "hang-up" the seal.

CONCLUSIONS

1. Type PTO Dura Seals in the design and materials of construction tested performed totally satisfactory in distilled water containing 2.5% by weight boric acid under all conditions tested.

2. External cooling is not required.

3. Bypass flushing of the pump product from the discharge to the seal faces provides adequate cooling and lubrication.

4. The projected wear life of the seal faces when operated at various steady, stable conditions on a continuous basis were:

CONDITIONS		Projected Wear Life
Product Temp., °F	Pressure	Hours
150	V.P. + 6 ft. head	79,000
150	250 PSIG	40,400
300	V.P. + 6 ft. head	3,800
350	450 PSIG	4,770

5. Wear increases when the conditions are cycled from one to another. However, even after several product temperature and pressure cycles, seal wear was minimal and the seals could be returned to a normal condition and operate satisfactorily.

6. Seal leakage is essentially nil when the seals operate at any single condition on a continuous basis.

7. Seal leakage of a minor nature often occurs when changing from one condition to another.

8. Immobilization or seal "hang-up" from boric acid crystallization on the atmospheric side of the seal could not be made to occur from any combination of cycle changes and/or periodic minor leakage. The boric acid crystals appear to be dissolved and washed away from the seal area by any minor leakage that occured.

TEST SEAL

The seals tested were of 2" shaft size rotating at 3550 RPM and are shown schematically in Figs. I-1 and I-2. Figure I-1 is a PTO Dura Seal design which was used for most of the testing. Figure I-2 is a modified PTO design having the insert supported against the gland in a manner similar to our HPTO high pressure Dura Seal series. The purpose of testing both designs was to indicate that either design performs equally well and could be substituted if the need should arise.

The secondary seals were EPT terpolymer "O" rings in all instances. This compound is approved for use in the radiation environment anticipated for nuclear power plants where such seals are to be used. Other secondary seal materials; such as, Durafite, were not tested because an "O" ring is considered the most reliable and least expensive for this service. At the time of our first report (1969), no elastomer was considered satisfactory, hence the choice of Durafite was mandatory.

No secondary bushing seal was used with the test seals. In our prior testing it was found that such secondary seals did not adversely effect operation or hangup characteristics of the seals. It is even possible that secondary seals may reduce any tendency to hangup the seal by retaining liquid leakage longer and, thereby, tending to wash away any boric acid crystal buildup more readily. Since a design without the secondary seal may present the more severe condition for the seal, it was decided not to include it in the test arrangement.

The rotary seal ring was of solid Tung-Car 62-6 (nickel binder) and the insert of No. 5 carbon. The compression unit was of 316 stainless steel and springs, pins and set screws #20 stainless steel.

The insert rubbing face design used for the final testing had a balance of 31% and face width of .175". The insert rubbing face nose length was standard at .125" for both the PTO design and HPTO design inserts. There was no anti-rotation pin used for either insert.

TEST EQUIPMENT AND FLUID

The test arrangement consisted of a heavy duty centrifugal pump circulating product to a 15 gallon accumulator tank. The top of the tank was approximately 6 feet above the seal chamber so that at the vapor pressure condition the seal actually had vapor pressure plus 6 feet of head. Figure I-3 is a schematic of the best arrangement used.

Temperature of the product was monitored by a dial thermometer in the discharge line and a thermocouple in the seal chamber as a double check.

Pressure was maintained by an external air operated pressurizing pump monitored by a calibrated pressure gage in the system.

Environmental control to the seal chamber consisted of a bypass flush from the discharge. A full 1/2" stainless steel tubing bypass line was used. The throat bushing had a .0075" radial clearance. The bypass volume was approximately 1-1/2 GPM for all tests.

The product fluid was distilled water with 2.5% by weight boric acid (4.375 PPM Boron).

TEST CONDITIONS

The specific conditions tested singly and in combination were:

Condition	Product Temperature °F	°C	Seal Chamber Pressure
1	150	66	V.P. + 6 ft. static head
2	150	66	250 PSIG
3	300	148	V.P. + 6 ft. static head
4	350	176	450 PSIG

It is believed that these conditions in various combinations represent the best and worst that might occur to a mechanical seal in a pump used for residual heat removal, containment spray injection, etc.

The tests were broken down into three categories, as follows:

1. Tests at a steady state condition (one condition only). These tests established the wear rate to be expected for each condition of temperature and pressure outlined above.

2. Tests with moderate cycling from condition 3 to 4 and then to 1, which represents a breakdown situation.

3. Tests with multiple cycling of the conditions. These tests were designed to try to foul the seal with boric acid crystals and cause a seal failure due to hangup of some type and are not representative of any set of conditions that might occur, to our knowledge.

It is firmly believed that the seal design presented can withstand any condition or combination of conditions that might occur and recover to operate normally. The entire test series was carried out with the objective of finding a way to fail the seal within the constraints of the conditions that could be encountered. As will be shown, the seal performed extremely well and recovered from adverse conditions many times over.

RESULTS

The results of testing are summarized in Table I-1 and shown graphically in Figures I-4, I-5, and I-6.

STEADY STATE CONDITION TESTS

Tests 1 through 8 of Table I-1 and Figure I-4 show the results of the steady state testing. The results of these tests reveal the expected life for the seals for a variety of potential operating conditions.

Tests 1 and 2 are a condition anticipated as a normal operating condition of 150°F and vapor pressure which may occur for long periods of time. It can be seen that at this condition the seal faces have a projected life of 79,000 hours or more than nine years. In the two tests of 238 hours duration each, used to determine the wear life, there was no measurable wear on the Tung-Car face.

Tests 3 and 4 reveal the wear of the seal if the temperature was 150°F and the pressure in the range of 250 PSIG. This condition may occur for long periods in some systems. The wear of the carbon at this condition was nominal and resulted in a projected seal life of 40,400 hours or nearly five years.

Inspection of the seal faces indicated no pitting or chipping on the carbon face and a narrow groove (.010" - .020" wide) on the Tung-Car seal ring face, adjacent to the O.D. of the contact area of the carbon wear face. This groove was 0.7 mils and 0.55 mils deep respectively and a matching ridge was observed on the carbon nose O.D. The exact cause of this grooving is not understood but it has been observed when sealing hot water and when sealing high pressure using carbon against Tung-Car. This phenomenon was observed in all tests of the series except tests 1 and 2 above where it was not evident. In the very severe test cycles of tests 13 and 14, these grooves were still of nominal depth and width. It is believed that this grooving proceeds to a point and is self-limiting and, therefore, has very little effect on the total projected wear life of the seal.

Tests 5 and 6 conducted at 300°F and vapor pressure represent the most severe conditions for wear since the liquid film between the seal faces turns to a vapor and the faces are essentially running in a vapor. The wear per hour shown on Figure I-4 was .03274 mils per hour for a projected seal life of 3,800 hours. There was no liquid leakage during these tests; however, there were white crystals of boric acid around the area of the pump and base near the seal. These crystals are the evidence of vapor leakage. It is estimated that 5 - 10 grams of crystals were in the area which would translate into 200 to 400 cc of liquid leakage for the test duration of about 72 hours.

Inspection of the carbon wear faces following these tests revealed some face pitting and a few small chips out of the I.D. edge. The damage was not extensive and the seal would have returned to normal operation without difficulty.

Inspection of the Tung-Car face revealed a narrow groove about 0.6 mils deep at the O.D. contact area of the carbon face. This groove and corresponding ridge in the carbon were about the same as that observed in Tests 3 and 4.

It was evident that the seal would perform satisfactorily under this adverse condition and that it may have a reasonably long life (3800 hours projected) even when operated at this condition continuously.

Tests 7 and 8 conducted at 350°F and 450 PSIG represent another severe condition, principally due to the high temperature. Again a condition of emergency rather than norm is portrayed. The wear per hour averaged .0262 mils per hour which translates into a seal life of 4770 hours duration. Throughout these tests there was no liquid leakage except small amounts of boric acid crystals.

Inspection of the carbon revealed face pitting and minor chips on both I.D. and O.D. The damage was not extensive and the seal appeared that it would return to normal conditions without difficulty.

The Tung-Car seal ring revealed little effect except the small groove adjacent to the O.D. of the carbon wear face similar to that noted in tests 3 and 4. A measurement of depth was not taken.

MODERATE CYCLING TESTS

Tests 9, 10, and 11 of Table I-1 and Figure I-5 show the effects of a moderate cycle from one condition to another. These tests attempt to illustrate that the seal design will perform when in an emergency operating condition such as 300°F and vapor pressure and the condition changes to 350°F and 450 PSIG and then returns to more normal condition of 150°F and vapor pressure. The 150°F and 250 PSIG condition was not used because it is not as severe as that to 150°F and vapor pressure.

Figure I-5 shows the exact cycle and time at each condition for the tests. The total wear on the carbon is also shown and the total measurable leakage at each condition is noted. It can be seen that both wear and leakage were relatively constant from test to test. Most of the leakage occurred over a short period of time, usually following or during a change from one condition to another. There was a considerable buildup of boric acid crystals around the gland and shaft where leakage is expelled but the seal was apparently not "hung-up" or hampered since it recovered to leak-free operation in each instance. Again the leakage was often in the form of crystals rather than liquid and the amount is approximate and probably low since crystals often floated into the air and were lost. The notation of "nil" for leakage denoted that the amount of boric acid crystals was very small and not readily collectable.

The wear was generally high for each test. This would indicate that changing conditions increases wear considerably as compared to a steady state condition.

The carbon insert faces appeared satisfactory after each test with only minor pitting and chipping to indicate the severe conditions encountered.

The Tung-Car seal rings revealed the groove at the O.D. of the contact area with the carbon. The groove was 1.2 mils deep and after test 10 it was 1.8 mils deep. Test 11 was not measured. The grooves remained at about .020" wide. The groove was somewhat deeper but otherwise the same as observed before.

In all instances the seals performed well and at no time indicated imminent failure. On several occasions at high temperature the seal spit and popped periodically over several hours during changes from one condition to another while the seal re-adjusted to the new condition. This may have been a reaction during the wear-in period of the faces to a new condition and would account for the minor chipping and pitting on the carbon face.

It should be noted that the same carbon was used for tests 9 and 10 which was the PTO design and for test 11 the HPTO design was used. No difference in general operation was noted.

MULTIPLE CYCLING TESTS

Tests 12 and 13 of Table I-1 and Figure I-6 show the results from multiple cycling tests. These tests were conducted principally for the purpose of illustrating the ruggedness and recovery ability of the seal design proposed and to further determine whether or not boric acid solutions in this percentage range could immobilize or hang-up the seal.

Figure I-6 shows the cycling history imposed on the seal. Two separate tests were conducted using a new carbon insert of the HPTO design for each. Table I-2

shows the number of changes and conditions as well as total hours of operation in each condition for the entire test.

It can be seen that Test 12 endured 20 cycles for a total continuous time of 608 hours. After the 20th cycle the seal was leaking at 6 cc per minute but slowing when the test was terminated.

Examination of the seal revealed that the carbon face was severely pitted and several large chips had occurred on the O.D. and I.D. diameters. The cause of the leakage was believed due to face damage rather than seal immobilization. It is believed the seal would have gradually worn in so that the faces would seal off after a period of time. The Tung-Car face had a groove about 2 mils deep adjacent to the O.D. of the carbon rubbing face. Although the groove was a little deeper here than in prior tests, it was of the same general width (.020"). It is felt the extreme cycling would represent the very worst conditions for grooving that might be encountered. It is believed that about a 2-3 mil deep groove is about the worst that will be encountered and that this phenomena would not seriously effect seal life when returned to a normal condition.

Test 13 was a repeat of Test 12 with a new carbon and re-lapped Tung-Car seal ring. After 27 cycles and 905 hours, the test was terminated even though the seal was operating leak-free and satisfactorily. The test proceeded similar to test 12 in that minor leakage occurred at several times during the test, always related to a changing condition. In all cases the leakage stopped or became nil after a few hours operation.

Upon tear-down, the carbon appeared similar to that in test 12 but not as badly pitted. The Tung-Car seal ring had a groove 2.2 mils deep.

The wear on the carbon seal faces was extensive at 22.7 mils and 50 mils respectively but in consideration of the extensive cycling and conditions the faces held up well and the wear was moderate.

WEAR RATE AND PROJECTED SEAL LIFE

The projected seal life for the seal was determined based on the wear that occurred to the carbon graphite stationary element. The wear nose on the carbon is .125" long and its useful life is considered expended when this is worn away. It can be seen, however, that the seal would continue to function once the wear nose is expended since the rotary unit would then begin to wear into the main body of the carbon. The rate of wear would accelerate when the body was reached due to the wider contact area and greater heat generation. Therefore, the seal is considered worn out once the wear nose is expended.

The wear on the Tung-Car seal ring face is many times less than for the carbon and is generally disregarded for normal conditions. In the case of high temperature operation, such as 300°F and vapor pressure and 350°F and 450 PSIG, the tungsten carbide elementdoes wear but again in proportion to the highly accelerated wear of the carbon it is still a small matter and not considered in the projected life of the seal as shown in this report.

A projected seal life is not shown for the moderate cycle and rapid cycle conditions. It is believed that the combination of extreme conditions for such long periods of time would not occur but once and, therefore, a projected life would not be a realistic factor.

LEAKAGE AND IMMOBILIZATION

One of the major concerns with seals for this service is leakage and the possibility of immobilizing or hanging up the seal. Leakage in particular was quite modest and infrequent throughout this testing. As noted before, it seemed to occur only during a change from one condition to another and even then it did not occur with each change of the same type; it was not predictable as to which change might produce moderate leakage. It could only be speculated, but it is believed that when boric acid crystals build up from vapor leakage, the seal ring tends to be held up by deposits on the sleeve adjacent to the seal faces. This restriction of the forward movement of the seal ring begins to reduce the closing force on the faces which eventually causes some liquid leakage through the faces. The liquid leakage soon washes away the boric acid, which is readily dissolved, and frees the seal ring, thereby stopping leakage.

Immobilization, which is sometimes referred to as hang-up, is related to a deposited buildup usually emanating from between the seal rubbing faces. In this case it may be occurring but, if so, it is also self-destructing by virtue of the leakage.

Upon careful inspection of the seal area after each test, it was noticed that the area adjacent to the seal on the sleeve and in front of the "O" ring shaft packing was clear and free of any boric acid. The area near the outlet to the gland was usually covered with boric acid crystals. The crystal buildup was readily washed away with cool tap water requiring little or no mechanical scrubbing for removal. The ease with which the boric acid crystals were washed away supports our premise that boric acid will not immobilize the seal in any permanent fashion.

It was believed that these tests demonstrated that the seal design will take extensive abuse and continue to seal and that boric acid crystals do not readily immobilize the seal. The number of cycles to extreme conditions and the intermittent liquid leakage during some cycles provided ample opportunity to destroy the seal faces causing extensive leakage or immobilization of the shaft packing or the movable seal ring. The seal withstood all this abuse many times over and it was concluded that the seal will withstand the severe conditions and changes and it should not be immobilized by boric acid crystals under any combination of conditions that might be encountered when sealing 2.5% borated water. In our 1969 Report it was speculated that liquid leakage dissolves and washes away boric acid crystals and these tests seemed to further strenthen this hypothesis.

TABLE I-1

SUMMARY OF TEST RESULTS: 2.5% BORATED WATER

TEST NO.	PRODUCT CONDITIONS TEMP. °F	PRESS. PSIG	NUMBER OF CONDITION CHANGES TEMP.	PRESS.	TOTAL TEST TIME HOURS	LEAKAGE	TOTAL CARBON WEAR MILS	AVERAGE PROJECTED SEAL LIFE HOURS
STEADY STATE CONDITION TESTS								
1	150	V.P.	0	0	238	Nil	0.45	79600
2	150	V.P.	0	0	238	Nil	0.30	
3	150	250	0	0	351	Nil	1.05	40400
4	150	250	0	0	305	Nil	1.00	
5	300	V.P.	0	0	72	Nil	2.25	3800
6	300	V.P.	0	0	70	Nil	2.40	
7	350	450	0	0	53	Nil	1.10	4770
8	350	450	0	0	92	Nil	2.70	
MODERATE CYCLE CONDITION TESTS								
9	150/350	V.P./450	5	5	324	Nil	17.0	-
10	" "	" "	2	2	348	Fig. I-5	11.0	-
11	" "	" "	3	3	519	Nil	14.2	-
MULTIPLE CYCLE CONDITION TESTS								
12	150/350	V.P./450	20	20	608	Fig. I-6	22.7	-
13	" "	" "	27	27	905	" "	50.7	-

TABLE I-2

NUMBER OF CHANGES TO VARIOUS CONDITIONS FOR MULTIPLE CYCLE TESTS 12 AND 13

TEST NO.	TEST CONDITION	NO. OF TIMES	TOTAL HOURS AT CONDITION
12	150°F & V.P.	8	383
12	300°F & V.P.	7	119
12	350°F & 450 PSIG	5	106
	Total	20	608 hrs.
13	150°F & V.P.	8	465
13	300°F & V.P.	11	264
13	350°F & 450 PSIG	8	176
	Total	27	905 hrs.

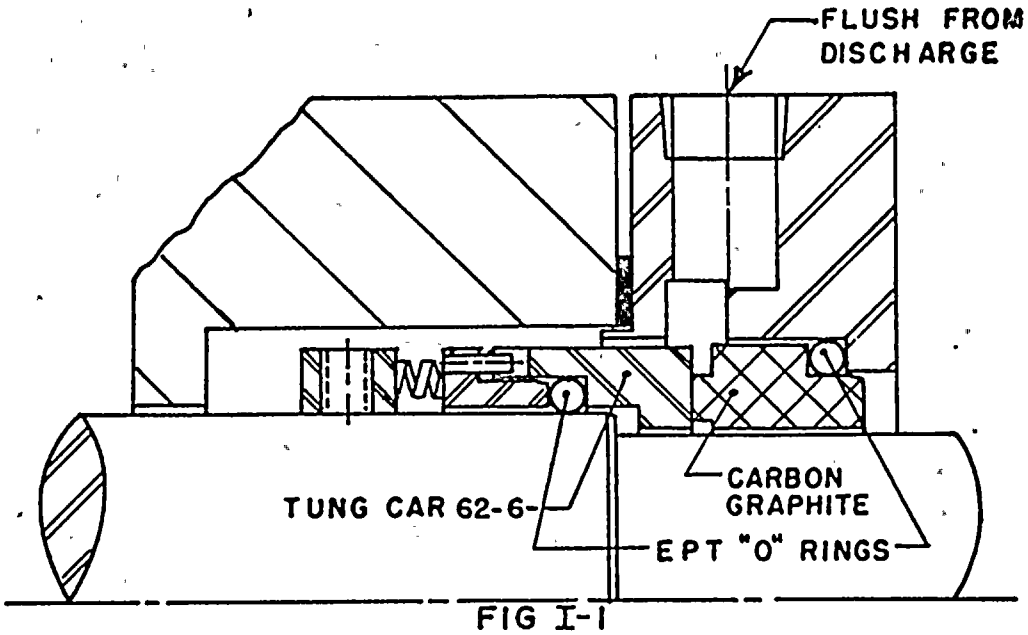


FIG I-1

TYPE "PTO" TEST SEAL WITH BYPASS FLUSH

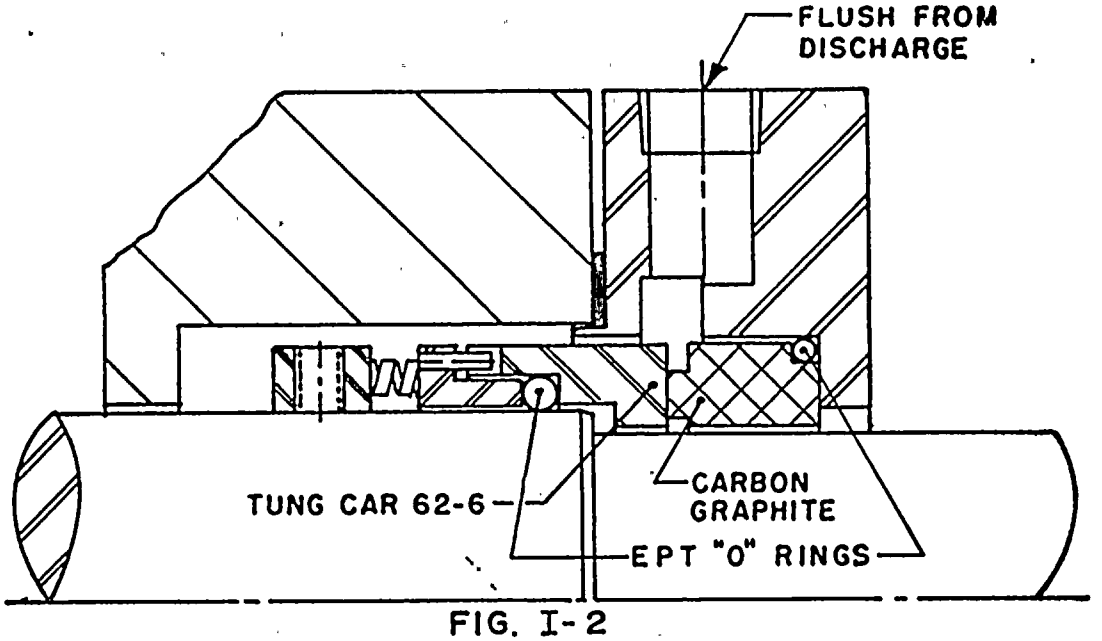


FIG. I-2

MODIFIED TYPE "HPTO" TEST SEAL WITH BYPASS FLUSH

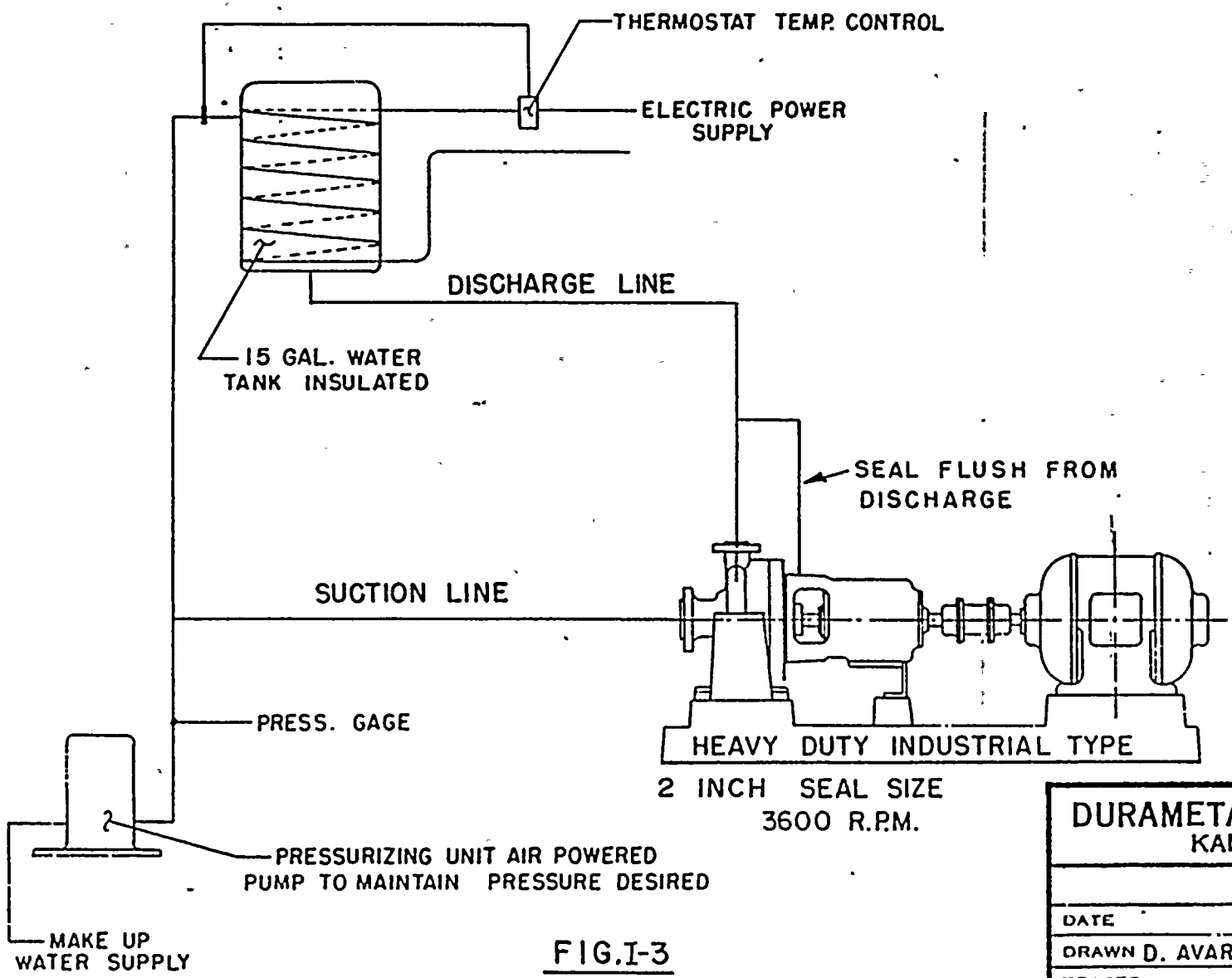


FIG.I-3

SCHEMATIC OF TEST SETUP

DURAMETALLIC CORPORATION KALAMAZOO, MICH.	
DATE	SCALE NONE
DRAWN D. AVARD	
TRACED	Dwg. No.
CHECKED	

TEST NO.	PRODUCT CONDITIONS		TEST TIME, HOURS	TOTAL CARBON WEAR MILS	PROJECTED SEAL LIFE HOURS
	TEMP. °F	PRESS. P.S.I.G.	100 200 300		
1	150	V.P.		0.45	79,600
2	150	V.P.		0.30	
3	150	250		1.05	40,400
4	150	250		1.00	
5	300	V.P.		2.25	3,800
6	300	V.P.		2.40	
7	350	450		1.10	4,770
8	350	450		2.70	

FIG. I-4 STEADY STATE CONDITION TEST RESULTS

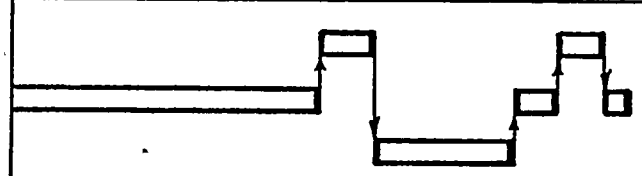
TEST NO.	PRODUCT CONDITIONS TEMP. °F	PRESS. P.S.I.G.	TEST TIME, HOURS (100 · 200 · 300 · 400 · 500)	TOTAL CARBON WEAR MILS.	TOTAL LEAKAGE C C
9	350 300 150	450 V. P. V. P.		17.0	NIL
10	350 300 150	450 V. P. V. P.		11.0	160 320 200
11	350 300 150	450 V. P. V. P.		14.2	NIL

FIG. I-5 MODERATE CYCLING CONDITION TEST RESULTS

TEST NO.	PRODUCT CONDITIONS		TEST TIME , HOURS
	TEMP. °F	PRESS. P.S.I.G.	200 400 600 800 1000
12	350 300 150	450 V.P. V.P.	LEAKAGE C C 140 725 120 260 160
13	350 300 150	450 V.P. V.P.	120 3240 350 110 15 28 60

FIG. I-6 MULTIPLE CYCLING CONDITION TEST RESULTS

requirements, most seal manufacturers have standardized on carbon-graphite for one seal face. Carbon-graphite is compatible with an extremely wide range of temperatures and corrosive environments. Despite its attractive antifrictional and inert qualities, carbon-graphite possesses a low elastic modulus. This simply means that it will bend or distort easily under pressure. Although not subject to fracture from thermal shock, carbon-graphite, is indeed fragile.

Therefore, when taking carbon-graphite's delicate nature into consideration, Durametallic decided that it would perform best as a stationary face. In the configuration of a stationary face, the carbon can be designed with a much larger cross-section than is possible in a seal ring thereby increasing its resistance to distortion and fracture from impact.

NO. 5 CARBON

No. 5 is Durametallic's designation for its standard carbon-graphite material. No. 5 Carbon possesses low porosity and has the highest elastic modulus among those grades available to the mechanical seal industry. It is formed by combining carbon-graphite with a phenolic resin binder. This mixture is then sintered, causing the binder to carbonize and leaving a residue similar to the carbon-graphite.

Although practically chemically inert, No. 5 Carbon will break down in the presence of some oxidizing agents.

NO. 6 CARBON

Also a Durametallic designation, No. 6 Carbon is chemically resistant to strong oxidizing agents that attack No. 5 Carbon. Although a premium grade of carbon-graphite, No. 6 is an almost binderless carbon with greater porosity and less desirable wear characteristics than No. 5 Carbon.

III.1.4 OTHER FACE MATERIALS

Until now our discussion has been confined to the discussion of metals and ceramics for rotary seal rings and carbon-graphite for stationary inserts. It should be pointed out here that in the mixer seal designs, Types MRO/MRT (Section II.1.2.) and Types MPO/MPT (Section II.2.2), the roles of these materials are reversed.

Another exception that deserves mention is the occasional practice of mating identical materials. This is only done with extremely hard materials; such as tungsten carbide or ceramics where abrasives are unavoidably present or unusual corrosion problems exist. Under such circumstances, the life achieved by rotating the same materials against each other will exceed the life that could be achieved through the use of more conventional face material combinations.

GLASS-FILLED DURAFLON

Duraflon is another Durametallic trade name signifying TFE resin (Teflon). The chemically inert quality of Duraflon speaks for itself. Consequently this material is occasionally used as a seal face material. Because plain Duraflon has a tendency to "cold-flow," stability is achieved through glass impregnation. Glass-filled Duraflon is a poor wearing material and is, therefore, limited to very low pressure-velocity ratings.

Temperature limitations of Dura Seal face materials can be found in Table III-B.

SECTION III.2
SECONDARY SEAL MATERIALS

Secondary seals applied to mechanical seals are defined more specifically as shaft packing and insert mounting. Because they are static and are called upon to seal imperfect surfaces, secondary seals must possess a degree of resiliency which will allow them to "seat" perfectly against adjacent surfaces. The most elastic or resilient of all secondary seals are elastomers which Durametallic applies in the configuration of "O" rings. However, the temperature and chemical resistance of elastomeric materials are often exceeded, thus requiring the use of other less resilient materials. Because these other materials lack the elasticity of elastomers, they assume configurations that tend to compensate for their limited resiliency. The purpose of this sub-section is to discuss the three types of secondary seals offered by Durametallic.

III.2.1 ELASTOMER "O" RINGS

It has already been pointed out that elastomers, as used for secondary seals by Durametallic, assume the configuration of "O" rings. Figure III-C illustrates the application of elastomer "O" rings as shaft packing and insert mounting.

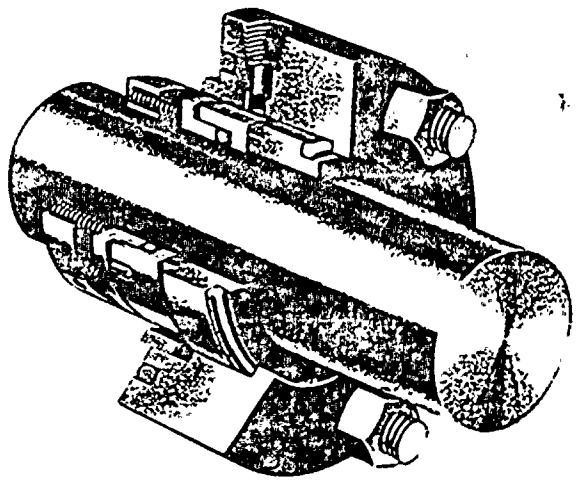


FIG. III-C "O" RING SECONDARY SEALS

BUNA N (NITRILE)

This material, often referred to as Nitrile, is a copolymer of butadiene and acrylonitrile. Buna N has an excellent resistance to petroleum products, also finding wide acceptance in water applications.

Buna N can be exposed to temperatures ranging from −40°F to +225°F (−40°C to +107°C).

Inherently Buna N Does not possess good resistance to ozone, sunlight, or weather. Therefore, spare Buna N "O" rings should not be stored in direct sunlight or adjacent to electrical equipment that may generate ozone.

NEOPRENE

Neoprene, correctly called Chloroprene rubber, was among the earliest of the synthetic rubbers available to seal manufacturers. It continues to be used for refrigerants; such as, freon and ammonia, and other mild services. Like Buna N, Neoprene can be subjected to temperatures from −40°F to +225°F (−40°C to +107°C).

BUTYL

This is an all petroleum product produced by copolymerizing isobutylene and isoprene.

Butyl rubber will resist the deteriorating effects of many mild liquids, such as MEK and acetone, but should not be used in petroleum oils. Its temperature range is −40°F to +225°F (−40°C to +1078C).

SILICONE RUBBER

Silicone elastomers are made from silicone, oxygen, hydrogen, and carbon. They usually display poor tensile strength, tear, and abrasion resistance.

Silicone "O" rings are not recommended for use in most petroleum fluids or ketones. They can be successfully applied to temperatures ranging from −80°F to +400°F (−62°C to +204°C).

Date 12/16/83

Time 10:30 AM

TELEPHONE CALL RECORD

From D. S. Kneppel of C-E 9452-510

To John Martin of Shell Oil Co. 800-231-6950

Contract Name and Number Arizona/660856

Route: S. E. Gilley (TDM-83-290)

J. S. Glazman

R. E. Haller

G. W. Parry

Subject: Shell Turbo 68 Oil Lubrication of the Ingersol-Rand HPSI Pump

Shell Turbo 68 is a turbine oil which will take long term continuous duty service at 120°F. There is no deterioration of the oil when the pump is idle. Changing the oil every 3 months is not necessary.

The oil can operate at a maximum temperature of 210-220°F for a few days. Six months at this temperature would result in complete conversion to an asphalt-like material.

After 30 days at 180°F some of the anti-oxidant additives in the oil would be depleted but there would be no significant degradation. Subsequent continuous operation at 120°F for 11 months will not result in any breakdown in the lubricity of the oil.

Radiation degradation is not a concern since any good grade of oil including the Shell Turbo 68 can tolerate 10^8 rads which is 100 times the normal service plus accident requirement.

Product information data sheets for this oil were requested.

D. S. Kneppel

Written By: D. S. Kneppel

Technical Bulletin
Shell Oil Company

SOC:51-80
(Supersedes SOC:51-77)

Shell Turbo® Oils

Premium quality turbine and general purpose R and O inhibited circulating oils

Product description

Shell Turbo Oils are premium quality lubricating oils designed to provide excellent lubrication of precision turbines in industrial and marine service, and in many other industrial lubrication applications. They are made from highly refined base oils which have been carefully selected to provide satisfactory viscosity/temperature characteristics, low foaming tendencies and good water separation properties. In addition, they contain proven additives to protect equipment against rusting and to resist oxidation for long service life.

Shell Turbo Oils are available in nine viscosity grades, ranging from 30 to 420 cSt at 40°C. Grade nomenclature conforms to the ASTM/ISO viscosity system.

General applications

The high quality of *Shell Turbo* Oils makes them suitable for a wide range of lubrication applications. These include general purpose plant lubrication, non-antiwear hydraulic and circulating oil systems, and as non-E.P. gear oils.

Standards for machine tool lubrication established by the American Society of Lubricatcn Engineers (ASLE) include a classification for Hydraulic Fluid and General Purpose Lubricants. Appropriate grades of *Shell Turbo* Oils recommended for these standards are shown in Table 2.

The American Gear Manufacturers Association's (AGMA) standard specification for lubrication of industrial enclosed gear drives (AGMA 250.03 dated May 1972) includes a classification for rust and oxidation inhibited oils for applications which do not require EP properties. Recommended *Shell Turbo* Oil grades are shown in Table 3.

Turbine applications

Shell Turbo Oils have a long, successful record of providing dependable turbine lubrication with trouble-free performance. The turbine operator should select the appropriate grade of *Shell Turbo* Oil in accordance with the viscosity recommendation of the manufacturer for the turbine he intends to lubricate. However, for various kinds of turbines, general recommendations are shown in Table 1.

Significant features of Shell Turbo Oils

Shell Turbo Oils have achieved a long record of reliable performance because of four significant features.

Superior oxidation stability

A laboratory test method widely used for evaluating the oxidation stability of inhibited turbine oils is ASTM D 943, Turbine Oil Stability Test (TOST). In this procedure, pure oxygen is bubbled through a mixture of turbine oil and water in the presence of copper and iron wire catalysts at 95°C. The TOST life is reported as the time in hours for the oil to reach an acidity (TAN-C) of 2.0. A modification of the TOST used by the Navy (MIL TOST) is terminated at 1000 hours, and oil condition is evaluated, especially sludge content.

Shell Turbo Oils 32 to 100 resist oxidation so well that they require considerably longer than 2000 hours under the severe conditions of the TOST to reach a TAN-C of 2.0. In the MIL TOST, sludging is held to an extremely low level, no more than 20 mg. This high resistance to deterioration means long service life for the oil. It minimizes deposits which could cause malfunction of governor mechanisms and reduced efficiency of oil coolers.

Table 1/Lubricants recommended for turbines

	Turbine oil viscosity cSt at 40°C	Shell lubricant
Steam turbines:		
Direct drive - ring oiled:		
with water cooling	54 - 75	Turbo Oil 68
without water cooling	81 - 113	Turbo Oil 100
Direct drive - forced feed	30 - 38	Turbo Oil 32
Gear drive - forced feed	54 - 75	Turbo Oil 68
Marine Turbines:		
All units	75 - 113	Turbo Oil 78
Hydraulic turbines:		
Large vertical machines	54 - 75	Turbo Oil 68
Small vertical machines	30 - 38	Turbo Oil 32
Horizontal machines	30 - 38	Turbo Oil 32

Non-corrosivity to metals

Corrosivity toward copper and copper alloys is evaluated by the ASTM D130 test. In this, *Shell Turbo* Oils give a rating of 1, representing a practically unchanged copper strip.

The ASTM D 665 Rust Test is an industry laboratory procedure designed to measure the rust-preventing characteristics of turbine oil in the presence of water. In this test *Shell Turbo* Oils not only prevent corrosion of a steel specimen in the presence of distilled water, but also in the presence of synthetic seawater, which is intended to simulate the more severe rusting conditions existing in marine vessels.

Contamination with water is a frequent occurrence in circulating oil systems, particularly in steam turbines. This water in the presence of air may cause rust in such areas as the bearing housings and governor mechanism. *Shell Turbo* Oils effectively inhibit corrosion of these critical parts, thus contributing to increased machine life and system reliability.

Fast separation of water

The rapid separation of water from oil is of paramount importance in a turbine oil circulating system to minimize opportunity for rusting and to prevent possible cavitation in critical areas such as sleeve bearings.

An accepted laboratory test to measure water separation is the ASTM D 1401 Emulsion Test, which measures the time required for the oil and water to separate after being mixed under prescribed conditions at 130°F (54°C). *Shell Turbo* Oils, because of their careful refining, blending, and selection of additives, all accomplish complete separation of water in less than 30 minutes. By this test the oil's demulsibility is considered very good to excellent.

Table 2/Shell Turbo Oils for hydraulic fluid and general purpose lubricants

ASLE Standard No.	ASLE Identifying No.	Shell recommended lubricant
ASLE 64-1	H-150	*Shell Turbo* Oil 32
ASLE 64-2	H-215	*Shell Turbo* Oil 46
ASLE 64-3	H-315	*Shell Turbo* Oil 68
ASLE 64-4	H-700	*Shell Turbo* Oil 150

Table 3/Shell Turbo Oils for non-EP rust and oxidation inhibited gear oils

AGMA No.	AGMA viscosity range SUS at 100°F	Equivalent viscosity cSt at 40°C	Shell recommended lubricant
1	193 - 235	37.1 - 45.4	*Shell Turbo* Oil 46
2	284 - 347	55.0 - 66.9	*Shell Turbo* Oil 68
3	417 - 510	80.2 - 98.1	*Shell Turbo* Oil 100
4	626 - 765	121 - 147	*Shell Turbo* Oil 150
5	918 - 1122	173 - 212	*Shell Turbo* Oil 220
6	1335 - 1632	252 - 306	*Shell Turbo* Oil 320

Good de-aeration properties

Intimate mixing of air and oil not only accelerates oil oxidation and deterioration but also may cause distress in bearings, gears and pumps if foam is circulated through the system. In turbines, this is more of a problem with geared units than with direct drive units. This detrimental effect may be minimized by allowing sufficient residence time in the oil reservoir to permit air release.

Shell Turbo Oils, except for grades 78 and 460, contain an antifoam agent to eliminate the buildup of stable foam.

Table 4/Shell Turbo Oils typical properties

Shell Turbo Oil grade	ASTM test	32	46	68	78[1]	100	150	220	320	460
Code number	method	65602	65603	65605	65606	65607	65608	65609	65610	65611
Gravity, °API	D1298	31	30	29	30	29	27	28	27	26
Color	D1500	1.0	1.0	1.0	0.5	1.0	2.0	4.0	5.0	6.0
Pour point, °F	D97	15	0	-0	10	0	0	10	10	10
Flash point, C.O.C., °F	D92	400	425	460	460	480	475	480	520	530
Viscosity, cSt at 40°C	D445	30.1	44.0	63.0	75.0	97.0	147	210	305	420
Viscosity, cSt at 100°C	D445	5.05	6.5	8.2	9.2	10.7	14	18	23	28
Viscosity index	D2270	92	95	95	95	94	93	93	93	93
Neutralization No., TAN-C	D974	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Cu corrosion, 3 hr. at 212°F	D130	1	1	1	1	1	1	1	1	1
Rust test	D665B	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Interfacial tension, 77°F, dynes/cm	D971	20	20	20	—	23	25	—	—	—
Emulsion test, minutes	D1401	6	9	10	17	10	15	17	17	30
Turbine oil stability test, hours	D943	2,000+	2,000+	2,000+	—	2,000+	—	—	—	—
Turbine oil stability test, MIL TOST, sludge, mg		14	15	18	20	20	—	—	—	—

[1]Approved under MIL-L-17331G and Amendment 1.

Shell Representative

Name	Address	Telephone

Shell Oil Company Sales Offices

Atlanta (404) 955-4600	320 Interstate North Parkway Atlanta, Georgia 30339	Southern California (714) 991-9200	511 N. Brookhurst Street Anaheim, California 92803
East Coast (301) 667-0410	Suite 705, Executive Plaza Two Hunt Valley, Maryland 21031	San Francisco (415) 820-7000	2401 Crow Canyon Rd. San Ramon, California 94583
Chicago (312) 887-5500	1415 West 22nd Street Oak Brook, Illinois 60521	Northwest (206) 453-3000	400 108th Avenue N.E. Bellevue, Washington 98004
Cleveland (216) 842-4000	7123 Pearl Road Middleburg Heights, Ohio 44130	St. Louis (314) 291-5700	Suite 1000, 500 Northwest Plaza St. Ann, Missouri 63074
Detroit (313) 855-9000	Suite 145, 31275 Northwestern Hwy. Farmington Hills, Mich. 48018		
Houston (713) 526-4631	2001 Kirby Drive Houston, Texas 77019		

November 1980

POWER SYSTEMS
COMBUSTION ENGINEERING, INC.

V-PAK-483

Date 12-16-83

Time 10:15A

TELEPHONE CALL RECORD

From R. HALLER of CE

To E. GOUVIER of APS

Contract Name and Number ANPP/14273

Route: J. GLAZMAN -(A)
S.E. GILLEY -(C)
T.E. FITZSIMMONS -(C)
D.S. KNEPPEL -(A)

Subject: LUBRICATION OF HPSI PUMP - MEQ

PER E.J. GOUVIER FROM ANPP PVNGS SITE RECORDS, THE LUBRICATION USED IN THE HPSI PUMPS IS:

SHELL TURBO 68

C-E 0010042 (Rev. 9/76)

Written By R. L. Haller

Barbarin, R. "Selecting Elastomeric Seals for Nuclear Service," Power Engineering, pp 58-60, (December 1977) 4 pp

Selecting elastomeric seals for nuclear service

Ref. 21

Compression set tests have proved more reliable than tensile tests in the selection of elastomer compounds for use as seals in a nuclear environment

Analysis No. 14273-9452-Q178, Rev. 00
Page A19 of A22

By ROBERT BARBARIN, Parker Hannifin Corp./Seal Group

In the early 1960s, the primary test used in selecting elastomers for reactor seals was a tensile test conducted on unstressed slabs of the compounds after they had been subjected to irradiation. These standard tests had the unfortunate ability to make compounds look very appealing to the nuclear engineer while completely failing the primary requirements of seal engineers. Today, a test has been developed which promises to satisfy the demands of both engineers. This is a test to determine the compression set of seals which are simultaneously squeezed (as they would be when installed) and irradiated (as they may be when in service) over prolonged periods. The new data provide criteria by which compounds may be selected for long life, normally requiring replacement only during conservatively scheduled five-year reactor overhauls.

Typical applications for elastomeric seals in and around nuclear reactors include the static seals in pressurized conduits containing radioactive fluids, and the dynamic seals in structural hydraulic snubbers.

Compression set

Compression set may be defined as the percent by which a seal fails to return to its original dimension after compression, expressed as a percent of its deflection. This loss of dimensional memory is due to changes in the elastomer's arrangement and density of molecular cross-links. As the change in cross-linking progresses, the seal will gradually take on the shape of the confining groove and relax the force that it exerts on the confining surfaces.

Since this normally occurs before tensile property changes, the tensile tests are frequently omitted as contemporary criteria for nuclear seal compound selection.

Of the three major types of radiation from nuclear fission, only gamma rays are normally considered a hazard to elastomer seals that are completely enclosed in conventional metal grooves. Alpha and beta rays are effectively stopped by thin metal barriers. Gamma rays, however, easily penetrate the typical elastomeric seal glands and cause cumulative changes in the compounds (see Table 1).

All elastomers tested to date have shown excessive compression set at 10^4 rads, yet a number of compounds showed acceptable compression set at 10^7 rads of gamma radiation dosage.

Therefore, no elastomer known today should be considered for

Table 1. Effects of gamma radiation on the principal properties of elastomeric compounds most often considered for seals in and around nuclear reactors. Compression set tests were conducted at room temperature and 25% deflection, for the number of days noted, while under radiation from cobalt strips in air.

Generic or Base Polymer (Compound No.)	Radiation Dosage in Rads	Hardness in Pts on Shore "A" Scale (Pts Change)	Tensile Strength in Psi @ Break (% Change)	Elongation in % @ Break (% Change)	Modulus in Psi @ 100% Stretch (% Change)	Tear Strength in lb/in. (% Change)	Compression Set Test Days Deflected	CS in % of Original Deflection
Silicone (S455-70)	Original	69	807	117	668	63	93	7.6
	10^7	72 (+3)	733 (-9)	89 (-24)	—	63 (0)	93	31.4
	10^8	85 (+16)	—	—	—	—	93	90.5
Silicone (S604-70)	Original	66	1010	149	695	70	93	3.8
	10^7	69 (+3)	1020 (+1)	129 (-13)	833 (+25)	62 (-11)	93	20.0
	10^8	85 (+19)	939 (-7)	31 (-79)	—	29 (-59)	93	92.4
EPT EPDM → Ethylene Propylene (E515-80)	Original	78	1450	213	689	164	93	16.2
	10^7	78 (0)	1220 (-16)	176 (-17)	740 (+7)	148 (-10)	93	46.6
	10^8	84 (+6)	1030 (-29)	79 (-63)	—	71 (-57)	93	96.2
EPR SP → Ethylene Propylene (E740-70)	Original	70	2080	233	554	174	93	6.7
	10^7	73 (+3)	2140 (+3)	194 (-17)	808 (+46)	163 (-6)	93	28.6
	10^8	79 (+9)	1700 (-18)	96 (-59)	—	70 (-60)	93	90.5
Fluorocarbon (V747-75)	Original	75	1510	190	634	128	93	14.7
	10^7	76 (+1)	1580 (+5)	130 (-32)	1120 (+77)	87 (-32)	93	66.7
	10^8	88 (+15)	1180 (-22)	29 (-85)	—	82 (-36)	93	93.3
Polyurethane (P642-70)	Original	66	3560	582	342	306	56	17.1
	10^7	67 (+1)	3570 (0)	491 (-16)	444 (+30)	374 (+22)	56	55.2
	10^8	66 (0)	1420 (-60)	201 (-65)	—	146 (-52)	56	91.4
Fluoro-silicone (L677-70)	Original	68	1050	180	520	72	128	13.3
	10^7	72 (+4)	668 (-36)	97 (-46)	—	—	128	67.6
	10^8	84 (+16)	—	—	—	—	128	97.1

pp 58-60

R E Heller

INGERSOLL-RAND
PUMPS

Engineered Pump Division
Ingersoll-Rand Company
942 Memorial Parkway
Phillipsburg, NJ 08865

VIA TELECOPY 203-688-1911 X-5179

9 DE 83

Combustion Engineering, Inc.
1000 Prospect Hill Rd.
Windsor, CT 06095

Attention: Mr. C. D. Blanchard
Dept. 9487-403

Ref: V-PCE-2814
CE Str to IR

Subject: AWPP/Palo Verde Units 1,2,&3
4X11CA-8 Stage HPSI Pump
CE P.O.#9500088/91/94
I-R Orders 001-36422/425/428

Gentlemen:

Pursuant to our phone conversation, the subject pump will operate successfully with the 300°F pump liquid temperature with the bearing temperature not exceeding the 180°F limit.

To determine an actual value of the bearing temperatures, a complex heat transfer analysis must be performed since there are many factors that effect the final steady state bearing temperature. To perform this analysis we will require a P.O. for $3000 and to be about 3 to 5 weeks to complete.

Please advise if you have any questions.

Sincerely yours,

P. F. Frederick

P. F. Frederick
Field Service Engineer
Engineered Pump Division

PFF:kab

cc: Mr. F. Antunes
Mr. J. Giammarinaro
Mr. K. Schumann

C-E Power Systems
Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095

Tel. 203/688-1911
Telex: 99297

C-E POWER SYSTEMS

December 8, 1983
V-PCE-2814

Ingersoll-Rand
Engineered Pump Division
942 Memorial Parkway
Phillipsburg, N.J. 08865

Attention: Kurt E.Schumann

Subject: ANPP Palo Verde UNits 1, 2 & 3
CA 4X11CA - 8 Stage HPSI Pump
C-E P.O. 9500088/91/94

Gentlemen:

We are attempting to finalize an environmental qualification report for the NRC and APS for the subject pump. To do so we need the following information from Ingersoll-Rand: what are the temperatures of the inboard and outboard pump bearings at steady state condition when pumped fluid temperature is 300°F and ambient temperature is 104°F.

Please reply by December 9, 1983.

This letter authorizes no costs.

Very truly yours,
COMBUSTION ENGINEERING, INC.

D. R. Wade

DRW/CDB:rre
F43661

ANPP-QUALIFICATIONS DATA

Bechtel Power Corporation

Engineers – Constructors

12400 East Imperial Highway
Norwalk, California 90650
MAIL ADDRESS
P.O. BOX 60860 - TERMINAL ANNEX, LOS ANGELES, CALIFORNIA 90060
TELEPHONE: (213) 807-2000

FEB 10 1983

B/CE-E-43422
MOC 237785
January 31, 1983

ANPP			
FEB 03 '83			
V#			
BOOK & APM	A	I	E
PE & PA	X		✓
RD & MD	X		✓
ICE	X		✓
CONTRACT			
STARTUP			
R H Holm	X		✓
H Amerine	X		✓
DUE			

Reviewed Submit comments please

Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095

Attention: Mr. Charles Ferguson
Project Manager

Subject: Arizona Nuclear Power Project
Bechtel Job 10407
Environmental Qualification
Parameters
File: N.1.01

SEE SHEETS 5 AND 6/14

Dear Mr. Ferguson:

The enclosed qualification parameters are to be used for qualification of NSSS supplied equipment for Palo Verde Nuclear Generating Station.

If you have any questions please contact us.

DESIGNATOR III — AUX BLDG —

Very truly yours,

BECHTEL POWER CORPORATION

W. G. Bingham
Project Engineering Manager
Los Angeles Power Division

WGB:BLA:kh

Enclosure: FSAR Table 3E-1 "Environmental Qualification Parameters"
Amendment 5, August, 1981 (14 pages, 1 copy)

cc: E. E. Van Brunt, Jr.
G. C. Andognini
J. R. Bynum
D. B. Fasnacht
J. M. Allen
R. H. Holm
W. L. MacDonald
D. B. Amerine (Jobsite)
Above w/o enclosure

G. Bidwell (CE)
Above w/enclosure

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 1 of 14) 5

CONTAINMENT BUILDING - ENVIRONMENTAL DESIGNATOR I (1 of 2)

Condition / Parameter	Normal/Abnormal (N)	Design Basis Accident (A) (Includes 40 Year Integrated)		
		LOCA	MSLB	TIME DURATION 5
Temperature (F)	50 - 120	350 350 302 302-270 270-200	370 350 302 302-270 270-200	4 Min 8 Min 8 Hr 42 Hr 2 Wk
Pressure (psig)	ATM.(a)	60 55 25 10		12 Min 8 Hr 42 Hr 2 Wk
Relative Humidity (%)	20 - 90%	Steam/Air Mixture		
Radiation (Rads) (40 Year Integrated Dose)	1×10^7	3.3×10^7 Gamma 2×10^8 Beta (non-sprayed enclosures) 1×10^8 Beta (all other areas)		5
Chemicals	None	o 4400 ppm Boron o 50 ppm Hydrazine o pH adjusted to 7.0-8.5 after 4 hours using Trisodium phosphate		

a. Structural Integrity Test Pressure = 69 psig.

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 2 of 14)

CONTAINMENT BUILDING - ENVIRONMENTAL DESIGNATOR I (2 of 2)

Condition / Parameter	Normal/Abnormal	Design Basis Accident LOCA/MSLB
Submergence	None	Below Plant El. 91'
Dust	1.52 $\mu G/M^3$	650 $\mu G/M^3$
Seismic	2 OBE's (Refer to Seismic Response Spectra)	1 SSE (Refer to Seismic Response Spectra)
Dynamic	Refer to Equipment Specifications for requirements	Refer to Equipment Specifications for requirements
Aging	Equipment must be qualified for 40 year life for environmental parameters	Equipment must be qualified for 40 year life plus DBA for environmental parameters

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 3 of 14)

MAIN STEAM SUPPORT STRUCTURE - ENVIRONMENTAL DESIGNATOR II (1 of 2)

Condition / Parameter	Normal/Abnormal (N)	Design Basis Accident (A) (Includes 40 Year Integrated)	
		LOCA/MSLB	Time Duration
Temperature (F)	28 - 120	300 (above El. 100')	15 minutes
Pressure (psig)	ATM	21 (above El. 100')	15 minutes
Relative Humidity (%)	20 - 90%	Steam/Air Mixture (above El. 100')	
Radiation (Rads) (40 Year (Integrated Dose)	$<10^3$	10^5 10^6 (above El. 100')	
Chemicals	None	None	

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Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 4 of 14)

MAIN STEAM SUPPORT STRUCTURE - ENVIRONMENTAL DESIGNATOR II (2 of 2)

Condition / Parameter	Normal/Abnormal	Design Basis Accident LOCA/MSLB
Submergence	None	None
Dust	1.52 $\mu G/M^3$ (Below El. 100') 61.3 $\mu G/M^3$ (Above El. 100')	650 $\mu G/M^3$ (Below El. 100') 131 mG/M^3 (Above El. 100')
Seismic	2 OBE's (Refer to Seismic Response Spectra)	1 SSE (Refer to Seismic Response Spectra)
Dynamic	Refer to Equipment Specifications for requirements	Refer to Equipment Specifications for requirements
Aging	Equipment must be qualified for 40 year life for environmental parameters	Equipment must be qualified for 40 year life plus DBA for environmental parameters

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 5 of 14) 5

AUXILIARY BUILDING - ENVIRONMENTAL DESIGNATOR III (1 of 2)

Parameter \ Condition	Normal/Abnormal (N)	Design Basis Accident (A) (Includes 40 Year Integrated)	
		LOCA/MSLB	Aux Steam Break
Temperature (F)	50 - 104	50 - 104	50 - 318F[a]
Pressure (psig)	ATM	ATM	1.5[b]
Relative Humidity (%)	20 - 90%	20 - 90%	20 - 100%
Radiation (Rads) (40 Year Integrated Dose)	3.5×10^4 (accessible areas) 1.25×10^7 (Volume Control Tank) 2.7×10^9 (Purification Ion Exch.)	1×10^6 (accessible areas) 1.25×10^7 (Volume Control Tank) 2.7×10^9 (Purification Ion Exch.)	
Chemicals	None	None	

a. Applicable to Class 1E electrical cable only (Class 1E cable satisfies qualification envelope for containment)

b. Pressure is a transient effect (i.e., several seconds duration)

8 5 5 8 8

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 6 of 14)

AUXILIARY BUILDING - ENVIRONMENTAL DESIGNATOR III (2 of 2)

Condition / Parameter	Normal/Abnormal	Design Basis Accident
		LOCA/MSLB
Submergence	None	None
Dust	1.52 $\mu G/M^3$	650 $\mu G/M^3$
Seismic	2 OBE's (Refer to Seismic Response Spectra)	1 SSE (Refer to Seismic Response Spectra)
Dynamic	Refer to Equipment Specifications for requirements	Refer to Equipment Specifications for requirements
Aging	Equipment must be qualified for 40 year life for environmental parameters	Equipment must be qualified for 40 year life plus DBA for environmental parameters

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Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 7 of 14)

CONTROL BUILDING - ENVIRONMENTAL DESIGNATOR IV (1 of 2)

Condition / Parameter	Normal/Abnormal (N)	Design Basis Accident (A) (Includes 40 Year Integrated) LOCA/MSLB
Temperature (F)	Control Room 75±5 Elec. Equip. Rooms (El. 100') 60-77 Other 40-104	Control Room 75±5 Elec. Equip. Rooms (El. 100') 60-104 Other 40-104
Pressure (psig)	ATM	ATM
Relative Humidity (%)	Control and Elec. Equip. Rooms (El. 100') 40-60% Other 20 - 90%	Control and Elec. Equip. Rooms (El. 100') 40-60% Other 20 - 90%
Radiation (Rads) (40 Year Integrated Dose)	$<10^3$	$<10^3$
Chemicals	None	None

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 8 of 14)

CONTROL BUILDING - ENVIRONMENTAL DESIGNATOR IV (2 of 2)

Condition / Parameter	Normal/Abnormal	Design Basis Accident
		LOCA/MSLB
Submergence	None	None
Dust	1.52 $\mu G/M^3$	420 $\mu G/M^3$
Seismic	2 OBE's (Refer to Seismic Response Spectra)	1 SSE (Refer to Seismic Response Spectra)
Dynamic	Refer to Equipment Specifications for requirements	Refer to Equipment Specifications for requirements
Aging	Equipment must be qualified for 40 year life for environmental parameters	Equipment must be qualified for 40 year life plus DBA for environmental parameters

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 9 of 14)

DIESEL GENERATOR BUILDING - ENVIRONMENTAL DESIGNATOR V (1 of 2)

Condition / Parameter	Normal/Abnormal (N)	Design Basis Accident (A) (Includes 40 Year Integrated)
		LOCA/MSLB
Temperature (F)	50 - 122 (D.G. Control Room) 50 - 140 (D.G. Area)	50 - 122 (D.G. Control Room) 50 - 140 (D.G. Area)
Pressure (psig)	ATM	ATM
Relative Humidity (%)	NA	NA
Radiation (Rads) (40 Year Integrated Dose)	$<10^3$	$<10^3$
Chemicals	None	None

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 10 of 14)

DIESEL GENERATOR - ENVIRONMENTAL DESIGNATOR V (2 of 2)

Condition / Parameter	Normal/Abnormal	Design Basis Accident LOCA/MSLB
Submergence	None	None
Dust	1.52 $\mu G/M^3$ (D.G Control Room) 61.3 $\mu G/M^3$ (D.G. Area)	420 $\mu G/M^3$ (D.G. Control Room) 131 mG/M^3 (D.G. Area)
Seismic	2 OBE's (Refer to Seismic Response Spectra)	1 SSE (Refer to Seismic Response Spectra)
Dynamic	Refer to Equipment Specifications for requirements	Refer to Equipment Specifications for requirements
Aging	Equipment must be qualified for 40 year life for environmental parameters	Equipment must be qualified for 40 year life plus DBA for environmental parameters

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 11 of 14) 5

FUEL BUILDING - ENVIRONMENTAL DESIGNATOR VI (1 of 2)

Condition / Parameter	Normal/Abnormal (N)	Design Basis Accident (A) (Includes 40 Year Integrated)
		LOCA/MSLB
Temperature (F)	50 - 104	50 - 104
Pressure (psig)	ATM	ATM
Relative Humidity (%)	20 - 90%	20 - 90%
Radiation (Rads) (40 Year Integrated Dose)	$<10^3$	10^5
Chemicals	None	None

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 12 of 14)

FUEL BUILDING - ENVIRONMENTAL DESIGNATOR (2 of 2)

Condition / Parameter	Normal/Abnormal	Design Basis Accident
		LOCA/MSLB
Submergence	None	None
Dust	1.52 $\mu G/M^3$	650 $\mu G/M^3$
Seismic	2 OBE's (Refer to Seismic Response Spectra)	1 SSE (Refer to Seismic Response Spectra)
Dynamic	Refer to Equipment Specifications for requirements	Refer to Equipment Specifications for requirements
Aging	Equipment must be qualified for 40 year life environmental parameters	Equipment must be qualified for 40 year life plus DBA for environmental parameters

Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 13 of 14) 5

OUTSIDE AREAS - ENVIRONMENTAL DESIGNATOR VII (1 of 2)

Condition / Parameter	Normal/Abnormal (N)	Design Basis Accident (A) (Includes 40 Year Integrated)
		LOCA/MSLB
Temperature (F)	25 - 116	25 - 116
Pressure (psig)	ATM	ATM
Relative Humidity (%)	13 - 100%	13 - 100%
Radiation (Rads) (40 Year Integrated Dose)	$<10^3$	$<10^3$ 5
Chemicals	None	None

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Table 3E-1

ENVIRONMENTAL QUALIFICATION PARAMETERS (Sheet 14 of 14)

OUTSIDE AREAS - ENVIRONMENTAL DESIGNATOR VII (2 of 2)

Condition / Parameter	Normal/Abnormal	Design Basis Accident
		LOCA/MSLB
Submergence	None	None
Dust	61.3 $\mu G/M^3$ (Geometric Mean)	131 mG/M^3
Seismic	2 OBE's (Refer to Seismic Response Spectra)	1 SSE (Refer to Seismic Response Spectra)
Dynamic	Refer to Equipment Specifications for requirements	Refer to Equipment Specifications for requirements
Aging	Equipment must be qualified for 40 year life for environmental parameters	Equipment must be qualified for 40 year life plus DBA for environmental parameters

5

cc: T. Fitzsimmon
M. Mancuso
R. Cyboron
J. Bruno
S. Gilley

INGERSOLL-RAND
PUMPS

Engineered Pump Division
Ingersoll-Rand Company
942 Memorial Parkway
Phillipsburg, NJ 08865

6 DE 83

Combustion Engineering, Inc.
1000 Prospect Hill Rd.
Windsor, CT. 06095

Attention: Mr. T. R. Casper

Subject: ANPP: P.O.9500088/89/90/91/92/93/94/95/96
Safeguard Pumps, Non-Metallic Materials
Mechanical Equipment Enviromented Qualification
4X11CA-8, 8X20WDF, 8X23WDF
4X11-8CA500X1D, 8X20WDF500X25E, 8X23WDF500X4D

Gentlemen:

As requested, please find the attached list of non-metallic materials used in these pumps.

4X11CA-8 Stage HPSI Pump

Part No.	Part Name	Material (Non-Metallic)
363B	Gasket-Flexitallic	Asbestos
363C	" "	"
363H	" "	"
363E	" "	"
363D	" "	"
284	Gasket for End Cover	Hydroil
	oil	SAE 10 Motoroil
	Trico Oiler	Glass Bottle
	"	Rubber Gasket at Bottle
429	Durametallic Seal	
	Dwg. #2D-152304, F.O. #14047-76, B/M #78008-78009	

Dura Part #	Part Name	Materials
2	Insert	#5 Carbon
6	O-Ring	EPT
11	"	"
24	Floating Bushing	#5 Carbon
G	Gasket	EPT
P	Shaft Packing	EPT

8X20WDF LPSI Pump

Part No.	Part Name	Material (Non-Metallic)
363A	Gasket-Flexitallic	Asbestos
363B	" "	"
456	O-Ring	EP
	O-Ring in Cyclone Separator	EPT
429	Durametallic Seal	
	Dwg. #2D-151340, F.O. #13800-76, B/M #77584	

Dura Part #	Part Name	Material
2	Insert	#5 Carbon
6	O-Ring	EPT
24	Floating Bushing	#5 Carbon
G	Gasket	EPT
P	Shaft Packing	EPT

8X23WDF Containment Spray

Part No.	Part Name	Material
363A	Gasket Flexitallic	Asbestos
363B	"	"
456	O-Ring	E.P.
	O-Ring in Cyclone Separator	E.P.T.
429	Durametallic Seal	
	Dwg. #2D-151340, P.O. #13800-76, B/M #77584	

Dura Part #	Part Name	Material
2	Insert	#5 Carbon
24	Floating Bushing	"
6	O-Ring	E.P.T.
G	Gasket	E.P.T.
P	Shaft Packing	E.P.T.

If you have any questions or require any additional information, please contact me.

Sincerely yours,

P. F. Frederick
Field Service Engineer
Engineered Pump Division

PFF:kab

cc: Mr. J. Giammarinaro

CUSTOMERS IDENTIFICATION

COMBUSTION ENGINEERING/WPPSS, DUKE & ANPP
HIGH PRESSURE SAFETY INJECTION PUMPS
CONPONENT CODE #31-15-54-4222-0

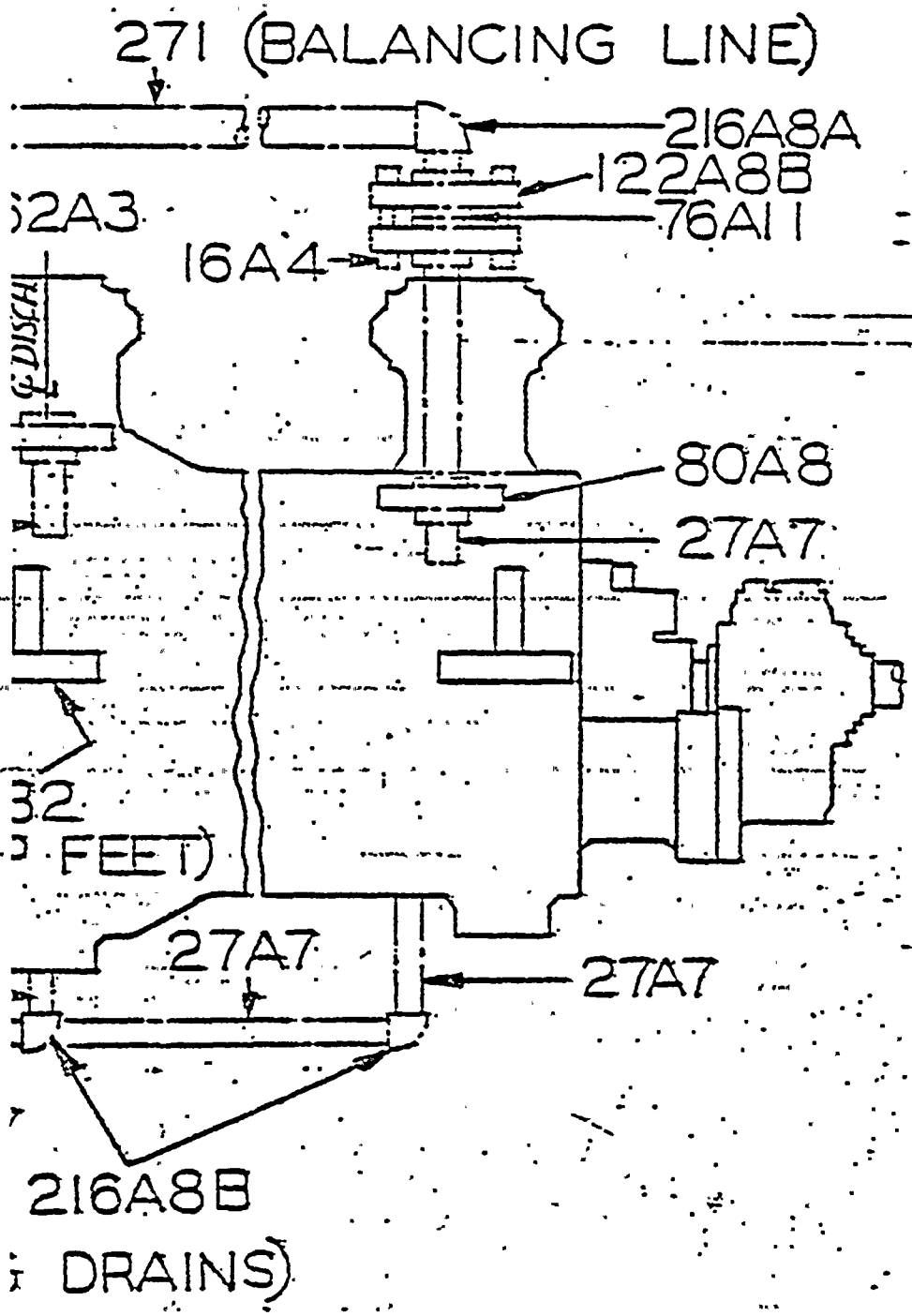
INGERSOLL-RAND IDENTIFICATION
ORDER NOS. 001-36400/02/04/07/10/13/16/19/22/25/28

CERTIFIED James Dean DATE 6 FE 76

REV. NO.	DATE	PAGE	DESCRIPTION	APPR. BY
0	6 FE 76	1-4	ORIGINAL ISSUE	JJ Engn 6NV78. M.S. DeNardo 6NV78
1	21 JY 76	3	REVISED PART 252A & 252B ADDED PART 252C	JJ Engn 6NV78. M.S. DeNardo 6NV78
2	22 FE 77	2 4	REVISED MATERIAL OF PART 56A ADDED PART 465	JJ Engn 6NV78. M.S. DeNardo 6NV78
3	7 NV 78	1-4	MADE GENERAL REVISIONS TO ALL PAGES	JJ Engn 6NV78 M.S. DeNardo 6NV78
4	15 JE 79	1	CHG'D. CUSTOMERS IDENTIFICATION ADDED I.R. ORDER NOS.	B. Buchelsman 28JE79
		2	DELETED ORDER NO.	M.S. DeNardo 28JE79
		3	ADDED MAT'L. TO PART NO. 178B, DELETED ASTERISKS FROM PART NOS. 171B & 171C & DELETED ORD. NO.	
		4	DELETED ORD. NO	
		5	ADDED MAT'L. TO PART NOS. 62A3, 16A4, 38A4, 27A7, 30A7E, 154A7, 216A8A, 216A8B, 122A8A, 122A8B, 80A8, & 163A8. PART NO. 38A4 WAS NUTS-EXTN. DELETED ORD. NO.	

(PL9A7)

CA PUMP


271 (BALANCING LINE)
216A8A
122A8B
76A11
52A3
16A4
80A8
27A7
27A7
27A7
216A8B
DRAINS)

PART NO.	NAME OF PART	MATERIAL
3A	IMPELLER-FIRST STAGE	**ASTM A296 CA 6NM
3B	IMPELLER-INTERMEDIATE STAGE	**ASTM A296 CA 6NM
3C	IMPELLER-LAST STAGE	**ASTM A296 CA 6NM
6A	RING-CASING-SUCT.GUIDE & 1ST STG.	**AISI TYPE 416(352-444 BHN)(IR2CK)
6B	RING-CASING-SPECIFY STAGE	**AISI TYPE 416(352-444 BHN)(IR2CK)
10	SHAFT	**ASTM A479 TYPE 304 HF (IR788)
11	KEY-IMPELLER	AISI TYPE 316 (IR 379CF)
12	KEY-COUPLING	AISI 1018 (IR 266)
31A	RING-OIL (PLAIN BEARING)	BRONZE (I.R. 673)
31B	RING-OIL (THRUST BEARING)	BRONZE (I.R. 673)
56A	DIFFUSOR-FIRST STAGE	**ASTM A296 CF8
56B	DIFFUSOR-INTERMEDIATE STAGE	**ASTM A182 F304
56C	DIFFUSOR-LAST STAGE	**ASTM A296 CF8
57A	SLEEVE-1ST STG. AT SHAFT NUT	AISI TYPE 316 (I.R. 379)
57B	SLEEVE-1ST STG.-PUMP SIDE	AISI TYPE 316 (I.R. 379)
59	SLEEVE-BALANCING	**AISI TYPE 416(262-302BHN) (IR2OH)
60A	RING-CHANNEL-INTERMEDIATE STG.	**ASTM A296 CF8
60B	RING-CHANNEL-NEXT TO LAST STG.	**ASTM A296 CF8
60C	RING-CHANNEL-LAST STG.	**ASTM A296 CF8
61	DRUM-BALANCING	**AISI TYPE 416(352-444BHN)(IR2CK)
82	SCREW-LOCK	AISI TYPE 316 (IR 379)
88A	BUSHING-STUFF. BOX EXTN.(SUCT. END)	**AISI TYPE 416(352-444 BHN)(IR2CK)
88B	BUSHING-STUFF. BOX EXTN.(DISCH.END)	**AISI TYPE 416(352-444 BHN (IR2CK)
109	RING-RETAINING (THRUST BRG.)	ASTM A109 (I.R. 249)
126A	NUT-SHAFT (SUCTION END)	**AISI TYPE 416(262-302BHN)(IR2OH)
126B	NUT-SHAFT (DISCHARGE END)	**AISI TYPE 416(262-302BHN)(IR2OH)
135A	SLEEVE-JOURNAL (PLAIN BRG.)	AISI C1215 (I.R. 9)
135B	SLEEVE-JOURNAL (THRUST BRG.)	AISI C1215 (I.R. 9)
157A	FLINGER-INBOARD & OUTBOARD (PLAIN BRG.)	ASTM A48 CL20A (I.R. 203)
157B	FLINGER-INBOARD (THRUST BRG.)	ASTM A48 CL20A (I.R. 203)
158	COVER-END-OUTBOARD (THRUST BRG.)	ASTM A48 CL25B (I.R. 202)
159A	HOUSING-BRG. (PLAIN BRG.)	ASTM A48 CL25B (I.R. 202)
159B	HOUSING-BRG. (THRUST BRG.)	ASTM A48 CL25B (I.R. 202)
160A	COVER-END-COUPLING SIDE (PLAIN BRG.)	ASTM A48 CL25B (I.R. 202)
160B	COVER-END-PUMP SIDE (PLAIN BRG.)	ASTM A48 CL25B (I.R. 202)
160C	COVER-END-PUMP SIDE (THRUST BRG.)	ASTM A48 CL25B (I.R. 202)
164	NUT-COUPLING	AISI TYPE 416 (I.R. 20)
167	SLEEVE-SPACING-SUCT.RING AT 1ST STG.	*AISI TYPE 416(262-352BHN)(IR2OH)
171A	PLATE-ADAPTER-BRG. BRACKET (SUCT. & DISCH. END)	AISI TYPE 304 (IR 407)
171B	BRACKET-BEARING ATTACHED TO BARREL SUCTION END	ASME SA240 TYPE 304
171C	BRACKET-BEARING ATTACHED TO BARREL DISCHARGE HEAD.	ASME SA240 TYPE 304
178A	STUD-BARREL TO DISCHARGE HEAD	*ASME SA193 GR. B7
178B	STUD GLAND-DISCH. & SUCT. END	*ASME SA193 GR. B8M OR B8
178C	STUD-SPLITTER	AISI TYPE 304

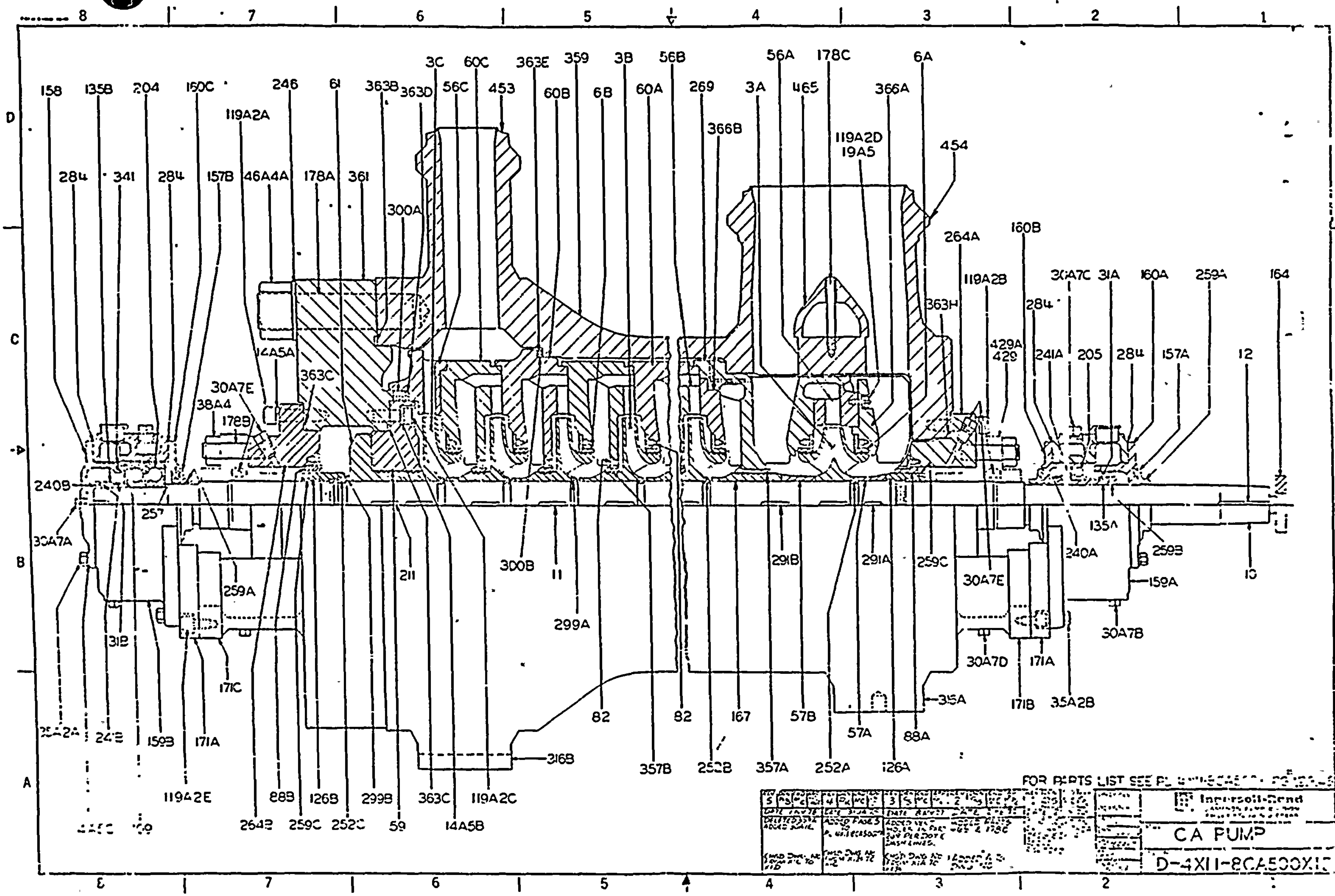
PART NO.	NAME OF PART	MATERIAL
204	BEARING-BALL-THRUST	STEEL
205	BEARING-BALL-PLAIN	STEEL
211	KEY-BALANCING DRUM	AISI TYPE 316 (IR 379CF)
240A	NUT-LOCK (PLAIN BRG.)	STEEL
240B	NUT-LOCK (THRUST BRG.)	STEEL
241A	WASHER-LOCK (PLAIN BRG.)	STEEL
241B	WASHER-LOCK (THRUST BRG.)	STEEL
246	WASHER-PLAIN (DISCH.HEAD TO BARREL)	AISI TYPE 416 (IR20)
252A	RING-SPLIT (IMPELLER) FIRST STAGE	AISI TYPE 316 (IR 379)
252B	RING-SPLIT (IMPELLER) SPECIFY STAGE	AISI TYPE 316 (IR 379)
252C	RING-SPLIT (BALANCING DRUM)	AISI TYPE 316 (IR 379)
257	SHIMS (THRUST BRG.) IF REQUIRED	STEEL (IR 249)
259A	SCREW-SET (FLINGER)	ASTM A574 (I.R. 318)
259B	SCREW-SET (JOURNAL SLEEVE)	ASTM A574 (I.R. 318)
259C	SCREW-SET (SHAFT SLEEVE NUT)	AISI TYPE 316 (IR 379)
264A	EXTENSION-STUFFING BOX SUCT. END	*ASME SA182 F304
264B	EXTENSION-STUFFING BOX DISCH. END	*ASME SA182 F304
269	RING-SUCTION	**ASTM A296 CF8
271	PIPE-BALANCE	*ASME SA312 TYPE 304,304L OR 316
284	GASKET-END COVERS	HYDROIL
291A	KEY-SLEEVE	AISI TYPE 316 (IR 379CF)
291B	KEY-SPACING SLEEVE	AISI TYPE 316 (IR 379CF)
299A	WASHER-RETAINING (SPLIT RING AT IMPELLER)	AISI TYPE 316 (IR 379)
299B	WASHER-RETAINING (SPLIT RING AT BAL.DRUM)	AISI TYPE 316 (IR 379)
300A	SPACER-GASKET-EXPAN. COMPENSATOR	AISI TYPE 300 SERIES (IR 669)
300B	SPACER-GASKET-EXPAN. COMPENSATOR	AISI TYPE 300 SERIES (IR 669)
316A	PIN BLOCK-FABRICATED TO BARREL	*ASME SA240 TYPE 304
316B	KEY BLOCK-FABRICATED TO BARREL	*ASME SA240 TYPE 304
332	PUMP FEET-FABRICATED TO BARREL	*ASME SA240 TYPE 304
341	SPRING-THRUST BEARING	STEEL (IR 223)
357A	BUSHING-SUCTION RING	**AISI TYPE 416(352-444BHN)(IR20K)
357B	BUSHING-CHANNEL RING	**AISI TYPE 416(352-444BHN)(IR20K)
359	BARREL	*ASME SA182 F304
361	HEAD-DISCH.	*ASME SA182 F304
363B	GASKET-BETWEEN BARREL & DISCH. HEAD	AISI TYPE 300 SERIES (I.R. 669)
363C	GASKET-BETWEEN DISCH.HD.& BAL. SLV. STUFF. BOX EXT. & DISCH. HD.	AISI TYPE 300 SERIES (I.R. 669)
363D	GASKET-EXPAN. COMPENSATOR	AISI TYPE 300 SERIES (I.R. 669)
363E	GASKET-BETWEEN CHANNEL RING & BARREL	AISI TYPE 300 SERIES (I.R. 669)
363H	GASKET-BETWEEN EXTN.& BARREL (SUCT.END)	AISI TYPE 300 SERIES (I.R. 669)
366A	GUIDE-SUCTION-1ST STAGE	**ASTM A296 CF8
366B	GUIDE-SUCTION-2ND STAGE	**ASTM A296 CF8
429	MECH.SEAL (SUCT. & DISCH.END)	REFER TO SEAL DETAIL
429A	GLAND MECH. SEAL	*ASME SA240 TYPE 316L
453	NOZZLE-DISCH.-FABRICATED TO BARREL	*ASME SA182 F304
454	NOZZLE-SUCT.-FABRICATED TO BARREL	*ASME SA351 CF8
465	SPLITTER FOR SUCTION NOZZLE	ASTM A296 CF8
35A2A	CAPSCREWS-END COVER (PLAIN & THRUST BRG.)	ASTM A307 GR. B (I.R. 175)
35A2B	CAPSCREWS-HOUSING (PLAIN & THRUST BRG.)	ASTM A307 GR. B (I.R. 175)

PART NO.	NAME OF PART	MATERIAL
119A2A	CAPSCREWS EXTENSION-DISCH. END	*ASME SA193 GR.B7 (PLATED PER FED. SPEC. NO.QQ-N-290A)
119A2B	CAPSCREWS EXTENSION-SUCT. END	*ASME SA193 GR.B7 (PLATED PER FED.SPEC. NO.QQ-N-290A)
119A2C	CAPSCREWS-BALANCING SLEEVE	AISI TYPE 316 (IR 379)
119A2D	CAPSCREWS-SUCTION GUIDE	AISI TYPE 316 (IR 379)
119A2E	CAPSCREW-ADAPTER LATE(PLAIN & THRUST BRG)	ASTM A307 GR.B (I.R. 318)
62A3	STUDS -BAL LINE	*ASME SA193 GR. B8M OR B8
16A4	NUTS -BAL. LINE	*ASME SA194 GR. 8 OR 8M
38A4	NUTS-GLAND	*ASME SA194 GR. 8 OR 8M
46A4A	NUTS -DISCH. HEAD	*ASME SA194 GR.2H
14A5A	WASHER-LOCK-EXTENSION	AISI TYPE 316 (IR 379)
14A5B	WASHER-LOCK-BALANCING SLEEVE	AISI TYPE 316 (IR 379)
14A5C	WASHER-LOCK-COVER	STEEL (IR 267)
19A5	CLIPS-LOCKING	AISI TYPE 316 (IR 379)
27A7	PIPE-DRAIN AND SEAL FLUSH	*ASME SA 312 TYPE 304,304L, OR 316
30A7A	PLUG-END COVER (THRUST BEARING)	STEEL
30A7B	PLUG-DRAIN (PLAIN & THRUST BRG.)	STEEL
30A7C	PLUG -(PLAIN & THRUST BRG.)	STEEL
30A7D	PLUG-DRAIN-BEARING BRACKETS	STEEL
30A7E	PLUG-EXTENSION & GLAND	*ASME SA182 F304,304L OR 316
154A7	CAP-PIPE DRAIN	*ASME SA182 F304,304L OR 316
216A8A	ELBOW -BAL. PIPE	*ASME SA182 F304L,304 OR 316
216A8B	ELBOW-DRAIN	*ASME SA182 F304L,304 OR 316
122A8A	FLANGE -BAL PIPE	*ASME SA182 F304,304L, OR 316
122A8B	FLANGE-BALANCE PIPE	*ASME SA182 F316,304L, OR 304
76A11	GASKET-FLANGE-BALANCE PIPE	AISI TYPE 300 SERIES (IR 669)
80A8	FLANGE-SEAL FLUSH	*ASME SA182 F304,304L OR 316
163A8	FLANGE-SEAL FLUSH	*ASME SA182 F304,304L OR 316

*THESE ARE PRESSURE BOUNDRY PARTS OR ATTACHEMENTS TO PRESSURE BOUNDARY PARTS AND THEY WILL CONFORM TO THE REQUIREMENTS OF ASME B&PV CODE, 1974 EDITION, SECTION III, DIVISION I, SUMMER OF 1974 ADDENDA.

**THESE NON-PRESSURE BOUNDARY PARTS WILL BE CERTIFIED BY CERTIFICATE OF CONFORMANCE TO THE APPLICABLE ASTM OR AISI MATERIAL SPEC.

NOTE: THE ASTM AND AISI MATERIAL SPECS. FOR THOSE PARTS NOT COVERED BY THE ABOVE FOOTNOTES ARE REFERENCED FOR CHEMICAL AND PHYSICAL INFORMATION ONLY.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FOR PARTS LIST SEE PL
Ingersoll-Rand
CA PUMP
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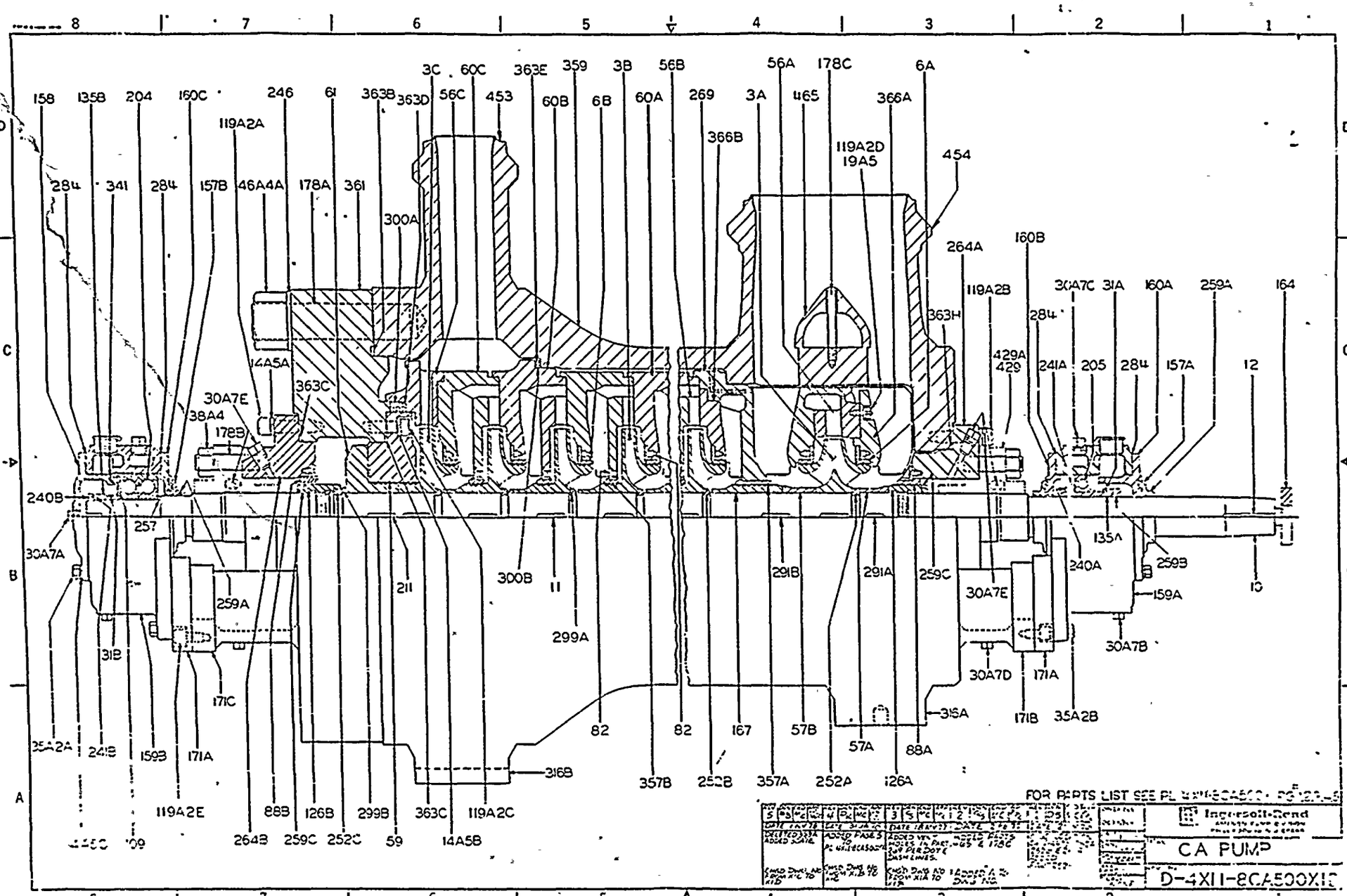
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FOR PARTS LIST SEE PL
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CA PUMP
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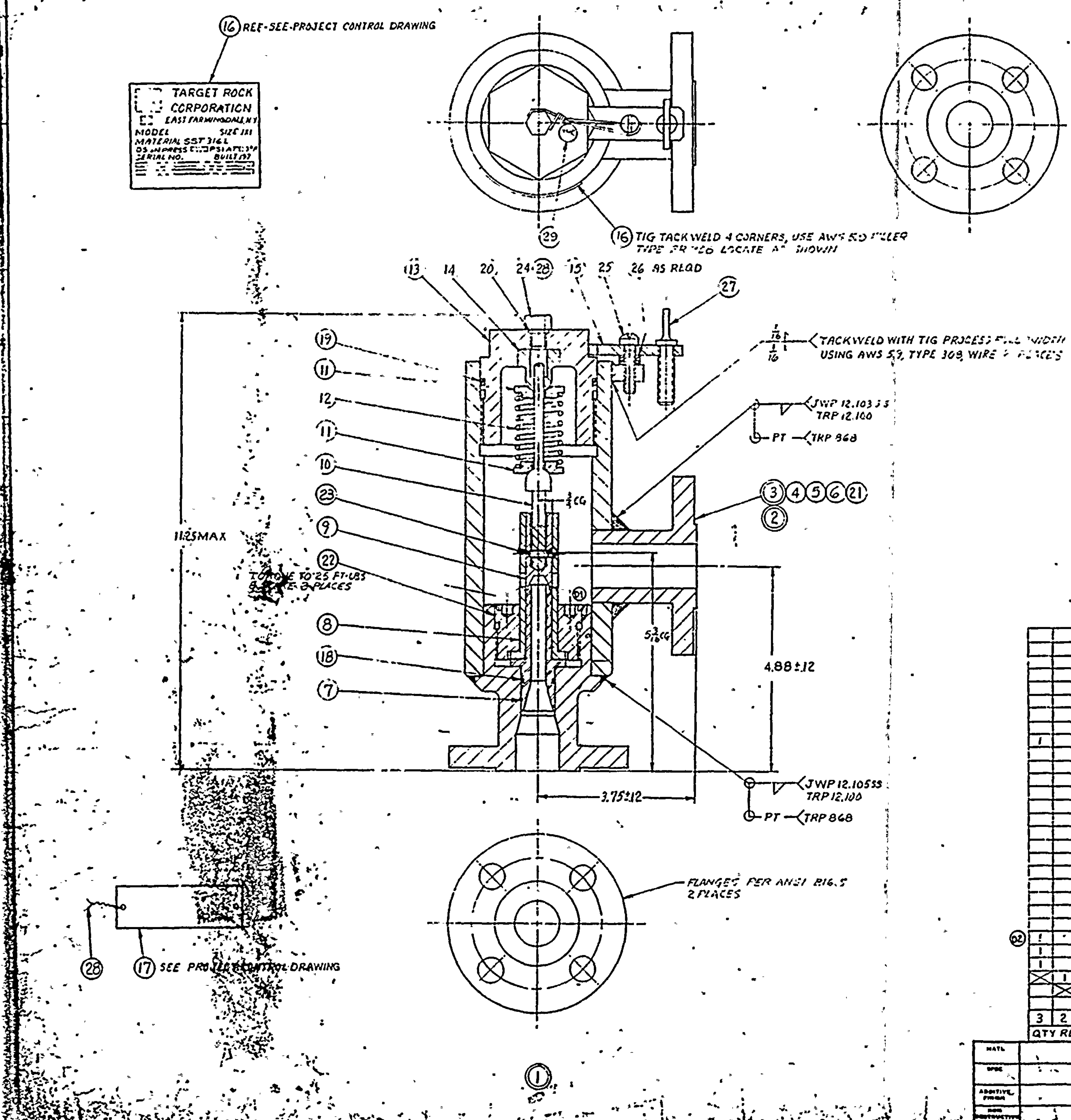

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	[illegible]	[illegible]	[illegible]
	B	FIND NO. 2 PART NO. WAS 300335	[illegible]	[illegible]
	C	ITEM 9 (REMARKS) ADDED ALT MATERIAL	[illegible]	[illegible]
	D	QTY & PICTORIAL CHANGE TO INLET FLANGE; ITEM 4, 5, 6 ADDED ALT MATL	[illegible]	[illegible]

TI APERTURE CARD

UNCONTROLLED DRAWINGS
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76Q-001
76Q-006

Also Available On Aperture Card

QTY REQD 3	QTY REQD 2	QTY REQD 1	FIND NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
		1	29	102358	LOCKWIRE SEAL	TIN PLATED STEEL		
		A/R	28	.031 DIA	LOCKWIRE	S.S. 300 SERIES		
		1	27	3/8-16UNC X 1 3/8 LG	GAG, THUMB SCREW	S.S. 300 SERIES		SHOULDER PATTERN
		A/R	26	1/4 NOM I.D. X 1/2 O.D.	WASHER, PLAIN	S.S. 300 SERIES		
		1	25	1/4-20UNC X 1 1/8 LG	SCREW, FIL. HD, DRILLED	S.S. 300 SERIES		
		1	24	102304	PLUG	S.S. 300 SERIES		
		1	23	.125 DIA X .50 LG	DOWEL PIN	S.S. 300 SERIES		
		1	22	200870	LOCK NUT	S.S. 300 SERIES		CHROME PLATE THDS
1			21	102338-2	LUG	S.S. 300 SERIES		
		1	20	ARP 568-012	O-RING	SILICONE RUBBER		
		1	19	ARP 568-230	O-RING	SILICONE RUBBER		
		1	18	ARP 568-017	O-RING	SILICONE RUBBER		
		1	17	100900	IDENT TAG	S.S. 300 SERIES		
		1	16	100899	NAMEPLATE	S.S. 300 SERIES		
		1	15	102337-2	LOCKING TAB	S.S. 300 SERIES		
		1	14	102303-2	ADAPTER	S.S. 17-4PH		AGE HARD AT 1100°F
		1	13	200868	BONNET	S.S.	ASME SA479-316	CHROME PLATE THDS
		1	12	300304-2	SPRING	S.S. A-286		
		2	11	102322-2	SPRING RETAINER	S.S.	ASME SA479-316	
		1	10	200824	STEM	S.S.	ASME SA479-410	Rc 25-32
		1	9	102320	DISC	STELLITE 6B		[illegible]
		1	8	200871	DISC GUIDE	S.S.	ASME SA479-316	
		1	7	200872	NOZZLE SEAT	S.S.	ASME SA479 316	
1			6	200874	BODY, ROUGH MACH.	S.S.	ASME SA316-316	ALT MAT'L S.S. ASME SA421-316
1			5	200873	FLANGE, OUTLET	S.S.	ASME SA479-316L	ALT MAT'L S.S. ASME SA479-316
1			4	200869	FLANGE, INLET	S.S.	ASME SA479-316L	ALT MAT'L S.S. ASME SA479-316
X	1		3	300309-3	BODY, WELDMENT			
	X	1	2	300335	BODY, FINAL MACH.			
		X	1		RELIEF VALVE ASSEMBLY			

PARTS LIST

DRAWN R.C. MELIUS — CHECKED — APPROVED

1"X1" RELIEF VALVE ASSEMBLY 150 LB FLANGES

Target Rock Corporation

REH-S-1 D

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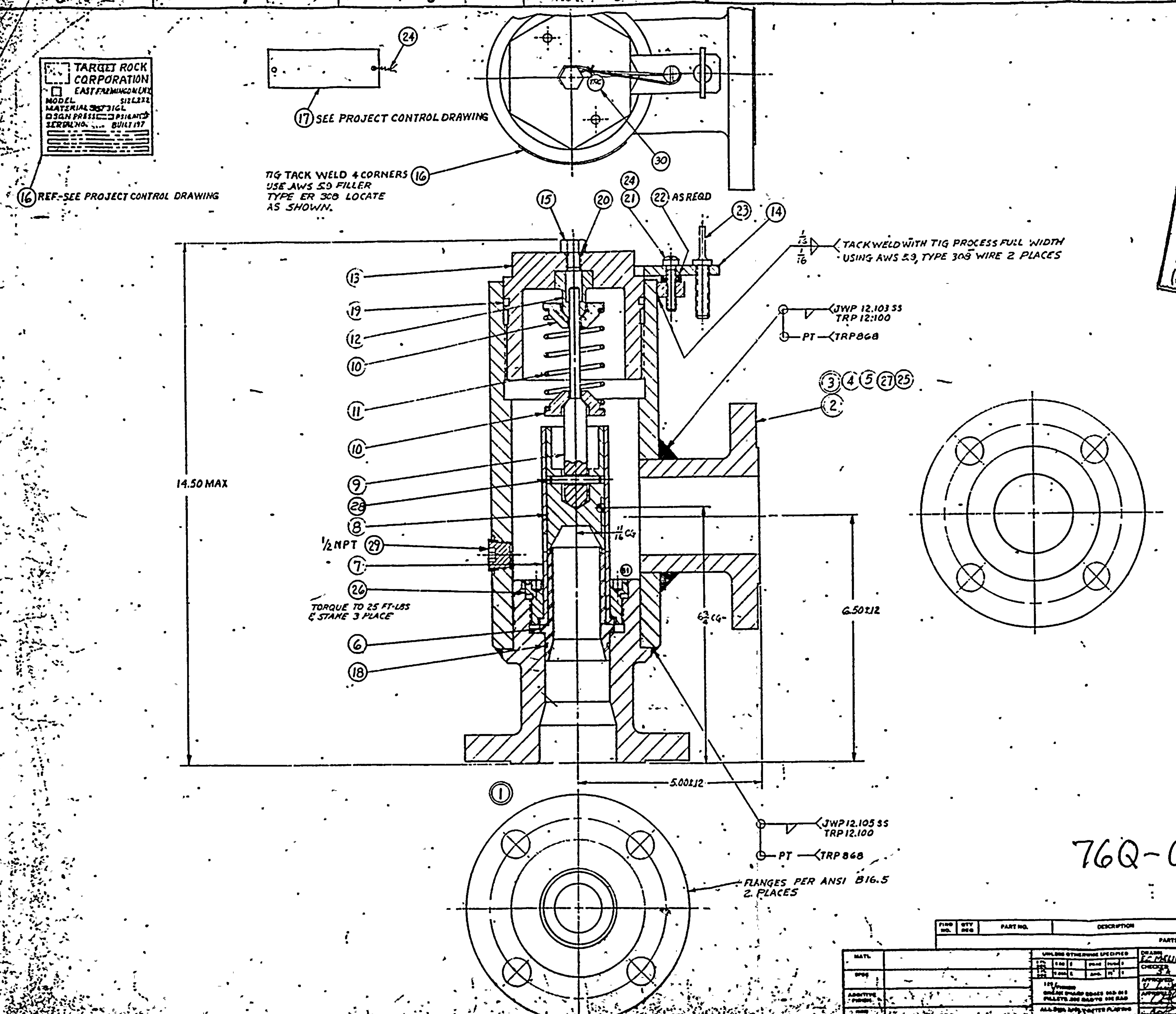

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ITEM 2 P/N WAS 400022 — ADDED ITEM 30 — ADDED TORQUE TO ITEM 26 — REMOVED "NY" FROM NAME PLATE (ITEM 16) — ITEM 10 MAT'L WAS 300 SERIES & ADDED MATL. SPEC.	7-14-77	SK 8/15/77
	B	① MADE PICTORIAL CHANGE TO INLET FLANGE ② ADDED ALTERNATE MATL SPEC FOR ITEM 4,5,25	WSH 11/21/79	[illegible]
	C	ITEM 10 P/N WAS 102300-2 ITEM 11 P/N WAS 102299-3 ITEM 12 P/N WAS 102303-4	7/10/83	[illegible]

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TI APERTURE CARD

Also Available On Aperture Card

76Q-002

FIND NO.	QTY REQ	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS

PARTS LIST

2"X2" RELIEF VALVE ASSEMBLY 150 LB FLANGES

Target Rock Corporation

DRAWN E.C. MELIUS · CHECKED · APPROVED

DO NOT SCALE DRAWING

SCALE FULL

2X2 REH5-1 C

DATA CODE 1-9
ACTIVITY PKG NO. N/A
ENGR SYSTEM NO. EN
QUAL CLASS Q
13-10407
3641-10-3

8403090014-02

REVISIONS: SEE SHEET 1 OF 2

TI APERTURE CARD

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Also Available On Aperture Card

76Q-002

QTY REQD 3	QTY REQD 2	QTY REQD 1	FIND NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
		1	30	102358	LOCKWIRE SEAL	TIN PLATED STEEL		
		1	29	1/2 NPT	PIPE PLUG, INTERNAL HEX	S.S. 300 SERIES		
		1	28	.1875 DIA X 1.38 LG	DOWEL PIN	S.S. 300 SERIES		
1			27	102338-1	LUG	S.S. 300 SERIES		
		1	26	200866-1	LOCKNUT	S.S. 300 SERIES		CHROME PLATE THDS
1			25	200867-1	FLANGE, INLET	S.S.	ASME SA479-316L	ALT MATL - SS - ASME SA-479-316
		A/R	24	.031 DIA	LOCKWIRE	S.S. 300 SERIES		
		1	23	3/8-16UNC-2A X 1 3/8 LG	GAG, THUMB SCREW	S.S. 300 SERIES		SHOULDER PATTERN
		A/R	22	1/4 NOM.	WASHER, PLAIN	S.S. 300 SERIES		
		1	21	1/4-20UNC-2A X 1 1/8 LG	SCREW, FIL. HD. DRILLED	S.S. 300 SERIES		
		1	20	ARP568-012	O-RING	SILICONE RUBBER		
		1	19	ARP568-238	O-RING	SILICONE RUBBER		
		1	18	ARP568-030	O-RING	SILICONE RUBBER		
		1	17	100900	IDENT TAG	S.S. 300 SERIES		
		1	16	100899	NAMEPLATE	S.S. 300 SERIES		
		1	15	102304	PLUG	S.S. 300 SERIES		
		1	14	102337-1	LOCKING TAB	S.S. 300 SERIES		
		1	13	300311	BONNET	S.S.	ASME SA479-316	CHROME PLATE THDS
		1	12	102303-7	ADAPTER	S.S. 17-4 PH		AGE HARD. AT 1075°F
		1	11	700-0073	SPRING	S.S. 302		ASSOCIATED
		2	10	102322-4	SPRING RETAINER	S.S.	ASME SA479-316	
		1	9	102301	STEM	S.S.	ASME SA479-410	Rc 26-32
		1	8	102331-2	DISC	STELLITE 6B		
		1	7	200834-1	DISC GUIDE	S.S.	ASME SA479-316	
		1	6	200833	NOZZLE SEAT	S.S.	ASME SA479-316	
1			5	200829-1	FLANGE, OUTLET	S.S.	ASME SA479-316L	ALT MATL - SS - ASME SA-479-316
1			4	300310-1	BODY, ROUGH MACH.	S.S.	ASME SA376-316	ALTERNATE: ASME SA479-316
X	1		3	300309-1	BODY, WELDMENT			
	X	1	2	400023	BODY, FINAL MACH			
		X	1		RELIEF VALVE ASSY			

PARTS LIST

SUBSTANDARD ORIGINAL — NOT SUITABLE FOR LEGIBLE REPRODUCTION

DRAWN: F.C. MELIUS — DATE: 6-28-77

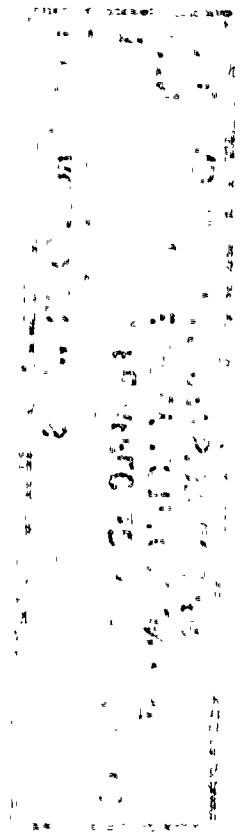
2" X 2" RELIEF VALVE ASSEMBLY 150LB FLANGES

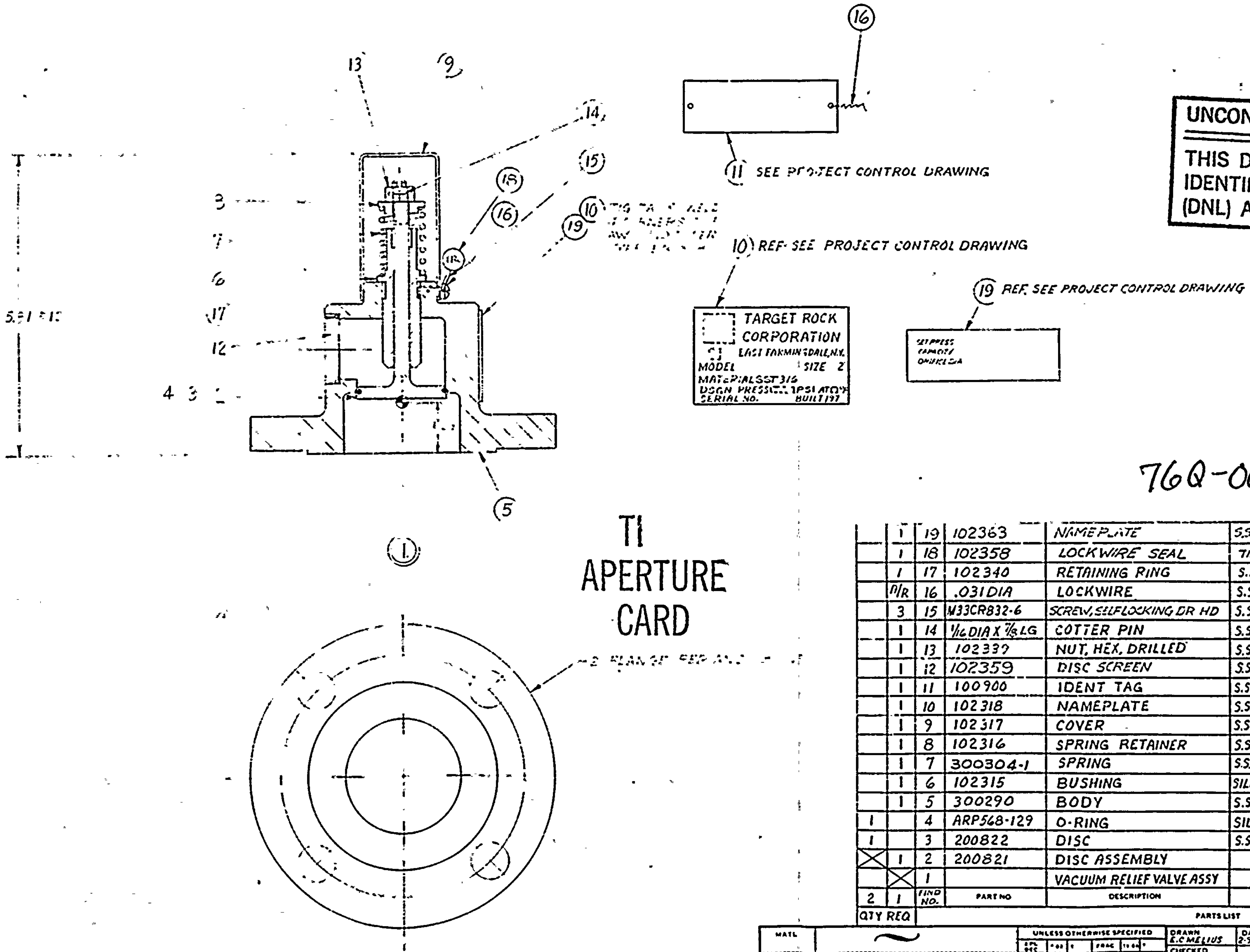
Target Rock Corporation

DO NOT SCALE DRAWING

2X2RER-64 — C

8403090014-03





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Also Available On Aperture Card

76Q-003

PARTS LIST

QTY REQ 2	QTY REQ 1	FIND NO.	PART NO	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
	1	19	102363	NAMEPLATE	S.S. 300 SERIES		
	1	18	102358	LOCKWIRE SEAL	TIN PLATED STEEL		
	1	17	102340	RETAINING RING	S.S. 300 SERIES		SPRING TEMPER
	N/R	16	.031 DIA	LOCKWIRE	S.S. 300 SERIES		
	3	15	M33CR832-6	SCREW, SELFLOCKING DR HD	S.S. 300 SERIES		NYLOK
	1	14	1/16 DIA X 7/8 LG	COTTER PIN	S.S. 300 SERIES		
	1	13	102339	NUT, HEX, DRILLED	S.S. 300 SERIES		
	1	12	102359	DISC SCREEN	S.S. 300 SERIES		
	1	11	100900	IDENT TAG	S.S. 300 SERIES		
	1	10	102318	NAMEPLATE	S.S. 300 SERIES		
	1	9	102317	COVER	S.S. 300 SERIES		
	1	8	102316	SPRING RETAINER	S.S. 300 SERIES		
	1	7	300304-1	SPRING	S.S. A-286		
	1	6	102315	BUSHING	SILICON BRONZE		
	1	5	300290	BODY	S.S.	ASME SA479-316	
1		4	ARP568-129	O-RING	SILICONE RUBBER		
1		3	200822	DISC	S.S	ASME SA479-316	
X	1	2	200821	DISC ASSEMBLY			
	X	1		VACUUM RELIEF VALVE ASSY			

UNLESS OTHERWISE SPECIFIED

125 √ FINISH
BREAK SHARP EDGES .005-.015
FILLETS .005 RAD TO .032 RAD
ALL DIM APPLY AFTER PLATING

DRAWN E.C MELIUS 2-9-77
CHECKED 5-5-77
APPROVED

2" VACUUM RELIEF VALVE ASSEMBLY 150 LB FLANGE

Target Rock Corporation, E. Farmingdale, New York

CODE IDENT. NO. 93160

2"VRES-S-1 REV A

DO NOT SCALE DRAWING

SCALE FULL | WT | TAA 76Q | SHEET 1 OF 1

DATA CODE 1.2
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ENGR SYSTEM NO.
QUAL CLASS Q

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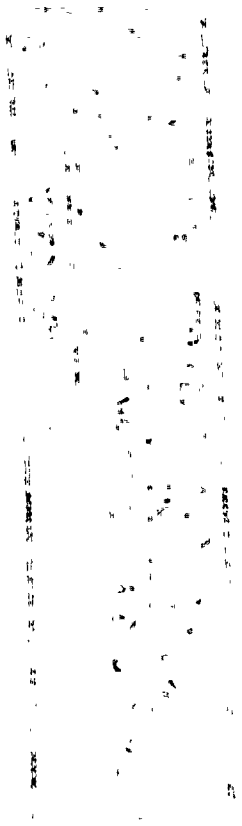

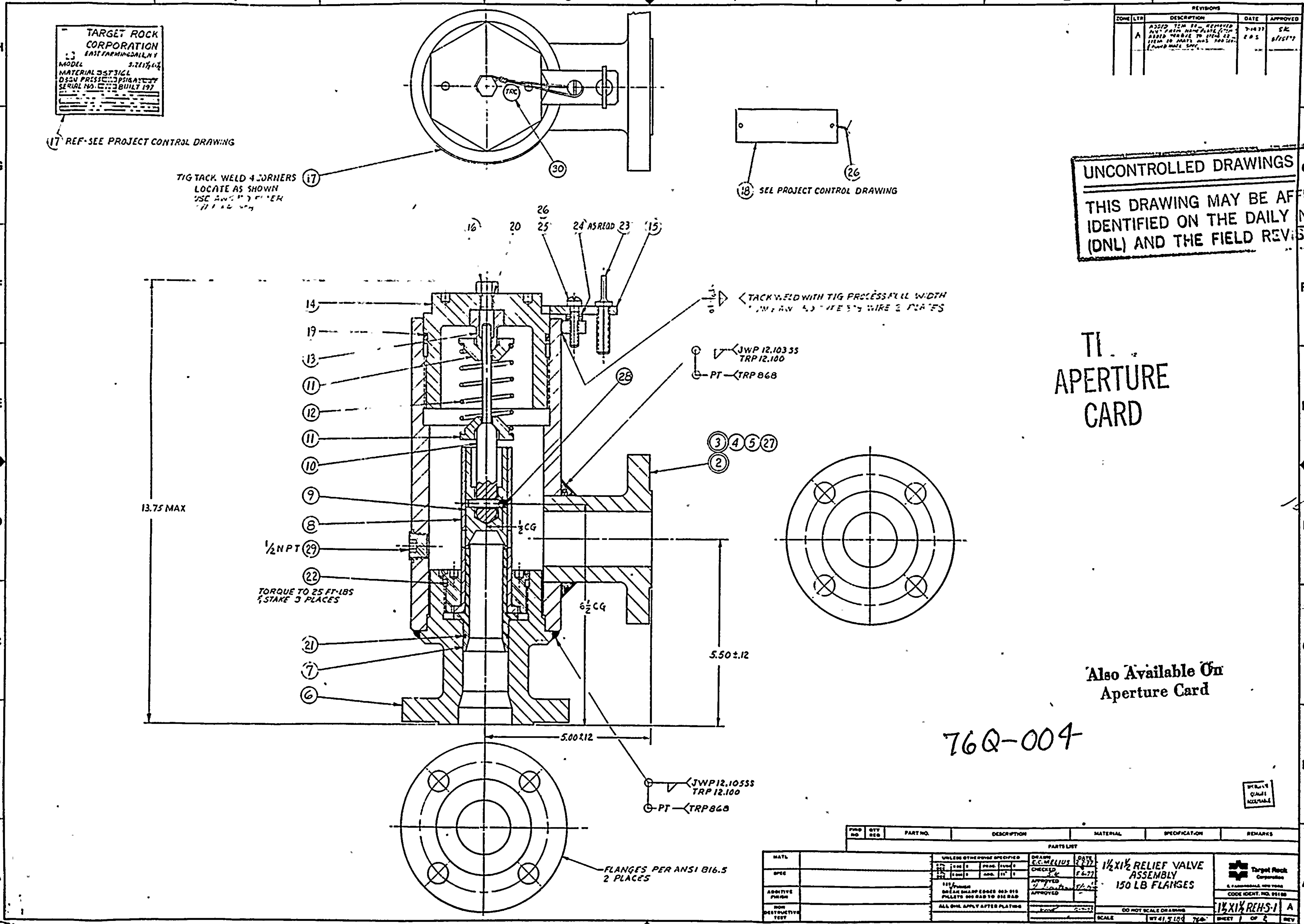

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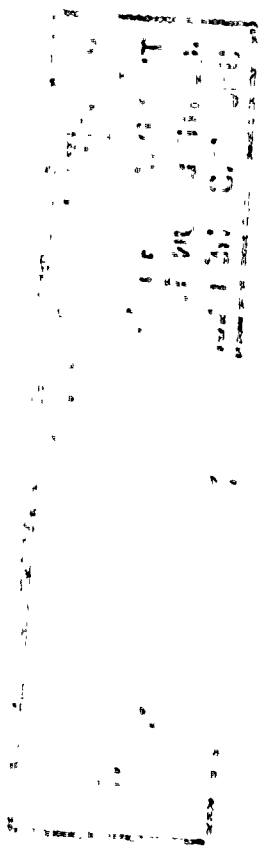
TI
APERTURE
CARD

Also Available On
Aperture Card

76Q-004

8403090014-05



TI APERTURE CARD

UNCONTROLLED DRAWINGS

THIS DRAWING MAY BE AFFECTED BY DOCUMENTS IDENTIFIED ON THE DAILY NOTIFICATION LIST (DNL) AND THE FIELD REVISION LOG (FRL).

Also Available On Aperture Card

76Q-004

QTY REQD 3	QTY REQD 2	QTY REQD 1	FIND NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
		1	30	102358	LOCKWIRE SEAL	TIN PLATED STEEL		
		1	29	1/2 NPT	PIPE PLUG, INTERNAL HEX	S.S. 300 SERIES		
		1	28	.1875 DIA X 1.12 LG	DOWEL PIN	S.S. 300 SERIES		
1			27	102338-1	LUG	S.S. 300 SERIES		
		A/R	26	.031 DIA	LOCKWIRE	S.S. 300 SERIES		
		1	25	1/4-20UNC X 1 1/4 LG	SCREW, FIL. HD. DRILLED	S.S. 300 SERIES		
		A/R	24	1/4 NOM I.D. X 1/2 O.D.	WASHER PLAIN	S.S. 300 SERIES		
		1	23	3/8-16UNC X 1 3/8 LG	GAG, THUMB SCREW	S.S. 300 SERIES		SHOULDER PATTERN
		1	22	200866-2	LOCK NUT	S.S. 300 SERIES		CHROME PLATE THDS
		1	21	ARP568-026	O-RING	SILICONE RUBBER		
		1	20	ARP568-012	O-RING	SILICONE RUBBER		
		1	19	ARP568-238	O-RING	SILICONE RUBBER		
		1	18	100900	IDENT TAG	S.S. 300 SERIES		
		1	17	100899	NAMEPLATE	S.S. 300 SERIES		
		1	16	102304	PLUG	S.S. 300 SERIES		
		1	15	102337-1	LOCKING TAB	S.S. 300 SERIES		
		1	14	300311	BONNET	S.S.	ASME SA479-316	CHROME PLATE THDS
		1	13	102303-4	ADAPTER	S.S. 17-4PH		AGE HARD AT 1075°F
		1	12	102299-4	SPRING	S.S. A-286		
		2	11	102300-2	SPRING RETAINER	S.S.	ASME SA479-316	
		1	10	102301	STEM	S.S.	ASME SA479-410	Rc 26-32
		1	9	102331-1	DISC	STELLITE 6B		
		1	8	200834-2	DISC GUIDE	S.S.	ASME SA479-316	
		1	7	200832	NOZZLE SEAT	S.S.	ASME SA479-316	
1			6	300310-2	BODY, ROUGH MACH	S.S.	ASME SA376-316	
1			5	200829-2	FLANGE, OUTLET	S.S.	ASME SA479-316L	
1			4	200867-2	FLANGE, INLET	S.S.	ASME SA479-316L	
X	1		3	300309-2	BODY, WELDMENT			
	X	1	2	400024	BODY, FINAL MACH			
		X	1		RELIEF VALVE ASSEMBLY			

PARTS LIST

UNLESS OTHERWISE SPECIFIED

ALL DIM APPLY AFTER PLATING

DO NOT SCALE DRAWING

DRAWN E C MELINS — CHECKED SK — DATE 5-6-77

1 1/2 X 1 1/2 RELIEF VALVE ASSEMBLY 150 LB FLANGES

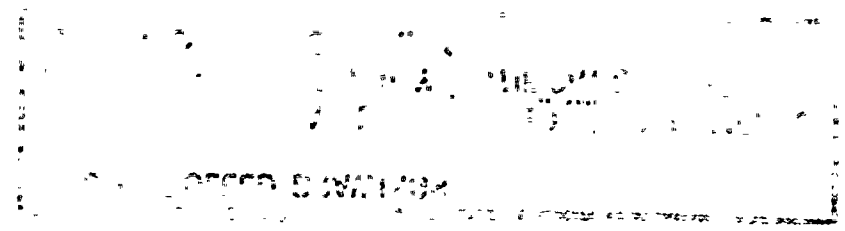
Target Rock Corporation

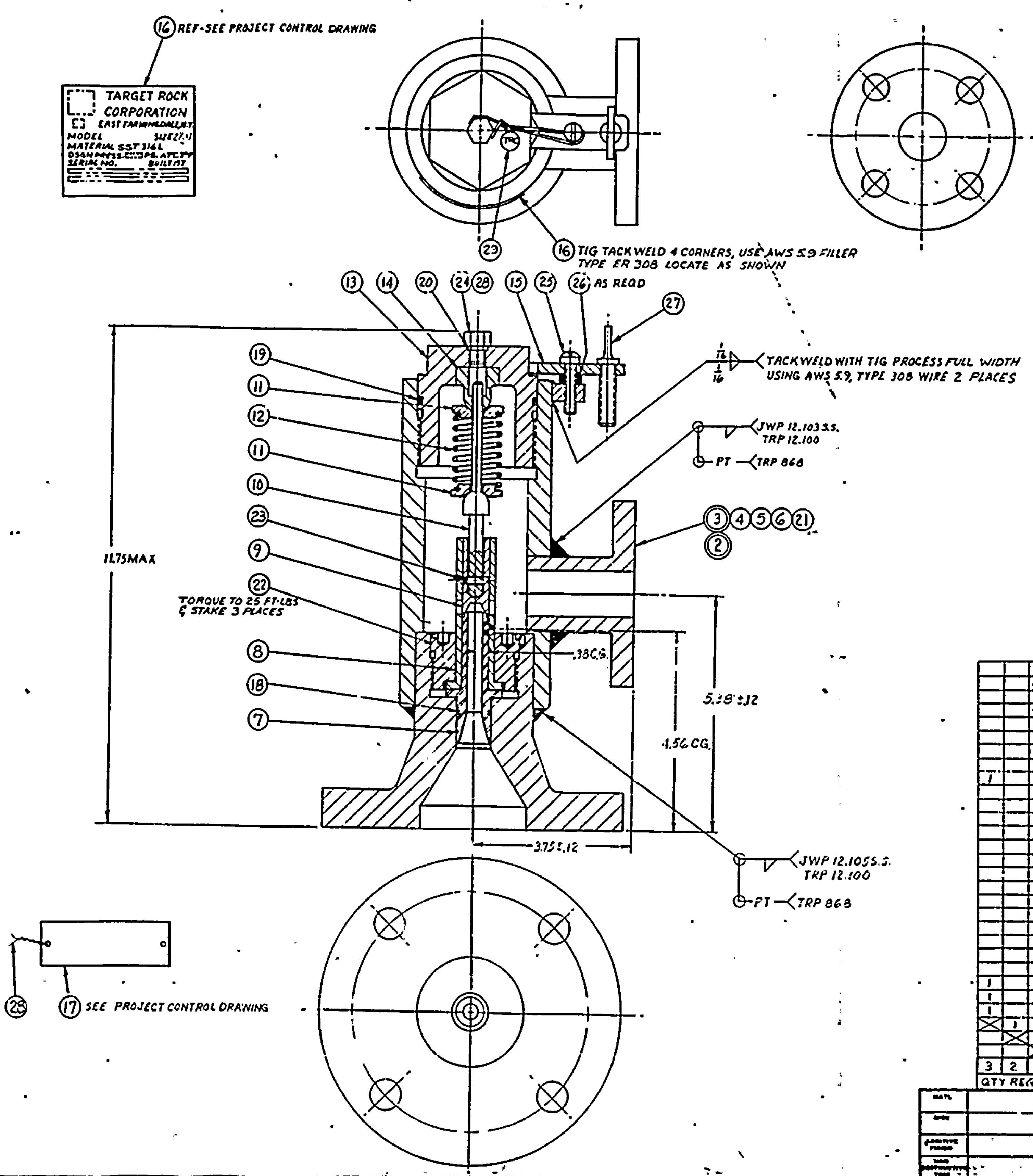
CODE IDENT NO. 95163

1 1/2 X 1 1/2 REH-S-1 — REV A — SHEET 2 OF 2

76Q-004

8403090014-06





TI APERTURE CARD

UNCONTROLLED DRAWINGS

THIS DRAWING MAY BE AFFECTED BY DOCUMENTS IDENTIFIED ON THE DAILY NOTIFICATION LIST (DNL) AND THE FIELD REVISION LOG (FRL).

Also Available On Aperture Card

76Q-005

REV	DESCRIPTION	DATE	APPROVED
A	ITEM 9, (REMARKS) ADDED ALT MATL		
B	ITEM 9, MATL WAS STELLITE #6; REMOVED ALT MATL; ITEM 4 ASME SA-564 GR 630; P/N WAS 102320-1		
C	ITEM 12 WAS ... MATL A 286		
D	(9) ITEM 6 WAS ASME 376-316	6-25-80	

QTY REQD 3	QTY REQD 2	QTY REQD 1	FIND NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
		1	29	102358	LOCKWIRE SEAL	TIN PLATED STEEL		
		A/R	28	.031 DIA	LOCKWIRE	S.S. 300 SERIES		
		1	27	#-16UNC X 1½ LG	GAG, THUMB SCREW	S.S. 300 SERIES		SHOULDER PATTERN
		A/R	26	#NOM I.D. X 1½ O.D.	WASHER, PLAIN	S.S. 300 SERIES		
		1	25	¼-20UNC X 1⅛ LG	SCREW, FIL. HD., DRILLED	S.S. 300 SERIES		
		1	24	102304	PLUG	S.S. 300 SERIES		
		1	23	.125 DIA X .50 LG	DOWEL PIN	S.S. 300 SERIES		
		1	22	200870	LOCK NUT	S.S. 300 SERIES		CHROME PLATE THDS
1			21	102338-2	LUG	S.S. 300 SERIES		
		1	20	ARP 568-012	O-RING	SILICONE RUBBER		
		1	19	ARP 568-230	O-RING	SILICONE RUBBER		
		1	18	ARP 568-017	O-RING	SILICONE RUBBER		
		1	17	100900	IDENT TAG	S.S. 300 SERIES		
		1	16	100899	NAMEPLATE	S.S. 300 SERIES		
		1	15	102337-2	LOCKING TAB	S.S. 300 SERIES		
		1	14	102303-2	ADAPTER	S.S. 17-4PH		AGE HARD AT 1100°F
		1	13	200868	BONNET	S.S.	ASME SA479-316	CHROME PLATE THDS
		1	12	C1100-112-2500S	SPRING	S.S. 302		ASS. - SPRING CARD
		2	11	102322-2	SPRING RETAINER	S.S.	ASME SA479-316	
		1	10	200824	STEM	S.S.	ASME SA479-410	Rc 26-32
		1	9	102320-4	DISC	S.S. 17-4 PH	ASME SA-564 GR 630	AGE HARD AT 1100°F
		1	8	200871	DISC GUIDE	S.S.	ASME SA479-316	
		1	7	200872	NOZZLE SEAT	S.S.	ASME SA479-316	
1			6	202233	BODY, ROUGH MACH.	S.S.	ASME SA479-316L	
1			5	202043	FLANGE, OUTLET	S.S.	ASME SA479-316L	
1			4	300463	FLANGE, INLET	S.S.	ASME SA479-316L	
X	1		3	400041-1	BODY, WELDMENT			
	X	1	2	300465	BODY, FINAL MACH.			
		X	1		RELIEF VALVE ASSEMBLY			

PARTS LIST

2½ X 1" RELIEF VALVE ASSEMBLY 150 LB FLANGES

Target Rock Corporation

2½X1REHS-1 D

DO NOT SCALE DRAWING

SCALE FULL

DATA CODE 1.1.1.2

ACTIVITY PROG NO N/A

ENGR SYSTEM NO SP

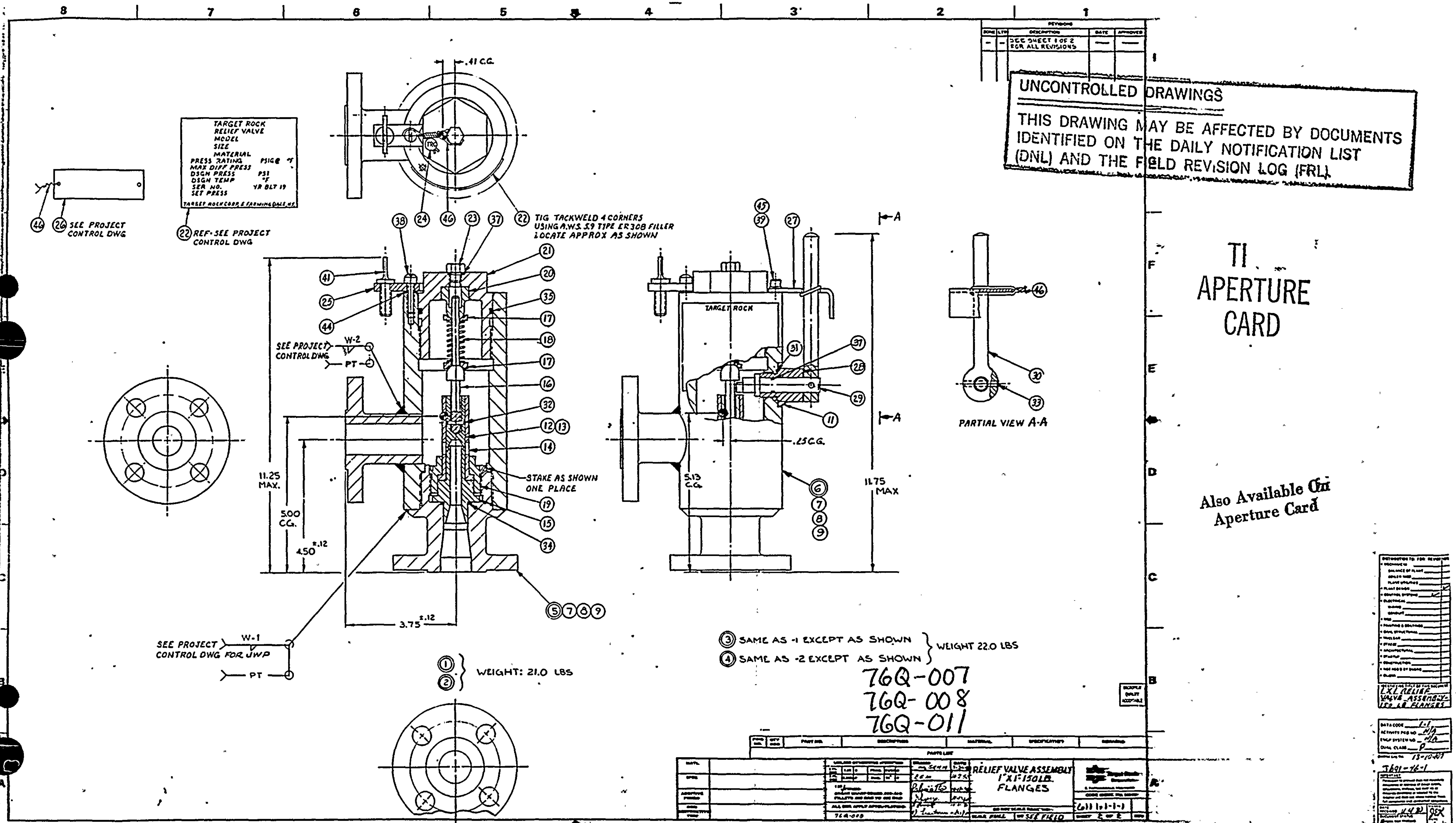
QUAL CLASS Q

13-10407

J691-35-3

SAME

8403090014-07



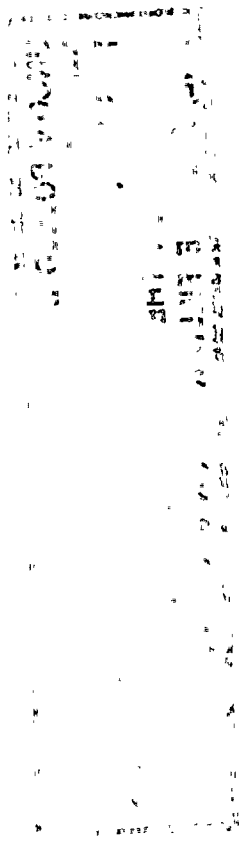
UNCONTROLLED DRAWINGS

THIS DRAWING MAY BE AFFECTED BY DOCUMENTS IDENTIFIED ON THE DAILY NOTIFICATION LIST (DNL) AND THE FIELD REVISION LOG (FRL).

TI APERTURE CARD

Also Available On Aperture Card

8403090014-08



NOTES:
1. THE PROJECT CONTROL DRAWING FOR EACH PROJECT WILL SPECIFY a. THE SPECIFIED PART NO. OF ITEMS NOT IDENTIFIED IN THE BILL OF MATERIAL. b. THE NAMEPLATE & IDENTIFICATION TAG FILL IN DATA. c. THE VALVE ASSEMBLY OPTIONS. d. IF ANY PARTS OR MATERIALS ARE DIFFERENT THAN THOSE IDENTIFIED IN THE BILL OF MATERIAL.

MATERIAL.
2. THE VALVE DESCRIBED HERE ON IS A 1"X1" ISOLB RELIEF VALVE, IT IS AVAILABLE WITH HARD OR SOFT DISCS & WITH OR WITHOUT MANUAL LIFTS. THE PROJECT CONTROL DRAWING WILL SPECIFY THE OPTIONS BEING ORDERED.

611 1x1-1-1 - □ VALVE ASSY NUMBER
- PROJECT CONTROL DRAWING WILL SPECIFY.
- 10-HARDSEAT-NO MNL LIFT
- 20-SOFTSEAT-NO MNL LIFT
- 30-HARDSEAT-WITH MNL LIFT
- 40-SOFTSEAT-WITH MNL LIFT
- BASIC VALVE DRAWING NO.

3. SEE PROJECT CONTROL DRAWING FOR APPLICABLE NOTES, WELDING PROCEDURE & DESIGN DATA.

76Q-007
76Q-008
76Q-011

										FIND NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
						1	1			36					
						1	1	1	1	35	300-2228	O-RING	SILICONE RUBBER		
						1	1	1	1	34	300-2020	O-RING	SILICONE RUBBER		
						1	1			33	441-0001	GROOVE PIN	SS 300 SER		
						1	1	1	1	32	430-0014	DOWEL PIN	SS 300 SER		
						1	1			31	300-2021	O-RING	SILICONE RUBBER		
						1	1			30	102467-1	LIFTING LEVER	C.S.		NICKEL PLATED
						1	1			29	102730-1	SHAFT	SS 17-4PH	ASME SA564 GR 630	Rc 32-38
						1	1			28	102811-1	NUT, LIFTING LEVER	SS 316	ASME SA 479	CHROME PLATE
						1	1			27	102729-1	BRACKET	SS 300 SER		
						1	1	1	1	26	100900-1	IDENT TAG	SS 300 SER		
						1	1	1	1	25	102302-2	LOCKING TAB	SS 300 SER		
						1	1	1	1	24	102358-1	LOCKWIRE SEAL	TIN PLD STEEL		
						1	1	1	1	23	102304-1	PLUG	SS 300 SER		
						1	1	1	1	22	202334-1	NAMEPLATE	SS300SER		
						1	1	1	1	21	200788-1	BONNET	SS 316	ASME SA479	CHROME PLATE
						1	1	1	1	20	SEE PROJECT CONTROL DWG	ADAPTER	SS17-4PH		Rc32-38
						1	1	1	1	19	102462-3	RETAINER	SS 316		CHROME PLATE
						1	1	1	1	18	SEE PROJECT CONTROL DWG	SPRING	SS 302	AMS 5688	
						2	2	2	2	17	SEE PROJECT CONTROL DWG	SPRING RETAINER	SS 300SER		
						1	1	1	1	16	200824-1	STEM	SS 410	ASME SA479	Rc 26-32
						1	1	1	1	15	102460-3	NOZZLE SEAT	SS 316	ASME SA479	
						1	1	1	1	14	102461-3	DISC GUIDE	SS 316	ASME SA479	
						1		1		13	102728-1	DISC, (SOFT INSERT)	SS17-4 PH / POLY AMIDE-IMIDE	ASME SA564 GR 630	Rc 32-38
							1		1	12	102797-1	DISC	SS17-4PH	ASME SA564 GR 630	Rc 32-38
							1	1		11	102731-1	LOCKING TAB	SS 300 SERIES		
										10					
				1	1					9	202045-4	BODY R/M	SS 316L	ASME SA479	
				1	1					8	202043-1	FLANGE, OUTLET	SS 316L	ASME SA479	
				1	1					7	202725-1	FLANGE, INLET	SS 316	ASME SA479	
				X		1	1			6	SEE PROJECT CONTROL DWG	BODY ASSY			
					X			1	1	5	SEE PROJECT CONTROL DWG	BODY ASSY			
						X				4	611 1x1-1-1-40	RELIEF VALVE ASSY			SOFT SEAT & LIFT
							X			3	611 1x1-1-1-30	RELIEF VALVE ASSY			HD SEAT & LIFT
								X		2	611 1x1-1-1-20	RELIEF VALVE ASSY			SOFT SEAT
									X	1	611 1x1-1-1-10	RELIEF VALVE ASSY			HARD SEAT
10	9	8	7	6	5	4	3	2	1	FIND NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS

QUANTITY REQUIRED

PARTS LIST

										FIND NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
										65					
										64					
										63					
										62					
										61					
										60					
										59					
										58					
										57					
										56					
										55					
										54					
										53					
										52					
										51					
										50					
										49					
										48					
										47					
						A/R	A/R	A/R	A/R	46	834-0001	LOCKWIRE	SS300 SER		
						2	2			45	211-0007	WASHER, SPLIT	SS 300 SER		
						A/R	A/R	A/R	A/R	44	200-0004	WASHER, PLAIN	SS 300 SER		
										43					
										42					
						1	1	1	1	41	072-0001	SCREW, THUMB, GAG	SS 300 SER		
										40					
						2	2			39	020-0012	SCREW, SOCKET HD	SS 300 SER		
						1	1	1	1	38	059-0001	SCREW, FIL HD DRILLED	SS 300 SER		
						2	2	1	1	37	300-2012	O-RING	SILICONE RUBBER		
10	9	8	7	6	5	4	3	2	1	FIND NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS

QUANTITY REQUIRED

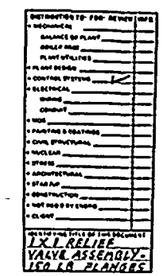
PARTS LIST

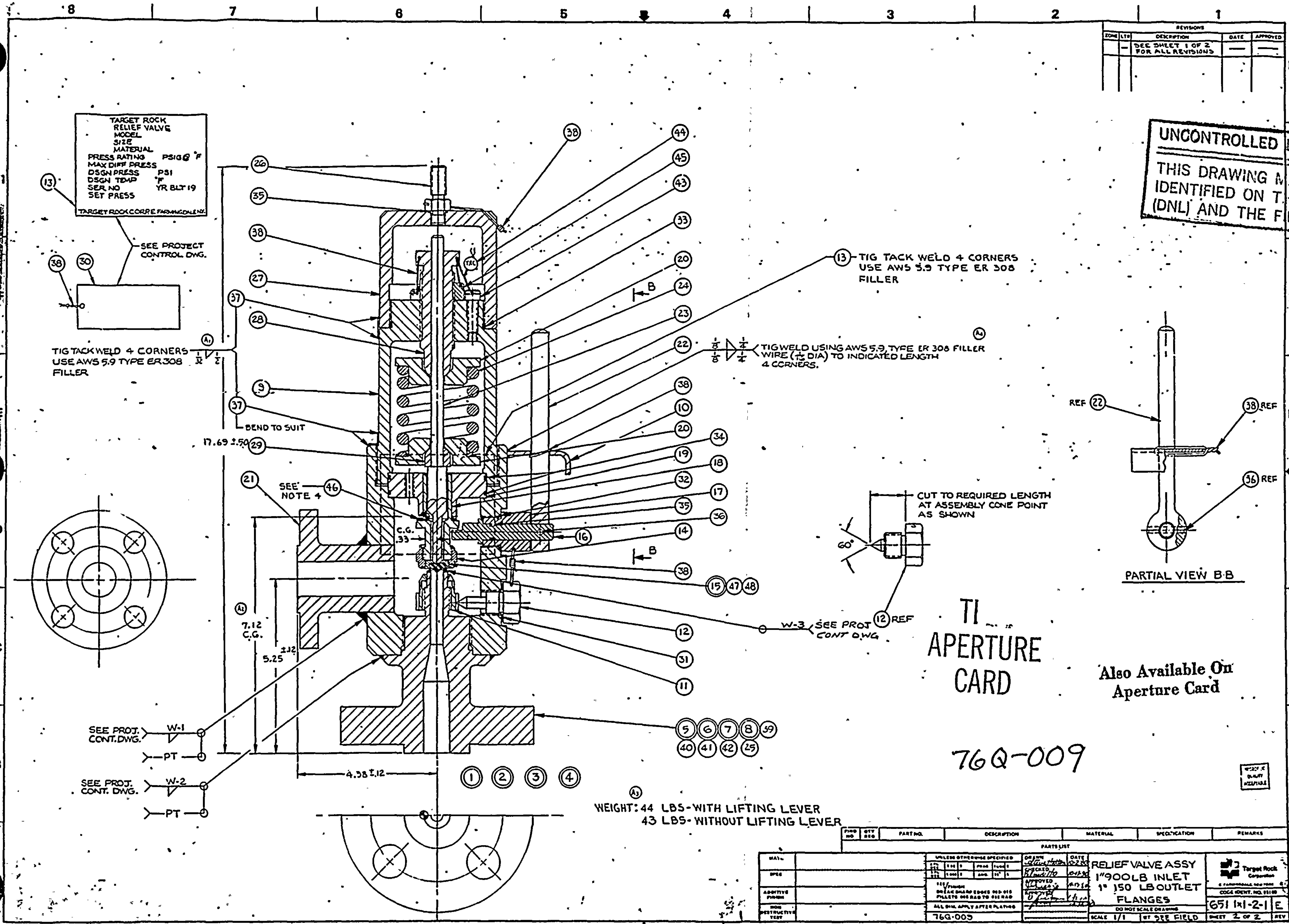
RELIEF VALVE ASSEMBLY 1"x1" ISOLB FLANGES

SCALE NONE

611 1x1-1-1

SHEET 1 OF 2




TARGET ROCK
RELIEF VALVE
MODEL
SIZE
MATERIAL
PRESS RATING PSIG@ °F
MAX DIFF PRESS
DSGN PRESS PSI
DSGN TEMP °F
SER NO YR BLT 19
SET PRESS
SEE PROJECT CONTROL DWG.
TIG TACK WELD 4 CORNERS USE AWS 5.9 TYPE ER308 FILLER
BEND TO SUIT
SEE NOTE 4
C.G.
TIG TACK WELD 4 CORNERS USE AWS 5.9 TYPE ER 308 FILLER
TIG WELD USING AWS 5.9, TYPE ER 308 FILLER WIRE (1/16 DIA) TO INDICATED LENGTH 4 CORNERS.
CUT TO REQUIRED LENGTH AT ASSEMBLY CONE POINT AS SHOWN
SEE PROJ CONT DWG
PARTIAL VIEW B-B
SEE PROJ. CONT. DWG.
WEIGHT: 44 LBS - WITH LIFTING LEVER
43 LBS - WITHOUT LIFTING LEVER
PARTS LIST
UNLESS OTHERWISE SPECIFIED
BREAK SHARP EDGES
ALL DIM. APPLY AFTER PLATING
76Q-005
RELIEF VALVE ASSY
1" 900LB INLET
1" 150 LB OUTLET
FLANGES
DO NOT SCALE DRAWING
Target Rock Corporation
651 1x1-2-1
SCALE 1/1
SHEET 2 OF 2
E
SEE SHEET 1 OF 2 FOR ALL REVISIONS

UNCONTROLLED DRAWINGS

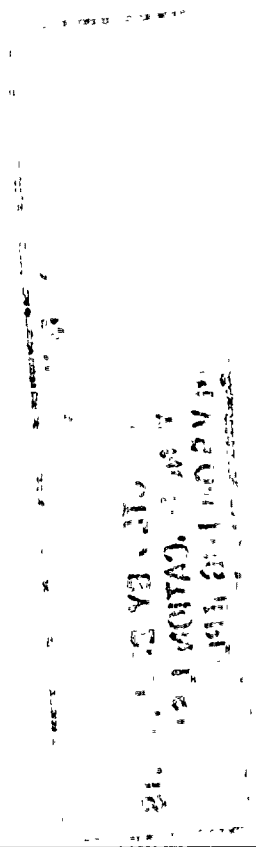
THIS DRAWING MAY BE AFFECTED BY DOCUMENTS IDENTIFIED ON THE DAILY NOTIFICATION LIST (DNL) AND THE FIELD REVISION LOG (FRL).

TI APERTURE CARD

Also Available On Aperture Card

76Q-009

8403090014-10



NOTES:

1. THE PROJECT CONTROL DRAWING FOR EACH PROJECT WILL SPECIFY (a) THE SPECIFIED PART NO. OF ITEMS NOT IDENTIFIED IN THE BILL OF MATL. (b) THE NAMEPLATE & IDENTIFICATION TAG FILL IN DATA. (c) THE VALVE ASSEMBLY OPTIONS. (d) IF ANY PARTS OR MATERIALS ARE DIFFERENT THAN THOSE IDENTIFIED IN THE BILL OF MATERIAL.
2. THE VALVE DESCRIBED HERE ON IS A 1" - 900LB INLET, 1" 150 LB OUTLET VALVE, IT IS AVAILABLE WITH OR WITHOUT LOWER RING AND WITH OR WITHOUT MANUAL LIFTS. THE PROJECT CONTROL DRAWING WILL SPECIFY THE OPTIONS BEING ORDERED.

651 1x1-2-1 - ☐ VALVE ASSY NUMBER
- PROJECT CONTROL DRAWING WILL SPECIFY
  - 41 - WITH LIFTING LEVER & WITH LOWER RING
  - 40 - WITH LIFTING LEVER & WITHOUT LOWER RING
  - 21 - WITHOUT LIFTING LEVER & WITH LOWER RING
  - 20 - WITHOUT LIFTING LEVER & WITHOUT LOWER RING
- BASIC VALVE DRAWING

3. SEE PROJECT CONTROL DRAWING FOR APPLICABLE NOTES, WELDING PROCEDURE & DESIGN DATA.
4. TRIM TOP SURFACE OF ITEM 46 AS REQUIRED AT ASSEMBLY TO LIMIT LIFT TO .032 ±.001.
5. CONFIGURATION 6AF-1.

TI APERTURE CARD

76Q-009

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	C	1) ITEM 11 WAS: 202593-1 2) ITEM 14 WAS: 202594-1 3) ITEM 16 WAS: 202747-1. REVISED MATL & REMARKS. 4) ITEM 25 WAS: 202733-1 REVISED MATL & REMARKS 5) ON SHT 2 ADDED WELD CALL OUT N3. PICTORIALLY REVISED ACCORD.	11-12-81	12-15-81
	D	ITEMS 1,2,3 & 4 (REMARKS) "BLOW DOWN" REMOVED ADDED "LOWER" ITEM 11, DESCRIPTION WAS "RING BLOW DOWN" ADD ITEM 46, AND NOTES 4 & 5. NOTE 2, WAS REVISED	6-7-'82	6-9-'82
	E	ITEM 15 WAS P/N 202983-1 "DISC" ITEMS 47 & 48 ADDED	9/16/82	

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ITEM 3 WAS 651 1x1-2-1-20 ITEM 4 WAS 651 1x1-2-1-21 ITEM 5 WAS 300658-1 ITEM 6 WAS 300658-2 ITEM 7 WAS 300658-3 ITEM 8 WAS 300658-4 ITEM 10 ADDED QTY REQ FOR -3 AND -6. ITEM 15 DESCRIPTION WAS "DISC" ITEM 33 P/N WAS 300-2232 ITEM 39 P/N WAS 300657-1 ITEM 40 P/N WAS 300657-2 ITEM 41 P/N WAS 300657-3 REMARK WAS M/F 202741-2 ITEM 42 WAS P/N 300657-4 REMARK WAS M/F 202741-2 ITEM 43 WAS P/N 063-0004 ITEM 44 WAS P/N 102359-1 ITEM 45 WAS P/N 105-0003 REVISED NOTE 2 SHEET 2 1) WAS ½ 2) WAS 5.65 3) WAS 38 LBS WITH LEVER AND 37 LBS WITHOUT 4) WAS TYPE 308 FILLER	12/4/80	12-4-80
	B	ITEM 35 WAS 300-2013 ITEM 43 WAS 010-0003 ITEM 13 ADDED QTY TO -2, -4 ASSY ITEM 16 REMOVED QTY FROM -3, -4 ASSY	11/11/81	11-11-81

10	9	8	7	6	5	4	3	2	1	FIND NO	PART NO	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
										65					
										64					
										63					
										62					
										61					
										60					
										59					
										58					
										57					
										56					
										55					
										54					
										53					
										52					
										51					
										50					
										49					
						1	1	1	1	48	203243-1	DISC INSERT	POLYAMIDE IMIDE		
						1	1	1	1	47	203244-1	DISC	SS 17-4 PH	ASME SA-564 GRADE 630	Rc 32 - 38
						A/R	A/R	A/R	A/R	46	103029-1	SHIM	SS 300 SER		SEE NOTE 4
						1	1	1	1	45	102836-1	NUT, HEX JAM (REWORK)	SS 300 SER		MAKE FROM 105-0003
						1	1	1	1	44	102358-1	LOCKWIRE SEAL	TIN PLATED STL		
						2	2	2	2	43	021-0002	SCREW SOC HD CAP	SS300 SER		DRILLED HEAD
		1								42	300657-8	BODY P/M	SS 316	ASME SA479	M/F 202741-4
			1							41	300657-7	BODY P/M	SS 316	ASME SA479	M/F 202741-4
				1						40	300657-6	BODY P/M	SS 316	ASME SA479	M/F 202741-2
					1					39	300657-5	BODY P/M	SS 316	ASME SA479	M/F 202741-2
						A/R	A/R	A/R	A/R	38	834-0001	LOCKWIRE	SS300 SER		
						2	2	2	2	37	102831-1	LOCKING TAB	SS300SER		

QUANTITY REQUIRED — PARTS LIST

10	9	8	7	6	5	4	3	2	1	FIND NO	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
								1	1	36	441-0001	GROOVE PIN	SS 300 SER		
						1	1	2	2	35	300-2012	O-RING	SILICONE RUBBER		
						2	2	2	2	34	300-2040	O-RING	SILICONE RUBBER		
						1	1	1	1	33	300-2232	O-RING	SILICONE RUBBER		
								1	1	32	300-2021	O-RING.	SILICONE RUBBER		
							1		1	31	102532-1	GASKET	SOFT IRON & ASBESTOS		
						1	1	1	1	30	100900-1	IDENT. TAG	SS 300 SER		
						1	1	1	1	29	102785-1	COLLAR	SS 410	ASME SA479	Rc 26-32 CHROME PLATE
						1	1	1	1	28	202732-1	ADJUSTING SCREW	SS 410	ASME SA479	Rc 26-32 CHROME PLATE
						1	1	1	1	27	202731-1	CAP	SS 316	ASME SA479	
						1	1	1	1	26	102786-1	GAG BOLT	SS 316	ASME SA479	
		1	1	1	1					25	300834-1	INLET FLANGE	SS 316L	ASME SA479	CHROME PL M/F 202656-3
						1	1	1	1	24	SEE PROJECT CONTROL DWG	SPRING	SS 302	AMS 5688	
						1	1	1	1	23	202598-1	STEM	SS 410	ASME SA479	Rc 26-32 CHROME PLATE
								1	1	22	102467-1	LIFTING LEVER	C.S.		NICKEL PLATE
		1	1	1	1					21	202743-1	OUTLET FLANGE	SS 316L	ASME SA 479	
						2	2	2	2	20	SEE PROJECT CONTROL DWG	RETAINER, SPRING	SS 316		
						1	1	1	1	19	202730-1	GUIDE	SS 316		
						1	1	1	1	18	202596-1	DISC RETAINER	SS 410		Rc 26-32 CHROME PLATE
								1	1	17	102790-1	NUT, LIFTING LEVER	SS 316	ASME 479	
								1	1	16	202666-3	LIFTING STEM	SS 17-4 PH	ASME 564 GR. 630	Rc 32-38
						1	1	1	1	15	203245-1	DISC ASSY			
						1	1	1	1	14	300830-1	DISC HOLDER	SS 410		Rc 26-32
						1	1	1	1	13	202334-1	NAME PLATE	SS 300 SERIES		
							1		1	12	102793-1	SCREW, LOCKING	SS 316	ASME SA479	
							1		1	11	202991-1	LOWER RING	SS 410		Rc 26-32
				1	1					10	202729-1	BRACKET	SS 300 SERIES		
						1	1	1	1	9	202728-1	BONNET	SS 316	ASME SA479	CHROME PLATE THREADS
		X				1				8	300658-8	BODY ASSY, F/M			
			X				1			7	300658-7	BODY ASSY, F/M			
				X				1		6	300658-6	BODY ASSY, F/M			
					X				1	5	300658-5	BODY ASSY, F/M			
						X				4	651 1x1-2-1-20	RELIEF VALVE ASSY	WITHOUT LIFTING LEVER & WITHOUT LOWER RING		
							X			3	651 1x1-2-1-21	RELIEF VALVE ASSY	WITHOUT LIFTING LEVER & WITH LOWER RING		
								X		2	651 1x1-2-1-40	RELIEF VALVE ASSY	WITH LIFTING LEVER & WITHOUT LOWER RING		
									X	1	651 1x1-2-1-41	RELIEF VALVE ASSY	WITH LIFTING LEVER & WITH LOWER RING		

QUANTITY REQUIRED — PARTS LIST

RELIEF VALVE ASSY 1" 900LB INLET 1" 150 LB OUTLET FLANGES

Target Rock Corporation

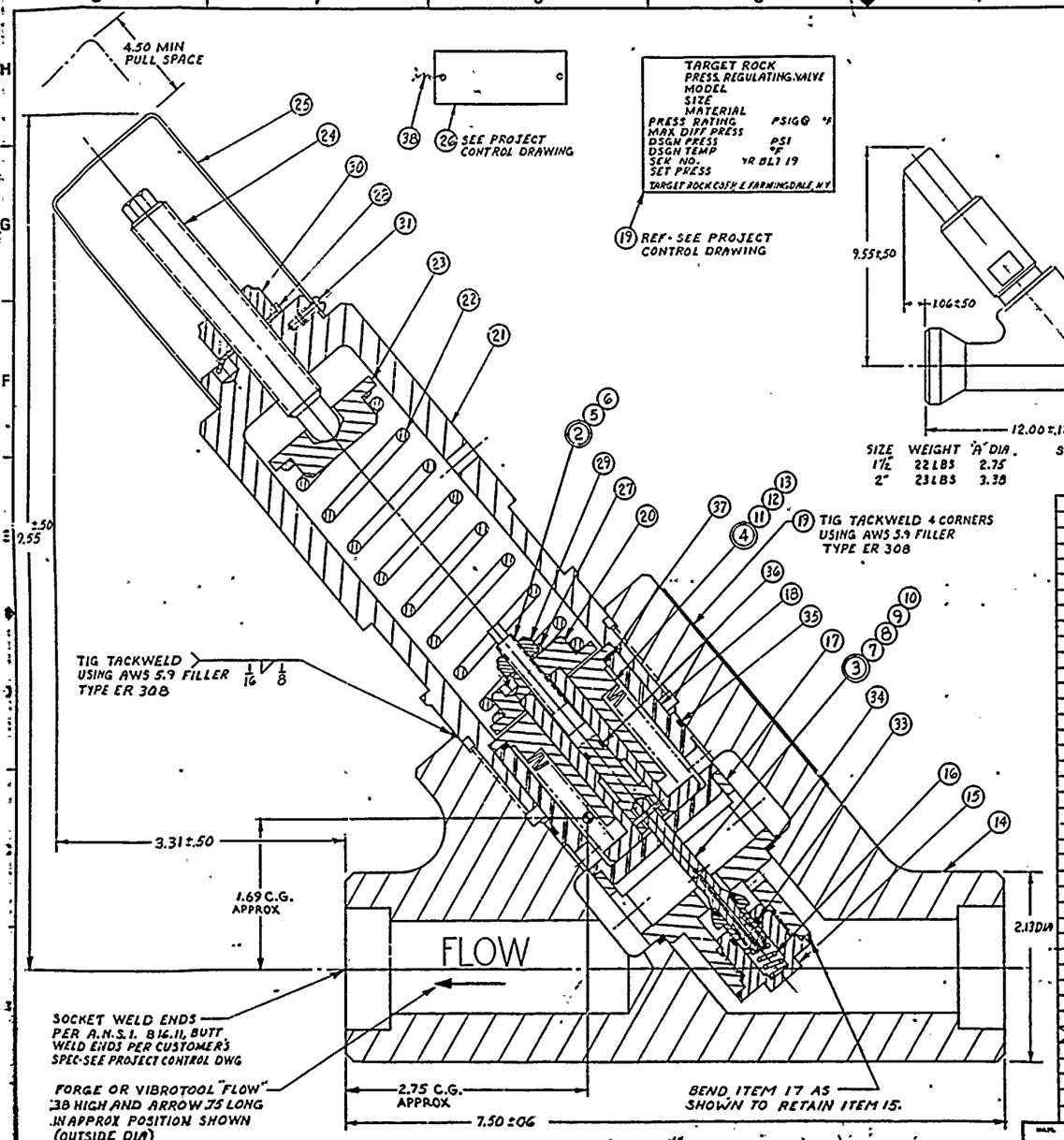
DO NOT SCALE DRAWING — SCALE NONE — 651 1x1-2-1 — REV E — SHEET 1 OF 2

ALL DIM APPLY AFTER PLATING — 76Q-009

Also Available On Aperture Card

DATA CODE 2-0 — ACTIVITY PKG NO. N/A — ENGR SYSTEM NO. N/A — QUAL CLASS Q

8403090014-11



TI APERTURE CARD

76Q-010

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ITEM 2 WAS -2. ITEM 3 WAS -1. ITEM 10 WAS -1. ITEM 25 WAS -1. ITEM 31 WAS 069-0032-0250-02-01. ITEM 34 WAS 300-1688-0094-02. ITEM 38 WAS 300-2000-0094-02. FIXED PICTURE TO AGREE WITH DETAILS ADDED MAIL SPECS COND. TO ITEMS 36, 37, 38 & 39 UPDATED TAB SHTS.	ESJR 6-23-80	[illegible] 7-8-80
	B	ITEM 37 WAS 300-1029. ITEM 39 WAS 300-1007.	ESJR 9-23-80	[illegible]

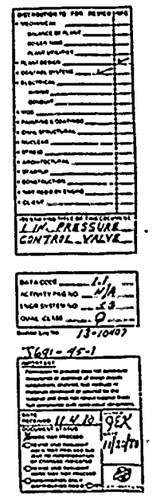
ITEM NO.	QTY REQD	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
		A/R	38	834-0001	LOCKWIRE	SS 300 SER		
		1	37	300-2029	O-RING	SILICONE RUBBER		
		1	36	300-2007	O-RING	SILICONE RUBBER		
		1	35	300-2132	O-RING	SILICONE RUBBER		
		1	34	300-2030	O-RING	SILICONE RUBBER		
		1	33	300-2011	O-RING	SILICONE RUBBER		
			32					
		3	31	069-0002	SCREW, PAN HD, SLOTTED	SS 18-8		SELF-LOCKING
		1	30	115-0003	NUT, FLEXLOC, THIN	SS 18-8		
		1	29	117-0002	NUT, FLEXLOC	SS 18-8		
		1	28	202-0007	WASHER	SS 300 SER		
		1	27	202-0005	WASHER	SS 300 SER		
		1	26	100900-1	IDENT TAG	SS 300 SER		
		1	25	102703-2	COVER	SS 300 SER		
		1	24	102278-5	ADJUSTING SCREW	SS 17-4PH	ASME SA 564 & 630 COND H-1100	RC 33-38 CHROME PLATED
		1	23	SEE PROJECT CONTROL DWG	SPRING RETAINER	SS 300 SER		
		1	22	SEE PROJECT CONTROL DWG	MAIN SPRING	SS A-286		
		1	21	202471-1	SPRING HOUSING	SS 316	ASME SA 479	CHROME PLATED
		1	20	SEE PROJECT CONTROL DWG	SPRING RETAINER	SS 300 SER		
		1	19	202334-1	NAMEPLATE	SS 300 SER		
		1	18	202410-1	SLEEVE	SS 316	ASME SA 479	
		1	17	202409-1	SEAT/SLEEVE	SS 316	ASME SA 479	
		1	16	700-0034	SPRING	55302		
		1	15	202408-1	CAP	SS 316	ASME SA 479	CHROME PLATED
		1	14	SEE PROJECT CONTROL DWG	BODY	SS 316	ASME SA 182 GR F316	
1			13	202405-1	BELLOWS GUIDE	SS 316	ASME SA 479	
1			12	202404-1	BELLOWS HEAD	SS 316	ASME SA 479	CHROME PLATED
1			11	202464-1	BELLOWS	INCONEL 718		
	1		10	102380-2	UPPER RETAINER	SS 17-4 PH	ASME SA 564 GR 630 COND H-1100	RC 33-38 CHROME PLATED
	1		9	301-0002	O-RING	SILICONE RUBBER		
	1		8	102378-1	SEAL RING	POLYIMIDE		
	1		7	102379-1	LOWER RETAINER	SS 17-4PH	ASME SA 564 GR 630 COND H-1100	RC 33-38 CHROME PLATED
		1	6	430-0001	DOWEL PIN	SS 18-8		
		1	5	102585-1	ADJUSTING STEM	SS 17-4PH	ASME SA 564 GR 630 COND H-1100	RC 33-38 CHROME PLATED
		1	4	202403-1	BELLOWS ASSY			
		1	3	200946-2	SEAL ASSY			
		1	2	200948-3	SEAL & STEM ASSY			
		1	1	700 10-2-1	VALVE ASSEMBLY			

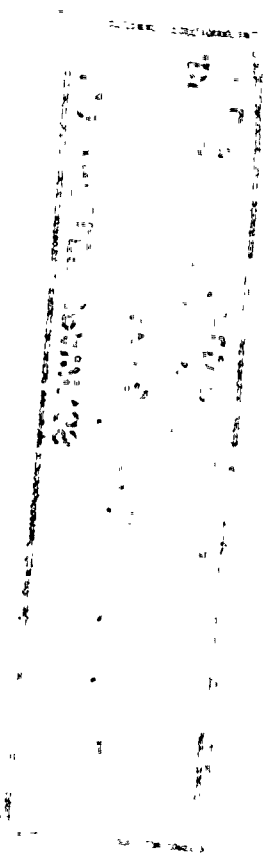
PARTS LIST REF CLEARANCE DWG SK-4051

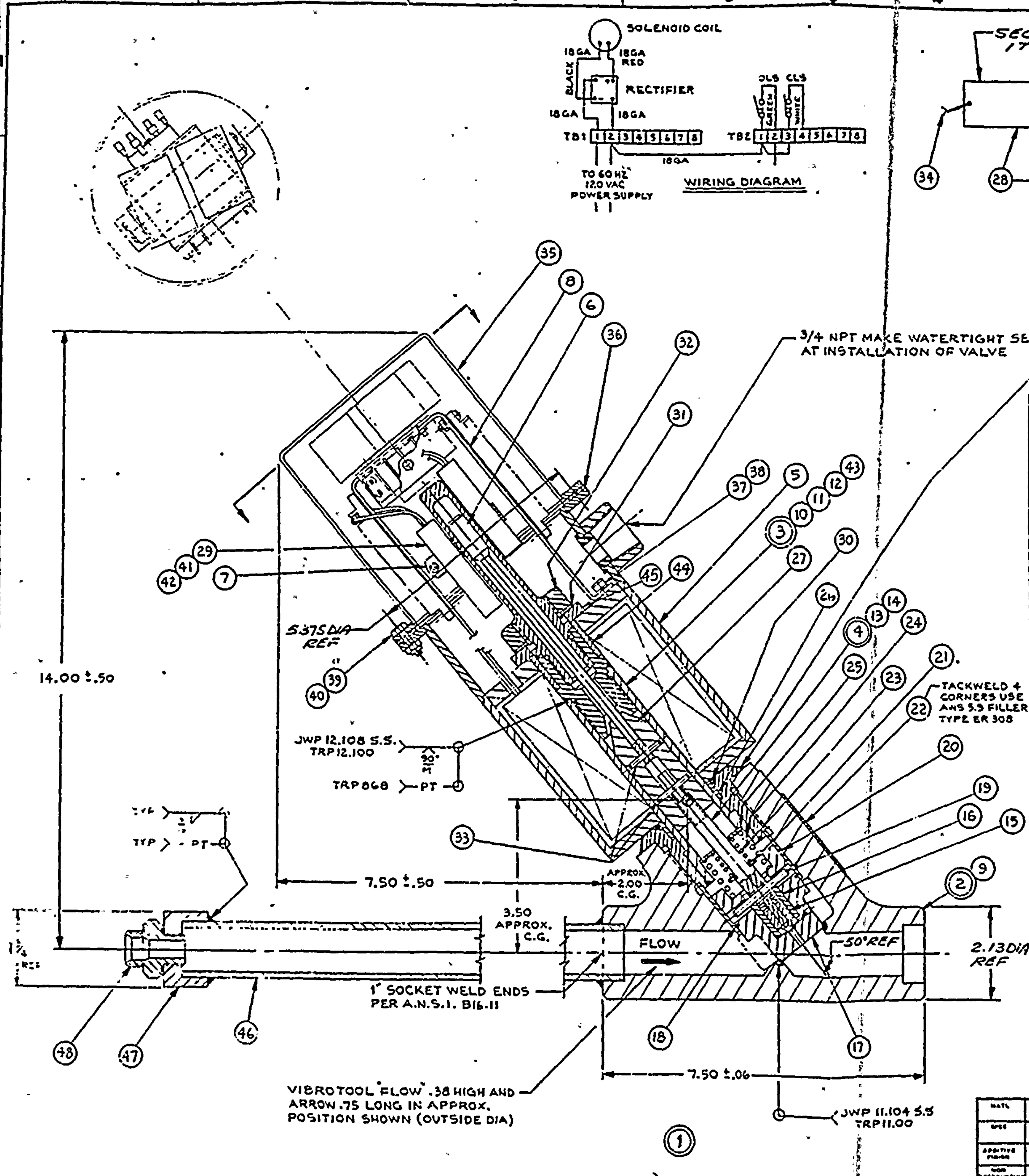
VALVE ASSEMBLY PRESSURE REGULATING THRU ¼ SIZES

700 10-2 [illegible]

Also Available On Aperture Card







SHT. 171 OF 171
REF. MICROFICHE FILE FOR 8½ X 11 DOCS.

NOTES:
1. FRONT VIEW LOCATION OF C.G. IS ON ℄.

76CC-001 test valve as identified in TRC Rpt 3580

4	3	2	1	ITEM NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	REMARKS
			2	48	8COS-316	CONNECTOR	S.S.		GYROLOK
			2	47	SK 3503-4	CAP	S.S.		
			2	46	1" SCH160 × 2" LG	PIPE	S.S.		
			1	45	SK-10680-1	SPACER	S.S. 300 SER		
			1	44	SK-10669-1	SLEEVE	C.S. 1015 TO 1020		
	1			43	200938-1	BONNET TUBE	S.S.		
			AR	42		SHRINK TUBING	TYPE I 3/16 DIA GREEN		RAYCHEM
			AR	41		SHRINK TUBING	RT876 3/16 DIA WHITE		RAYCHEM
			4	40	50FK-1032	NUT, SELF-LOCKING	S.S. 300 SER		FLEX LOC
			4	39	#10-32UNF × 3/4 LG	SCREW, HEX HD	S.S. 300 SER		
			4	38	#10	LOCKWASHER, SPLIT	S.S. 300 SER		
			4	37	#10-32UNF × 1/2 LG	SCREW, SOC HD	S.S. 300 SER		
			1	36	200989-1	GASKET	ASBESTOS AND RUBBER (NBR)		
			1	35	202013-1	COVER & RING ASSY	S.S. 300 SER		
			AR	34	.031 DIA	LOCKWIRE	S.S. 300 SER		
			2	33	125 × 0875 HDK	SPIROL PIN	S.S. 300 SER	AISI OR EQUIV.	CEM CO.
			1	32	1⅛-12UNF-2B	NUT, HEX, JAM	S.S. 300 SER		
			1	31	1⅛ NOM I.D. × ⅛	LOCKWASHER EXT TOOTH	S.S. 300 SER		
			1	30	ARP568-128	O-RING	SILICONE RUBBER		
			2	29	100967-1	REED SWITCH ASSY			
			1	28	100900-1	IDENT TAG	S.S. 300 SER		
			1	27	100720-1	PLUNGER	S.S. 410	AISI OR EQUIV.	ANNEALED AND CHROME PLATED
			1	26	SK-10671-1	SLEEVE	C.S. 1010 TO 1020	AISI OR EQUIV	
			1	25	5710-93-60	WASHER	S.S. 300 SER	AISI OR EQUIV	SEASTROM CO.
			1	24	200933-1	SPRING	A-286	AMS 5734	
			1	23	200933-2	SPRING	A-286	AMS 5734	
			1	22	100583-1	NAMEPLATE	S.S. 300 SER		
			1	21	MS15795-816	WASHER	S.S. 300 SER		
			1	20	102178-4	SLEEVE	STELLITE 6B		
			1	19	100639-1	PIN	S.S. 17-4 PH	AMS 5643	Rc 32-38
			1	18	100637-1	PISTON RING	S.S. 17-7 PH	AMS 5644	Rc 38-50
			1	17	200894-1	DISC MAIN	S.S. 17-4 PH	ASME SA564 GR630	Rc 32-38
			1	16	200891-1	SLEEVE	S.S. 17-4 PH	ASM 5643	Rc 32-38 AND CHROME PLATED
			1	15	102356-1	PILOT DISC	HAYNES 25	AMS 5759	COLD WORKED
1				14	102398-1	BALL	HAYNES 25	AMS 5759	COLD WORKED
1				13	200962-2	STEM	S.S. 316	AISI OR EQUIV.	
	1			12	[illegible]	INDICATOR TUBE	S.S.	ASME SA-479-316L	
	1			11	[illegible]	FIXED CORE	S.S. 410	ASME SA 182 F6	ANNEALED
	1			10	[illegible]	BONNET	S.S. 347/348	ASME SA-479	
		1		9	300337-1	BODY P/M	S.S.	ASME SA 182 F316L	[illegible]
			1	8	SK-10672-1	ELECTRICAL ASSY	— —		
			1	7	200805-1	CLAMP ASSY	S.S. 300 SER		
			1	6	200519-1	MAGNET HOLDER & ROD ASSY	S.S. 300 SER	AISI OR EQUIV.	
			1	5	300359-1	SOLENOID ASSY	— —	SOL COIL: CLASS H INSULATION	
X			1	4	200961-2	STEM ASSY	— —		
	X		1	3	200941-1	BONNET ASSY	— —		
		X	1	2	200934-1	BODY F/M	— —		STELLITE #6 [illegible]
			X	1		VALVE ASSY	— —		

QTY REQ — PARTS LIST

ENGINEERING TEST VALVE

Target Rock Corporation

SK-4017

SCALE 1/1 — SHEET 1 OF 1

DO NOT SCALE DRAWING

TI APERTURE CARD

Also Available On Aperture Card

VALVE Model, TAG No. And
MATERIAL SUMMARY

NON METALLIC SUBCOMPONENTS

TABLE 3 - VALVE TAG NUMBERS

PROJECT 76Q

CUSTOMER BECHTEL POWER CORPORATION P.O. 10407-13-JM-691

Model Number		P.O. Item	Tag Number
76Q-001		1	1 JEWA-PSV-61
PART NO.	MATERIAL	5	1 JEWB-PSV-62
ARP-568-12	Silicon	9	2 JEWA-PSV-61
ARP-568-230	"	13	2 JEWB-PSV-62
ARP-568-17	"	17	3 JEWA-PSV-61
		21	3 JEWB-PSV-62
		45	1 JEWA-PSV-47
		46	1 JEWB-PSV-48
		49	2 JEWA-PSV-47
		50	2 JEWB-PSV-48
		53	3 JEWA-PSV-47
		54	3 JEWB-PSV-48
76Q-002		25	1 JEWA-PSV-103
PART NO.	MATERIAL	26	1 JEWB-PSV-104
ARP568-012	Silicon	27	2 JEWA-PSV-103
ARP568-238	"	28	2 JEWB-PSV-104
ARP568-030	"	29	3 JEWA-PSV-103
		30	3 JEWB-PSV-104
76Q-003		31	1 JEWA-PSV-105
PART NO.	MATERIAL	32	1 JEWB-PSV-106
ARP-568-129	Silicon	33	2 JEWA-PSV-105
		34	2 JEWB-PSV-106
		35	3 JEWA-PSV-105
		36	3 JEWB-PSV-106
76Q-004		43	1 JECA-PSV-75
PART NO.	MATERIAL	44	1 JECB-PSV-76
ARP568-026	Silicon	47	2 JECA-PSV-75
ARP568-012	"	48	2 JECB-PSV-76
ARP568-238	"	51	3 JECA-PSV-75
		52	3 JECA-PSV-76

Table 3 continued on Page 17

T-691-65-2

TABLE 3 (Continued From Page 16)

Model Number		P.O. Item	Tag Number
76Q-005		57	1-JSPA-PSV-137
PART NO.	MATERIAL	58	1-JSPA-PSV-139
ARP-568-12	Silicon	59	1-JSPA-PSV-141
ARP568-230	"	60	1-JSPA-PSV-143
ARP568-17	"	61	1-JSPB-PSV-138
		62	1-JSPB-PSV-140
		63	1-JSPB-PSV-142
		64	1-JSPB-PSV-144
		65	2-JSPA-PSV-137
		66	2-JSPA-PSV-139
		67	2-JSPA-PSV-141
		68	2-JSPA-PSV-143
		69	2-JSPB-PSV-138
		70	2-JSPB-PSV-140
		71	2-JSPB-PSV-142
		72	2-JSPB-PSV-144
		73	3-JSPA-PSV-137
		74	3-JSPA-PSV-139
		75	3-JSPA-PSV-141
		76	3-JSPA-PSV-143
		77	3-JSPB-PSV-138
		78	3-JSPB-PSV-140
		79	3-JSPB-PSV-142
		80	3-JSPB-PSV-144
76Q-006		81	1-JECA-PSV- 95
		82	1-JECB-PSV- 96
SAME AS	76Q-001	83	1-JECA-PSV- 97
		84	1-JECB-PSV- 98
		85	1-JECA-PSV- 99
		86	1-JECB-PSV-100
		87	1-JECA-PSV-101
		88	1-JECB-PSV-102
		89	1-JECA-PSV-103
		90	1-JECB-PSV-104
		91	1-JECA-PSV-105
		92	1-JECB-PSV-106
		93	1-JECA-PSV-107
		94	1-JECB-PSV-108
		95	1-JECB-PSV-109

TABLE 3 Continued From Page 17

Model Number		P.O. Item	Tag Number
76Q-006		96	2-JECA-PSV-95
PART NO.	MATERIAL	97	2-JECB-PSV-96
SAME AS 76Q-001		98	2-JECA-PSV-97
		99	2-JECB-PSV-98
		100	2-JECA-PSV-99
		101	2-JECB-PSV-100
		102	2-JECA-PSV-101
		103	2-JECB-PSV-102
		104	2-JECA-PSV-103
		105	2-JECB-PSV-104
		106	2-JECA-PSV-105
		107	2-JECB-PSV-106
		108	2-JECA-PSV-107
		109	2-JECB-PSV-108
		110	2-JECB-PSV-109
		111	3-JECA-PSV-95
		112	3-JECB-PSV-96
		113	3-JECA-PSV-97
		114	3-JECB-PSV-98
		115	3-JECA-PSV-99
		116	3-JECB-PSV-100
		117	3-JECA-PSV-101
		118	3-JECB-PSV-102
		119	3-JECA-PSV-103
		120	3-JECB-PSV-104
		121	3-JECA-PSV-105
		122	3-JECB-PSV-106
		123	3-JECA-PSV-107
		124	3-JECB-PSV-108
		125	3-JECB-PSV-109

TABLE 3 CONTINUED FROM PAGE 18

MODEL NUMBER		P.O. ITEM	TAG NUMBER
760-007		127	1-JECA-PSV-117
300-2012	Silicon	142	2-JECA-PSV-117
300-2228	"	157	3-JECA-PSV-117
300-2020	"		
760-008		129	1-JSGA-PSV-312
SAME AS 760-007		131	1-JSGA-PSV-319
		133	1-JSGB-PSV-325
		135	1-JSGB-PSV-305
		144	2-JSGA-PSV-312
		146	2-JSGA-PSV-319
		148	2-JSGB-PSV-325
		150	2-JSGB-PSV-305
		159	3-JSGA-PSV-312
		161	3-JSGA-PSV-319
		163	3-JSGB-PSV-325
		165	3-JSGB-PSV-305
760-009		128	1-JSGA-PSV-309
PART NO.	MATERIAL	130	1-JSGA-PSV-316
300-2013	Silicon	132	1-JSGB-PSV-322
300-2040	"	134	1-JSGB-PSV-302
300-2232	"	143	2-JSGA-PSV-309
300-2021	"	145	2-JSGA-PSV-316
102532-1	¢ASBESTOS	147	2-JSGB-PSV-322
202747-1	Polyamide Imide	149	2-JSGB-PSV-302
		158	3-JSGA-PSV-309
		160	3-JSGA-PSV-316
		162	3-JSGB-PSV-322
		164	3-JSGB-PSV-302
760-010		138	1-JSGB-PCV-303
PART NO.	MATERIAL	139	1-JSGA-PCV-310
300-2029	Silicon	140	1-JSGA-PCV-317
300-2007	"	141	1-JSGB-PCV-323
300-2132	"	153	2-JSGB-PCV-303
300-2030	"	154	2-JSGA-PCV-310
300-2011	"	155	2-JSGA-PCV-317
301-0002	"	156	2-JSGB-PCV-323
102370-1	Polyimide	168	3-JSGB-PCV-303
		169	3-JSGA-PCV-310
		170	3-JSGA-PCV-317
		171	3-JSGB-PCV-323
760-011		136	1-JECA-PSV-121
SAME AS 760-007		137	1-JECB-PSV-120
		151	2-JECA-PSV-121
		166	3-JECA-PSV-121
		167	3-JECB-PSV-120
		152	2-JECB-PSV-120

300-2021 Silicon
102728-1 polyamide-imide

T691-65-3

VALVE SERVICE TEMPERATURE SUMMARY

REF DRAWINGS 13-M-ECP-001, 13-M-ECF-001
13-M-EWP-001, 13-M-EWF-001
13-M-SPP-001, 13-M-SPF-001
13-M-SGP-001, 13-M-SGF-001

TABLE 3 - VALVE TAG NUMBERS

PROJECT 76Q

CUSTOMER BECHTEL POWER CORPORATION P.O. 10407-13-JM-691

Model Number	Service Temp.	PO ITEM NO.	Tag Number
76Q-001 1X1 REH-S-1 DESIGN TEMP: 200F	125F/105F	1	1 JEWA-PSV-61
	125F/105F	5	1 JEWB-PSV-62
	125F/105F	9	2 JEWA-PSV-61
	125F/105F	13	2 JEWB-PSV-62
	125F/105F	17	3 JEWA-PSV-61
	125F/105F	21	3 JEWB-PSV-62
	151F/111F	45	1 JEWA-PSV-47
	151F/111F	46	1 JEWB-PSV-48
	151F/111F	49	2 JEWA-PSV-47
	151F/111F	50	2 JEWB-PSV-48
	151F/111F	53	3 JEWA-PSV-47
	151F/111F	54	3 JEWB-PSV-48
76Q-002 2X2 REH-S-1 DESIGN TEMP: 150F	125F/105F	25	1 JEWA-PSV-103
	125F/105F	26	1 JEWB-PSV-104
	125F/105F	27	2 JEWA-PSV-103
	125F/105F	28	2 JEWB-PSV-104
	125F/105F	29	3 JEWA-PSV-103
	125F/105F	30	3 JEWB-PSV-104
76Q-003 2" VRES-S-1 DESIGN TEMP: 150F	125F/105F	31	1 JEWA-PSV-105
	125F/105F	32	1 JEWB-PSV-106
	125F/105F	33	2 JEWA-PSV-105
	125F/105F	34	2 JEWB-PSV-106
	125F/105F	35	3 JEWA-PSV-105
	125F/105F	36	3 JEWB-PSV-106
76Q-004 1½X1½ REH-S-1 DESIGN TEMP: 104F	57F	43	1 JECA-PSV-75
	57F	44	1 JECB-PSV-76
	57F	47	2 JECA-PSV-75
	57F	48	2 JECB-PSV-76
	57F	51	3 JECA-PSV-75
	57F	52	3 JECA-PSV-76

Table 3 continued on Page 17

T1691-65-2

TABLE 3 (Continued From Page 16)

Model Number	Service Temp	PO ITEM NO.	Tag Number
760-005 2½X1 REH-S-1 DESIGN TEMP: 200F	121F	57	1-JSPA-PSV-137
	121F	58	1-JSPA-PSV-139
	126F	59	1-JSPA-PSV-141
	122F	60	1-JSPA-PSV-143
	121F	61	1-JSPB-PSV-138
	121F	62	1-JSPB-PSV-140
	126F	63	1-JSPB-PSV-142
	122F	64	1-JSPB-PSV-144
	121F	65	2-JSPA-PSV-137
	121F	66	2-JSPA-PSV-139
	126F	67	2-JSPA-PSV-141
	122F	68	2-JSPA-PSV-143
	121F	69	2-JSPB-PSV-138
	121F	70	2-JSPB-PSV-140
	126F	71	2-JSPB-PSV-142
	122F	72	2-JSPB-PSV-144
	121F	73	3-JSPA-PSV-137
	121F	74	3-JSPA-PSV-139
	126F	75	3-JSPA-PSV-141
	122F	76	3-JSPA-PSV-143
	121F	77	3-JSPB-PSV-138
	121F	78	3-JSPB-PSV-140
	126F	79	3-JSPB-PSV-142
	122F	80	3-JSPB-PSV-144
760-006 1X1 REH-S-1 DESIGN TEMP: 200F	55F	81	1-JECA-PSV- 95
	55F	82	1-JECB-PSV- 96
	63F	83	1-JECA-PSV- 97
	63F	84	1-JECB-PSV- 98
	56F	85	1-JECA-PSV- 99
	56F	86	1-JECB-PSV-100
	56F	87	1-JECA-PSV-101
	56F	88	1-JECB-PSV-102
	57F	89	1-JECA-PSV-103
	57F	90	1-JECB-PSV-104
	57F	91	1-JECA-PSV-105
	57F	92	1-JECB-PSV-106
	57F	93	1-JECA-PSV-107
	57F	94	1-JECB-PSV-108
	56F	95	1-JECB-PSV-109

TABLE 3 (Continued From Page 17)

Model Number	SERVICE TEMP	PO Item No.	Tag Number
760-006	S5F	96	2-JECA-PSV-95
	S5F	97	2-JECB-PSV-96
	63F	98	2-JECA-PSV-97
	63F	99	2-JECB-PSV-98
	S6F	100	2-JECA-PSV-99
	S6F	101	2-JECB-PSV-100
	S6F	102	2-JECA-PSV-101
	S6F	103	2-JECB-PSV-102
	S7F	104	2-JECA-PSV-103
	S7F	105	2-JECB-PSV-104
	S7F	106	2-JECA-PSV-105
	S7F	107	2-JECB-PSV-106
	S7F	108	2-JECA-PSV-107
	S7F	109	2-JECB-PSV-108
	S6F	110	2-JECB-PSV-109
	S5F	111	3-JECA-PSV-95
	S5F	112	3-JECB-PSV-96
	63F	113	3-JECA-PSV-97
	63F	114	3-JECB-PSV-98
	S6F	115	3-JECA-PSV-99
	S6F	116	3-JECB-PSV-100
	S6F	117	3-JECA-PSV-101
	S6F	118	3-JECB-PSV-102
	S7F	119	3-JECA-PSV-103
	S7F	120	3-JECB-PSV-104
	S7F	121	3-JECA-PSV-105
	S7F	122	3-JECB-PSV-106
	S7F	123	3-JECA-PSV-107
	S7F	124	3-JECB-PSV-108
	S6F	125	3-JECB-PSV-109

TABLE 3 CONTINUED FROM PAGE 18

DESIGN TEMP 300F	MODEL NUMBER	Service Temp	P.O. Item	TAG NUMBER
	760-007 611-1X1-1-1-1X1	56F	127	1-JECA-PSV-117
		56F	142	2-JECA-PSV-117
		56F	157	3-JECA-PSV-117
DESIGN TEMP 300F	760-008 611-1X1-1-1-1X1	122F	129	1-JSGA-PSV-312
		122F	131	1-JSGA-PSV-319
		122F	133	1-JSGB-PSV-325
		122F	135	1-JSGB-PSV-305
		122F	144	2-JSGA-PSV-312
		122F	146	2-JSGA-PSV-319
		122F	148	2-JSGB-PSV-325
		122F	150	2-JSGB-PSV-305
		122F	159	3-JSGA-PSV-312
		122F	161	3-JSGA-PSV-319
		122F	163	3-JSGB-PSV-325
		122F	165	3-JSGB-PSV-305
DESIGN TEMP 300F	760-009 651-1X1-2-1-1X1	122F	128	1-JSGA-PSV-309
		122F	130	1-JSGA-PSV-316
		122F	132	1-JSGB-PSV-322
		122F	134	1-JSGB-PSV-302
		122F	143	2-JSGA-PSV-309
		122F	145	2-JSGA-PSV-316
		122F	147	2-JSGB-PSV-322
		122F	149	2-JSGB-PSV-302
		122F	158	3-JSGA-PSV-309
		122F	160	3-JSGA-PSV-316
		122F	162	3-JSGB-PSV-322
		122F	164	3-JSGB-PSV-302
DESIGN TEMP 300F	760-010 70010-2	122F	138	1-JSGB-PCV-303
		122F	139	1-JSGA-PCV-310
		122F	140	1-JSGA-PCV-317
		122F	141	1-JSGB-PCV-323
		122F	153	2-JSGB-PCV-303
		122F	154	2-JSGA-PCV-310
		122F	155	2-JSGA-PCV-317
		122F	156	2-JSGB-PCV-323
		122F	168	3-JSGB-PCV-303
		122F	169	3-JSGA-PCV-310
		122F	170	3-JSGA-PCV-317
		122F	171	3-JSGB-PCV-323
DESIGN TEMP 300F	760-011 611-1X1-1-1-1X1	56F	136	1-JECA-PSV-121
		56F	137	1-JECB-PSV-120
		56F	151	2-JECA-PSV-121
		56F	166	3-JECA-PSV-121
		56F	167	3-JECB-PSV-120
		56F	152	2-JECB-PSV-120

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REPORT NO. 3580 /-1
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QUALIFICATION EXTENSION ANALYSIS REPORT

AGING, SEISMIC AND ACCIDENT SIMULATION

FOR THE

TARGET ROCK CORPORATION

PROJECT 76Q SERIES

PRESSURE REGULATOR, VACUUM RELIEF

AND SAFETY RELIEF VALVES

PER REQUIREMENTS OF:

IEEE 323-1974

IEEE 344-1975

IEEE 382-1972

STANDARDS

BECHTEL POWER CORPORATION
P.O. NO. 10407-13-JM-691
PALO VERDE NUCLEAR GENERATING STATION
UNITS 1, 2 & 3
ARIZONA PUBLIC SERVICE COMPANY

TARGET ROCK CORPORATION

EAST FARMINGDALE, LONG ISLAND, N.Y

TR691-265-2

PREPARED BY_____
DATE_____
APPROVED BY_____
D_____

TARGET ROCK CORPORATION
EAST FARMINGDALE LONG ISLAND, N. Y.

PAGE ii OF 19
REPORT 3580 A1
PROJECT 760

REVISIONS

LETTER	DESCRIPTION	DATE	BY	APP.
---	First Issue	9/8/82	EA	DJ.
A	Per cust. comments.	12/10/82	EA	

X = PAGE CHANGED THIS REVISION
O = NO CHANGES THIS REVISION

PG NO.	–	A	B	C	D	E	F	G
TITLE	x	x						
i	x	x						
ii	x							
1	x	x						
2	x							
3	x							
4	x							
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APP.I	X							

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1.0 SCOPE

Target Rock Test Report Number 2375, Revision D, (Ref. 3.6, App. 1) is a Qualification Test Report which was run as a type test program for Target Rock Solenoid Operated Valves to demonstrate compliance with IEEE 323-1974 (Ref. 3.3), IEEE 344-1975 (Ref. 3.5) and IEEE 382-1972, (Ref. 3.4) standards. As called out, and included in the report, the test was run according to Target Rock Test Procedure 2192, Revision B (Ref. 3.6.1) on test valve configuration 77CC-001 (modified to SK 4017) and served to qualify Target Rock Solenoid Operated Valve Model No. 77CC-001.

The purpose of this report is to demonstrate by analysis and by comparison between the test valve and valve model numbers 76Q-001 thru -011 and between the applicable environmental parameters that non-metallic parts used in 76Q valves are qualified as an extension of the 77CC-001 qualification test. A

1.1 TEST RESULTS: 77CC-001 TEST VALVE, TARGET ROCK TEST REPORT NO. 2375

The 77CC-001 (modified per SK 4017) test valve was found to perform satisfactorily before, during and after a full qualification test program, and to be well designed for operation under all environmental exposures. Basic valve hardware was found satisfactory for a full 40 years of normal operation, plus 1 year of post LOCA operation. Silicone rubber o-ring seals were found suitable for ten (10) years operation. Target Rock recommends o-ring replacement after five (5) years operation.

2.0 CONCLUSIONS & CERTIFICATION

Based on the analyses presented in this report, it has been demonstrated that the environmental parameters used in Target Rock Qualification Test Report 2375, Revision D, envelope the required environmental parameters for the 76Q-001 thru -011 vacuum relief valves, pressure regulator and relief valves, called out in Bechtel Power Corporation Purchase Order #10407-13-JM-691.

The test valve and the 76Q valve assembly aging sensitive materials have also been compared and the type test qualification program, as reported in Report Number 2375 has been extended to qualify the 76Q valves. A

2.1 CERTIFICATION

Target Rock Corporation hereby certifies that the compliance report IEEE 323-1974, IEE 344-1975, and IEEE 382-1972 standards presented in Target Rock Qualification Test Report No. 2375, Revision B, also demonstrates qualification of 76Q-001 thru -011. The applicable valve tag numbers are given in Table 3.

3.0 REFERENCED DOCUMENTS

3.1 Bechtel Power Corporation P.O. No. 10407-13-JM-691.

3.2 Bechtel Power Corporation Specification No. 13-JM-691. "Specification for Palo Verde Nuclear Generating Station, Units No. 1,2 and 3, Arizona Public Service Company."

3.3 IEEE Standard 323-1974: "IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations."

3.4 IEEE Standard 382-1972:"IEEE Trial Use Guide for Type Test of Class I Electrical Valve Operators for Nuclear Power Generating Stations."

3.5 IEEE Standard 344-1975: "Guide for Seismic Qualification of Class IE Electrical Equipment for Nuclear Power Generating Stations."

3.6 Target Rock Report No. 2375, Revision D "Qualification Test Report: Aging, Seismic and Accident Silumation Test of Target Rock Corporation 1" Solenoid Valve, Model 77CC-001 (modified per SK 4017) per requirements of IEEE 323-1974, IEEE 344-1975 and IEEE 382-1972 Standards." (App. I). The following documents are included in Report Number 2375, (3.6 above):

3.6.1 APPENDIX F

Target Rock Report No. 2192, Revision B - "Qualification Test Procedure; Aging, Seismic and Accident Simulation Tests, 1" Solenoid Operated Globe Valve, N.C. (Energize to Open), TRC Model 77CC-001, modified to drawing number SK-4017.

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3.6.2 APPENDIX H

Target Rock, Drawing Number SK 4017, Revision None - Engineering Test Valve.

3.6.3 APPENDIX I

Target Rock Drawing No. 77CC-001, Revision A - 1" Solenoid Operated Globe Valve, ANSI 2500 lb., socket weld, project control drawing.

3.6.4 APPENDIX J

Target Rock Drawing No. 1 SMH-S-1, Revision B - 1" S.W. Solenoid Operated Globe Valve Assembly, "Y" Pattern, Normally Closed.

3.7 EPRI NP-2129 "Radiation Effects on Organic Materials in Nuclear Plants," November 1981.

3.8 EPRI NP-1558 "A Review of Equipment Aging Theory and Technology", September 1980.

4.0 NON-METALLIC COMPONENTS

Non-metallic components of the 76Q valve assemblies is listed in Table 1.

4.1 QUALIFICATION OF NON-METALLIC COMPONENTS

The silicone rubber o-rings are the parts considered least resistant to aging among the 76Q non-metallic components. Silicone rubber o-rings were part of the 77CC-001 test valve, and were qualified for conditions not surpassing the severity of the 77CC-001 test conditions. Section 4.2 of this report will compare 76Q environmental conditions and 77CC-001 test conditions to show

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TABLE I
NON-METALLIC COMPONENTS

VALVE #	QTY.	DESCRIPTION	MATERIAL	P/N
70010-2	1	O-Ring	Silicone Rubber	300-2029
	"	"	"	300-2007
	"	"	"	300-2132
	"	"	"	300-2030
	"	"	"	300-2011
	"	O-Ring	Silicone Rubber	300-0002
	1	Seal Ring	Polyimide	102378-1
	3	Screw	Nylon	069-0002
651 1x1-2-1	2	O-Ring	Silicone Rubber	300-2012
	2	"	"	300-2040
	1	"	"	300-2232
	1	O-Ring	Silicone Rubber	300-2021
	1	Gasket	Asbestos	102532-1
	1	Soft Disc Insert	Polyamide-Imide	203243-1
611 1x1-1-1	1-2	O-Ring	Silicone Rubber	300-2012
76Q-007	1	"	"	300-2228
008	1	"	"	300-2020
011	1	O-Ring	Silicone Rubber	300-2021
	1	Soft Disc Insert	Poly Amide-Imide	102728-1
2"VRE S-S-1	1	O-Ring	Silicone Rubber	ARP568-129
76Q-003	3	Screw	Nylon	058-0005
2 1/2x1REH-S-1	1	O-Ring	Silicone Rubber	ARP568-012
	"	"	"	ARP568-230
76Q-005	1	O-Ring	Silicone Rubber	ARP568-017
1 1/2x1 1/2REH-S-1	1	O-Ring	Silicone Rubber	ARP568-026
	"	"	"	ARP568-012
76Q-004	1	O-Ring	Silicone Rubber	ARP568-238
2x2REH-S-1	1	O-Ring	Silicone Rubber	ARP568-012
	"		"	ARP568-238
76Q-002	1	O-Ring	Silicone Rubber	ARP568-030
1x1REH-S-1	1	O-Ring	Silicone Rubber	ARP568-012
	"	"	"	ARP568-230
76Q-001, 006	1	O-Ring	Silicone Rubber	ARP568-017

1X1 REM-S-1
76Q-006

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4.2 COMPARISON OF ENVIRONMENTAL PARAMETERS

4.2.1 76Q ENVIRONMENTAL PARAMETERS

The most severe environmental parameters for the 76Q valve assemblies are given in Paragraph 4.3.7.5 of the 76Q Design Specification No. 13-JM-691. These environmental parameters are listed below:

Temperature:	See Figure 1
Pressure:	See Figure 2
Relative Humidity:	30% average, 100% max.
Radiation:	1.0×10^6 Rads. This is the integrated 40 year exposure combined with the accident dose.

A

4.2.2 COMPARISON BETWEEN THE ENVIRONMENTAL PARAMETERS FOR THE 77CC-001 TEST VALVE AND THE 76Q VALVE ASSEMBLIES

The environmental parameters for the 77CC-001 test valve are given in Target Rock Procedure 2192 (Ref. 3.6.1). The 77CC-001 LOCA temperature and pressure profiles are presented in Figure 1, which also shows the 76Q temperature and pressure profiles. A comparison between the environmental parameters for the 77CC-001 Test Valve and the specified environmental parameters for the 76Q valve assemblies is presented as follows.

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4.2.3 TEMPERATURE

4.2.3.1 TEMPERATURE FOR 40 YEAR NORMAL CONDITIONS

The normal environmental temperature for the 76Q valves ranges from 50°F to 120°F. The 77CC test temperature was 350°F (including margin) and the duration of the test was 33 days (Ref. 3.7.1). Solution of the Arrhenius equation indicates that running the test for 33 days at 350°F is equivalent to a 40 year life at a normal average temperature of 108°F and a maximum environmental temperature of greater than 140°F.

$t_a = t_s \exp\left\{\frac{E_a}{K_b}\left[\frac{1}{T_a} - \frac{1}{T_s}\right]\right\}$ $140F$

$t_a = 350,400 \exp\left\{\frac{.61}{8.617\times10^{-5}}\left[\frac{1}{449.67} - \frac{1}{315.27}\right]\right\}$

$t_a = 425.13$ hrs
17 days

$T_s = 140F$
1.44×10^3 hrs
58.79 days

4.2.3.2 TEMPERATURE FOR LOCA CONDITION.

The 76Q LOCA temperature profile, shown in comparison with the 77CC-001 test profile in Figure 1, has a maximum temperature of 300°F which occurs within the first 15 minutes. The 77CC-001 temperature profile envelopes the 76Q profile from after approximately 10 seconds to over the 10^6 second mark. The 10 seconds which are not enveloped are clearly negligible in comparison to the margin maintained for over 10^6 seconds.

4.2.4 PRESSURE

The 76Q specified 40 year normal pressure is atmospheric pressure. The 77CC temperature/humidity exposure test which was designed to simulate 40 year normal life conditions was also run at atmospheric pressure. For the LOCA and post LOCA accident load test (see Fig. 2), the test pressure varied from 66 psig for 8 hours to 11 psig after 14 days. The 76Q specification calls for a maximum of 21 psig for 15 minutes. The 77CC-001 test is the more severe, thus qualifying the 76Q valves.

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TEMPERATURE PROFILES

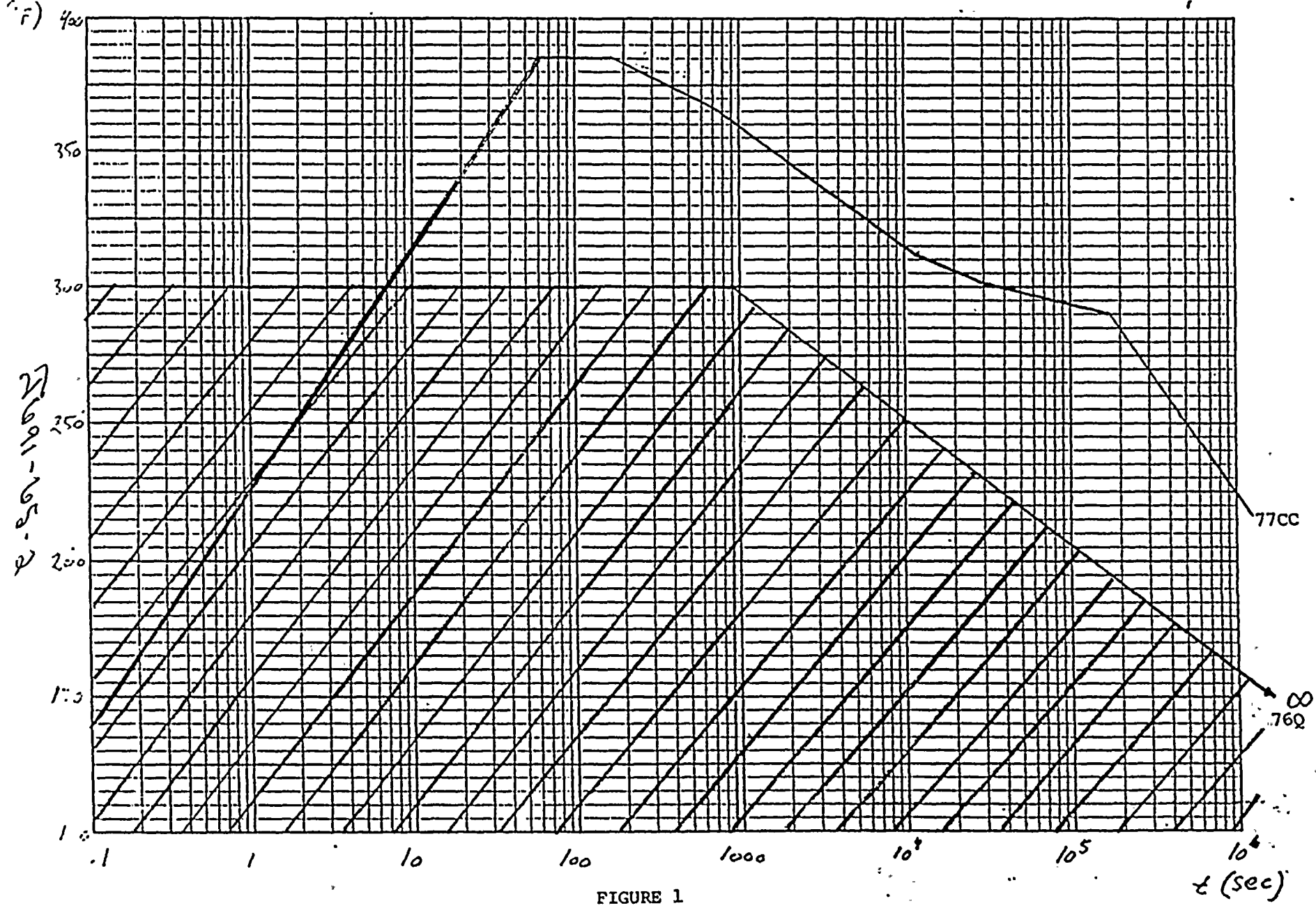

FIGURE 1

K·E SEMI-LOGARITHMIC 359-96
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PRESSURE PROFILES

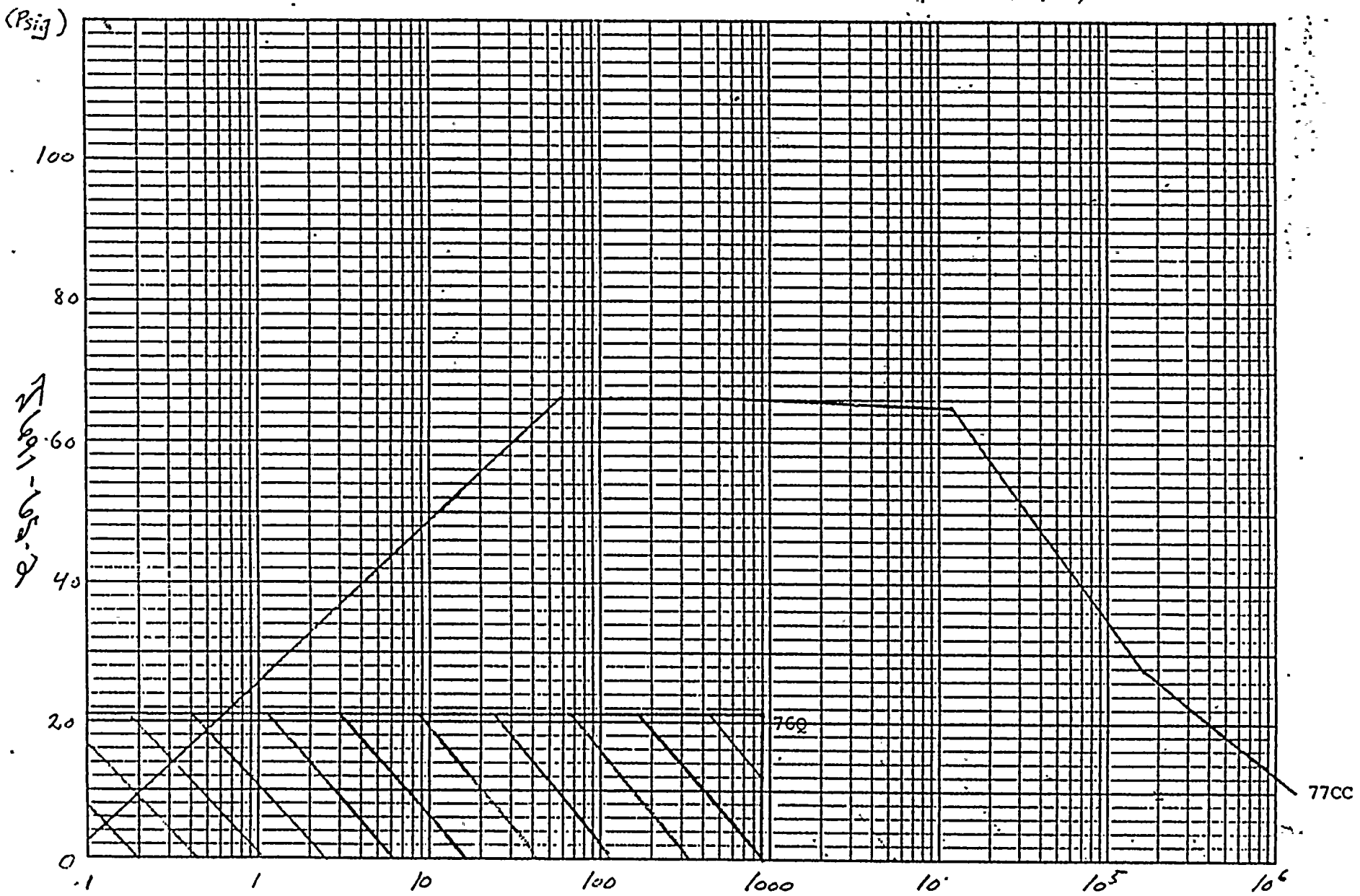

FIGURE 2

4.2.5 RADIATION (GAMMA)

The Model 77CC-001 valve was exposed to 22.7M rads as an aging dosage and an additional 112.6M rads during the accident for a total dosage of 1.353×10^8 rads, after which the valve functioned normally. This dosage was in excess of any requirements imposed prior to the date of the test.

The specified radiation for the 76Q valve assemblies is 1.0×10^5 rads, which is the integrated 40 year exposure combined with accident. This allows the qualification of the 77CC-001 valve to be extended to the 76Q valve assemblies. A

4.2.6 RELATIVE HUMIDITY

For the 76Q project, the maximum specified relative humidity is 100%, with an average relative humidity of 30%. The 77CC-001 valve experienced exposure to 100% relative humidity during the LOCA and post LOCA tests detailed in TR Report No. 2375. The relative humidity for the 77CC-001 simulated 40 year life test was nominally 55%. The actual value is difficult to measure under actual test condition and was probably close to 100% relative humidity, as evidenced by condensation on the test chamber double-pane window.

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4.2.7 SEISMIC QUALIFICATION A

The 76Q valve assemblies were seismically qualified by analysis in TR Reports 2161 and 2805. Furthermore, 76Q-003 and 76Q-004 was seismically tested in accordance with TRP 1965.

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4.2.8 ADDITIONAL INFORMATION

The 77CC-001 test valve underwent full production testing (except for hydrostatic testing which was only performed once at the time of initial production testing), between the various parts of the 77CC-001 test program. The test valve was subjected to cyclic aging, pressure loadings, and nozzle bending loads during the course of testing.

4.3 COMPARISON OF NON-METALLIC MATERIALS

4.3.1 ASBESTOS

Valve type 651 1x1-2-1 utilizes a gasket (P/N 102532-1) to seal between the ring locking screw and the valve body. The gasket contains asbestos as a filler material. Since the gasket is a metal-to-metal seal, with the asbestos acting as a back up while the press fit is formed, the asbestos will be considered exempt from aging analysis, as it is only effective during assembly.

4.3.2 POLYIMIDE

Part number 102378-1, is a polyimide sliding seal. From EPRI NP-1558, "A Review of Equipment Aging Theory and Technology", (see Table 2) it is found that the Relative Radiation Rsistance of Polyimide is over 10^7 rads for the "incipient to mild damage" region. Furthermore, the activation energy for polyimide (≅1.57) is higher than for silicone rubber (≅.61). Since silicone rubber was demonstrated to endure satisfactorily in TRC 2375 for sealing, polyimide should endure equally or better

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in these applications.

TABLE 2
RADIATION THRESHOLDS

MATERIAL	RADIATION THRESHOLD	SOURCE
Silicone Rubber	1×10^6	EPRI NP-1558 September 1980
Polyimide	1×10^7	EPRI NP-2129 November 1981
Polyamide-imide	1×10^9	Machine Design No. 6, 1981

4.3.3 POLYAMIDE-IMIDE

Parts number 102728-1 & 203243-1 are polyamide-imide disc inserts. Since Since no information is available about the activation energy of this material, the activation energy of the dominating component (polyimide) is assumed to be applicable. This material was analyzed in Section 4.3.2.

5.0 METALLIC COMPONENTS

The metallic components and valve bodies of the 760 valves were designed for 40 year service. Wall thicknesses were designed such that maximum projected stresses would not cause permanent deformation, and fatigue would be negligible. Safety margins allowed for any possible corrosion. Aging is, therefore, not expected to have any significant effect upon the metallic components of the 760 valves.

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6.0 QUALIFIED LIFE

The qualified life of the 76Q valves is 40 years, providing the non-metallic parts are changed every five (5) years of service or ten (10) years of storage, with the combination of service time and storage time not to exceed 10 years. Rubber o-rings are recommended to be replaced after disassembly of contacting parts. A

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TABLE 3 - VALVE TAG NUMBERS

PROJECT 76Q

CUSTOMER BECHTEL POWER CORPORATION P.O. 10407-13-JM-691

Model Number	P.O. Item	Tag Number
76Q-001	1	1 JEWA-PSV-61
	5	1 JEWB-PSV-62
	9	2 JEWA-PSV-61
	13	2 JEWB-PSV-62
	17	3 JEWA-PSV-61
	21	3 JEWB-PSV-62
	45	1 JEWA-PSV-47
	46	1 JEWB-PSV-48
	49	2 JEWA-PSV-47
	50	2 JEWB-PSV-48
	53	3 JEWA-PSV-47
	54	3 JEWB-PSV-48
76Q-002	25	1 JEWA-PSV-103
	26	1 JEWB-PSV-104
	27	2 JEWA-PSV-103
	28	2 JEWB-PSV-104
	29	3 JEWA-PSV-103
	30	3 JEWB-PSV-104
76Q-003	31	1 JEWA-PSV-105
	32	1 JEWB-PSV-106
	33	2 JEWA-PSV-105
	34	2 JEWB-PSV-106
	35	3 JEWA-PSV-105
	36	3 JEWB-PSV-106
76Q-004	43	1 JECA-PSV-75
	44	1 JECB-PSV-76
	47	2 JECA-PSV-75
	48	2 JECB-PSV-76
	51	3 JECA-PSV-75
	52	3 JECA-PSV-76

Table 3 continued on Page 17

TABLE 3 / Continued From Page 16 /

Model Number	P.O. Item	Tag Number
76Q-005	57	1-JSPA-PSV-137
	58	1-JSPA-PSV-139
	59	1-JSPA-PSV-141
	60	1-JSPA-PSV-143
	61	1-JSPB-PSV-138
	62	1-JSPB-PSV-140
	63	1-JSPB-PSV-142
	64	1-JSPB-PSV-144
	65	2-JSPA-PSV-137
	66	2-JSPA-PSV-139
	67	2-JSPA-PSV-141
	68	2-JSPA-PSV-143
	69	2-JSPB-PSV-138
	70	2-JSPB-PSV-140
	71	2-JSPB-PSV-142
	72	2-JSPB-PSV-144
	73	3-JSPA-PSV-137
	74	3-JSPA-PSV-139
	75	3-JSPA-PSV-141
	76	3-JSPA-PSV-143
	77	3-JSPB-PSV-138
	78	3-JSPB-PSV-140
	79	3-JSPB-PSV-142
	80	3-JSPB-PSV-144
76Q-006	81	1-JECA-PSV- 95
	82	1-JECB-PSV- 96
	83	1-JECA-PSV- 97
	84	1-JECB-PSV- 98
	85	1-JECA-PSV- 99
	86	1-JECB-PSV-100
	87	1-JECA-PSV-101
	88	1-JECB-PSV-102
	89	1-JECA-PSV-103
	90	1-JECB-PSV-104
	91	1-JECA-PSV-105
	92	1-JECB-PSV-106
	93	1-JECA-PSV-107
	94	1-JECB-PSV-108
	95	1-JECB-PSV-109

TABLE 3 Continued From Page 17

Model Number	P.O. Item	Tag Number
76Q-006	96	2-JECA-PSV-95
	97	2-JECB-PSV-96
	98	2-JECA-PSV-97
	99	2-JECB-PSV-98
	100	2-JECA-PSV-99
	101	2-JECB-PSV-100
	102	2-JECA-PSV-101
	103	2-JECB-PSV-102
	104	2-JECA-PSV-103
	105	2-JECB-PSV-104
	106	2-JECA-PSV-105
	107	2-JECB-PSV-106
	108	2-JECA-PSV-107
	109	2-JECB-PSV-108
	110	2-JECB-PSV-109
	111	3-JECA-PSV-95
	112	3-JECB-PSV-96
	113	3-JECA-PSV-97
	114	3-JECB-PSV-98
	115	3-JECA-PSV-99
	116	3-JECB-PSV-100
	117	3-JECA-PSV-101
	118	3-JECB-PSV-102
	119	3-JECA-PSV-103
	120	3-JECB-PSV-104
	121	3-JECA-PSV-105
	122	3-JECB-PSV-106
	123	3-JECA-PSV-107
	124	3-JECB-PSV-108
	125	3-JECB-PSV-109

TABLE 3 CONTINUED FROM PAGE 18

MODEL NUMBER	P.O. ITEM	TAG NUMBER
76Q-007	127	1-JECA-PSV-117
	142	2-JECA-PSV-117
	157	3-JECA-PSV-117
76Q-008	129	1-JSGA-PSV-312
	131	1-JSGA-PSV-319
	133	1-JSGB-PSV-325
	135	1-JSGB-PSV-305
	144	2-JSGA-PSV-312
	146	2-JSGA-PSV-319
	148	2-JSGB-PSV-325
	150	2-JSGB-PSV-305
	159	3-JSGA-PSV-312
	161	3-JSGA-PSV-319
	163	3-JSGB-PSV-325
	165	3-JSGB-PSV-305
76Q-009	128	1-JSGA-PSV-309
	130	1-JSGA-PSV-316
	132	1-JSGB-PSV-322
	134	1-JSGB-PSV-302
	143	2-JSGA-PSV-309
	145	2-JSGA-PSV-316
	147	2-JSGB-PSV-322
	149	2-JSGB-PSV-302
	158	3-JSGA-PSV-309
	160	3-JSGA-PSV-316
	162	3-JSGB-PSV-322
	164	3-JSGB-PSV-302
76Q-010	138	1-JSGB-PCV-303
	139	1-JSGA-PCV-310
	140	1-JSGA-PCV-317
	141	1-JSGB-PCV-323
	153	2-JSGB-PCV-303
	154	2-JSGA-PCV-310
	155	2-JSGA-PCV-317
	156	2-JSGB-PCV-323
	168	3-JSGB-PCV-303
	169	3-JSGA-PCV-310
	170	3-JSGA-PCV-317
	171	3-JSGB-PCV-323
76Q-011	136	1-JECA-PSV-121
	137	1-JECB-PSV-120
	151	2-JECA-PSV-121
	166	3-JECA-PSV-121
	167	3-JECB-PSV-120
	152	2-JECB-PSV-120

TL691-105-2

APS SUPPLEMENTAL CALCULATIONS

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BY	DATE	SUBJECT	SHEET NO.
MLR	27 Oct 83	Thermal Aging Analysis of	C-1 of 18
CHECKED BY	DATE	Non Metallic Subcomponents	JOB NO.
JS Bassewitz	12/28/83		

76Q-001
76Q-006 REF. Log J691-65, TRC Rpt 3580A pages 1-19.

Model	Design Temp	System	Service Temp	Max Ambient
IX1REH-S-1	200F	EC	56 to 76F	104F
		EW	105 to 151F	104F

Non Metallic Subcomponents

Part No.	Description	Material
ARP568-012	O Ring	Silicon
ARP568-017	O Ring	Silicon
ARP568-230	O Ring	Silicon

Material	Ea(eV)	y Intercept	End Point	Reference
Silicon	0.86	-18.3986	50% CS	E600-77

Aging Time and Temperature: 792 hours @ 350F (176.7C, 449.7K)

Required: (1) Determine the qualified lives for the silicon Orings based upon the Ambient or Service Temperature. (2) Determine maximum service temperature silicon Orings are qualified for.

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BY	DATE	SUBJECT	SHEET NO. C 2 of 18
CHECKED BY	DATE		JOB NO.

SOLUTION: EC SYSTEM

a) For the EC System since the maximum ambient is greater than the maximum service temperatures, 104F (40°C) will be used to calculate the qualified life.

ta = aging time = 792 hrs
Ta = aging temperature = 350F = 176.7°C = 449.7°K
ts = service time (qualified life)
Ts = service temperature = 40°C = 313°K
Kb = 8.617×10^{-5} eV/°K
Ea = activation energy = 0.86

$$ta = ts \exp\left\{\frac{Ea}{Kb}\left[\frac{1}{Ta} - \frac{1}{Ts}\right]\right\}$$

$$\ln(ts) = \ln(ta) - \left\{\frac{Ea}{Kb}\left[\frac{1}{Ta} - \frac{1}{Ts}\right]\right\}$$

$$\ln(ts) = \ln(792) - \left\{\frac{0.86}{8.617\times10^{-5}}\left[\frac{1}{449.7} - \frac{1}{313}\right]\right\}$$

$$\ln(ts) = 16.367236$$

$$ts = 12829.225 \text{ hrs} = \underline{1,464.5 \text{ YEARS}}$$

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BY	DATE	SUBJECT	SHEET NO. C3 of 18
CHECKED BY	DATE		JOB NO.

EW SYSTEM

b) FOR THE EW SYSTEM the MAXIMUM fluid temperature is greater than the ambient temperature. i.therefore it will be ASSUMED that the pressure relief VALVES are heated to temperatures equal to the system fluid temperature.

$t_a = 792 \text{ hrs}$

$T_a = 449.7°K$

$T_s = 151°F = 66.1°C = 339.1°K$

$K_b = 8.617 \times 10^{-5}$

$E_a = 0.86$

$$\ln(t_s) = \ln(t_a) - \left\{ \frac{E_a}{K_b} \left[\frac{1}{T_a} - \frac{1}{T_s} \right] \right\}$$

$$\ln(t_s) = \ln(792) - \left\{ \frac{0.86}{8.617 \times 10^{-5}} \left[\frac{1}{449.7} - \frac{1}{339.1} \right] \right\}$$

$$\ln(t_s) = 13.913$$

$t_s = 1.1024 \times 10^6 \text{ hrs} = \underline{125.57 \text{ YEARS}}.$

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BY	DATE	SUBJECT	SHEET NO. C4 of 18
CHECKED BY	DATE		JOB NO.

2 $\ln(t) = mx + b$

$m = \frac{Ea}{Kb}$

$x = 1/°K$

b = y intercept for silicon

$$\ln(t) = \frac{0.86}{8.617 \times 10^{-5}} (1/°K) - 18.3986$$

$$\ln(t) = 9980.2716 \left(\frac{1}{°K}\right) - 18.3986 \text{ for 50\% CS}$$

$$\frac{1}{°K} = \frac{\ln(t) + 18.3986}{9980.2716}$$

$$°K = \frac{19980.2716}{\ln(t) + 18.3986}$$

For a 40 year qualified life the service temperature is

$$°K = \frac{9980.2716}{\ln(350,400) + 18.3986} = 320.2$$

$°C = 320.2 - 273 = 47.2C$ for 50% CS

To determine the service temperature for which the silicon O rings were aged at 792 hrs at 150°C, first find 2 points on the original Arrhenius plot using the $\ln(t)$ equation

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BY	DATE	SUBJECT	SHEET NO. C5 of 18
CHECKED BY	DATE		JOB NO.

100°C = 373°K

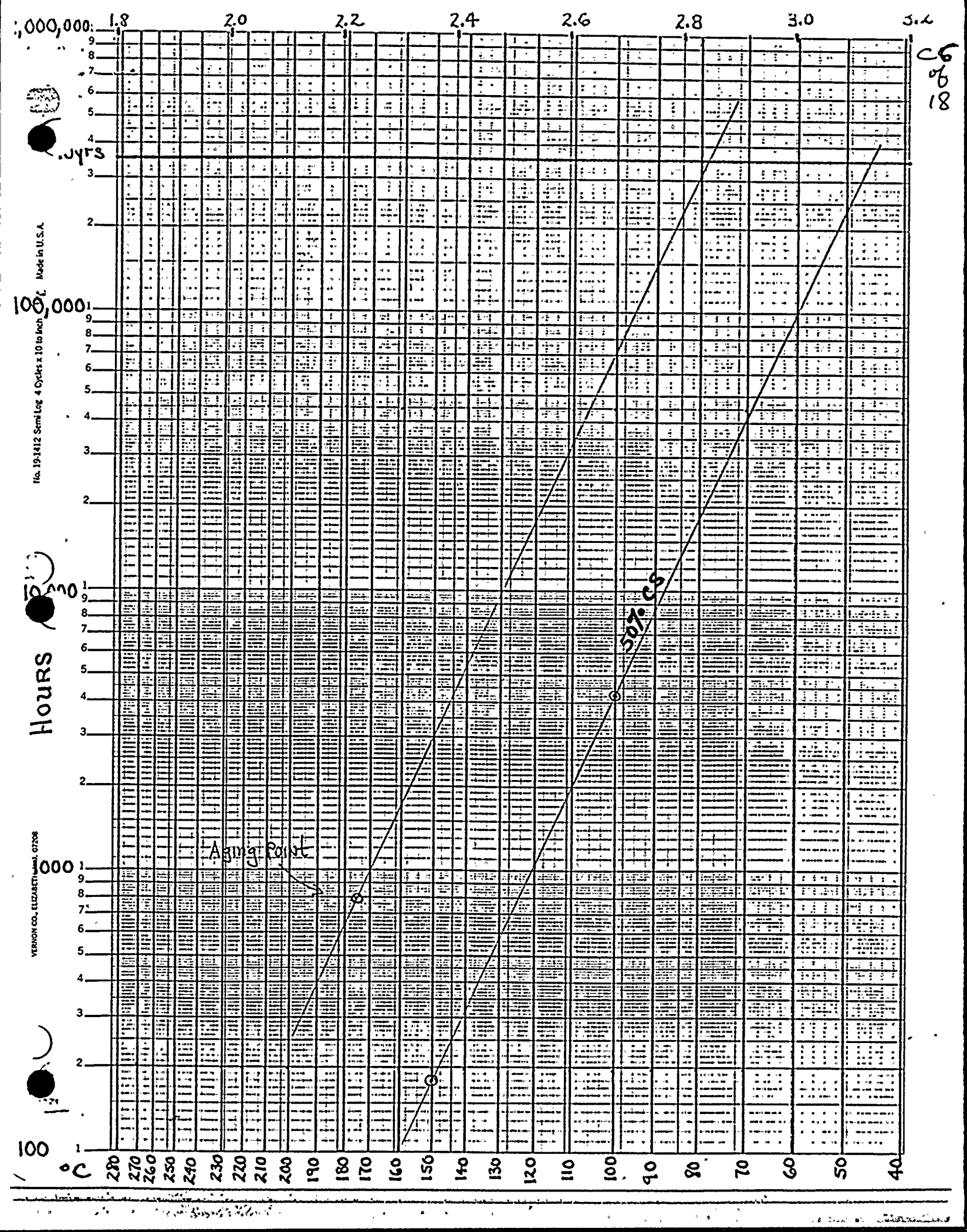
$\ln(t) = 9980.2716\left(\frac{1}{373}\right) - 18.3986$, $t = 4265$ hrs

150°C = 423°K

$\ln(t) = 9980.2716\left(\frac{1}{423}\right) - 18.3986$, $t = 180$ hrs

By drawing a parallel line through the aging point of 792 hrs and 176.7°C, the equivalent service temperature at 40yrs is 78°C = 172.4°F

CONCLUSION: Using the TRC approach where silicon O rings were aged 792 hrs at 350F. In the qualification of the 77CC-001 and the valve peformed satisfactorily, it can be concluded that if service temperatures remain below 172F then silicon O rings are qualified for a minimum of 40 years. No credit for aging is taken for the LOCA test aging affects on the solenoid valves.


1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
1,000,000
100,000
10,000
1000
100
Hours
.Yrs
°C
280
270
260
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220
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190
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160
150
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130
120
110
100
90
80
70
60
50
40
Agma Point
50% CS
No. 19-1412 Semi Log 4 Cycles x 10 to Inch Made in U.S.A.
VERNON CO., ELIZABETH, N.J. 07208
C6
06
18

aps.
WE CARE / HOW YOU LIVE

BY	DATE	SUBJECT	SHEET NO. C7 of 18
CHECKED BY	DATE		JOB NO.

76Q-002

Model	Design Temp	System	Service Temp	Max Ambient
2X2REH-S-1	150F	EW	105-125F	104F

NON METALLIC SUBCOMPONENTS

PART NO	DESCRIPTION	MATERIAL
ARP568-012	O RING	SILICON
ARP568-238	O RING	SILICON
ARP568-030	O RING	SILICON

SINCE the fluid service temperature is greater than the maximum Ambient, 125F (51.7°C) will be used as a basis for qualification

CONCLUSION: Based upon the calculations provided on pages 4 and 5, these pressure relief valves are qualified in excess of 40 yrs.

aps.
WE CARE | HOW YOU LIVE

BY	DATE	SUBJECT	SHEET NO. C8 of 18
CHECKED BY	DATE		JOB NO.

76Q-003

Model	Design Temp	System	Service Temp	Max Ambient
2"VRES-S-1	150F	EW	105 to 125	104

Part No	Desc	Material	
ARP568-129	O RING	Silicon	
058-0005	Spacer	Nylon	THIS component is used only as a spacer around the unthreaded section of 3 cover screws and provides NO SAFETY FUNCTION.

SINCE THE fluid service Temperature IS greater than the MAXIMUM AMBIENT, 125F (51.7°C) WILL BE USED AS A BASIS FOR QUALIFICATION

CONCLUSION: Based upon the calculations provided on pages 4 and 5, these pressure relief VALVES are QUALIFIED IN EXCESS OF 40 yrs

aps.
WE CARE | HOW YOU LIVE

BY	DATE	SUBJECT	SHEET NO. 9 of 18
CHECKED BY	DATE		JOB NO.

76Q-004

Model	DESIGN TEMP	SYSTEM	Service TEMP	MAX AMBIENT
1½x1½REH-S-1	104	EC	57 to 76F	104

PART NO.	DESC	MATERIAL
ARP568-026	O RING	Silicon
ARP568-012	O RING	Silicon
ARP568-238	O RING	Silicon

SINCE the ambient temperature is greater than the service temperature 104F (40°C) is used as the basis for qualification

CONCLUSION: BASED upon the CALCULATIONS provided ON pages 4 and 5, these PRESSURE relief VALVES are QUALIFIED IN EXCESS OF 40 yrs.

aps.
WE CARE | HOW YOU LIVE

BY	DATE	SUBJECT	SHEET NO. C10 of 18
CHECKED BY	DATE		JOB NO.

76Q-005

Model	DESIGN TEMP	SYSTEM	Service Temp(MAX)	MAX AMBIENT
2½x1REH-S-1	200F	SP.	126F	140F

PART NO	DESC	MATERIAL
ARP568-012	O RING	Silicon
ARP568-017	O RING	Silicon
ARP568-230	ORING	Silicon

Since the maximum ambient temperature is greater than the fluid service temperature 140F (60°C) is used as a basis for qualification.

Conclusion: based upon the calculations provided on pages 4 and 5, the pressure relief valves are qualified in excess of 40 years.

aps.
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BY	DATE	SUBJECT	SHEET NO. C11 of 18
CHECKED BY	DATE		JOB NO.

76Q-007
76Q-008
76Q-011

Model	DESIG TEMP	SYSTEM	MAX SERVICE TEMP	MAX AMBIENT
611-1X1-1-1X1	300F	EC	56-76F	104
		SG	122F	122F

PART NO	DESG	MATERIAL
300-2012	ORING	SILICON
300-2228	ORING	SILICON
300-2020	ORING	SILICON
300-2021	ORING	SILICON
102728-1	DISC	polyAmide-Imide

a. Silicon

The temperature selected for qualification for these pressure relief VALVES IS 122F. This temperature WAS selected IN the SG system because they do not come IN direct contact with any high temperature STEAM LINES AND are only subjected to the MAXIMUM AMBIENTS

CONCLUSION: For silicon rubber ORings, the qualified life is greater than 40 years based upon the calculations provided on pages 4 and 5

aps.
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BY	DATE	SUBJECT	SHEET NO. C12 of 18
CHECKED BY	DATE		JOB NO.

b. Polyamide-Imide

Page 14/19 of TRC report 3580A (Log 65-2, BECHTEL Page 16) states that NO INFORMATION IS AVAILABLE for this material however the activation energy for Polyimide (~1.57 eV) is assumed to be applicable.

Page B-7 of EPRI NP-1558, Sept 1980 that this material has AN ACTIVATION ENERGY OF 1.54 AS Applied as AN overcoat on a helical coil

To determine the relative thermal age sensitivity of Polyamide-Imide the approach will be to determine the aging time required at 350F to simulate 40 years at a continuous service temperature at 122F

$T_s = 122F = 50°C = 323°K$
$T_a = 350F = 176.7°C = 449.7°K$
$K_b = 8.617 \times 10^{-5}\ eV/°K$
$E_a = 1.54$
$t_s = 40\ yrs = 350,400\ hrs$

$$t_a = t_s \exp\left\{\frac{E_a}{K_b}\left[\frac{1}{T_a} - \frac{1}{T_s}\right]\right\}$$

$$t_a = 350,400\ hrs \exp\left\{\frac{1.54\ eV}{8.617 \times 10^{-5}\ eV/°K}\left[\frac{1}{449.7K} - \frac{1}{323K}\right]\right\}$$

$$t_a = 5.9482 \times 10^{-2}\ hrs = 3.6\ minutes.$$

CONCLUSION: BASED UPON AN extremely short aging time OF 3.6 minutes AT 350F NO SIGNIFICANT degradation will occur TO this material when exposed TO 122F for 40 yrs.

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BY	DATE	SUBJECT	SHEET NO. C13 of 18
CHECKED BY	DATE		JOB NO.

76Q-009

MODEL	DESIGN TEMP	SYSTEM	SERVICE TEMP	MAX AMBIENT
651-1X1-2-1-1X1	300F	SG	122F	122F

PART	DESC	MATERIAL
300-2012	O RING	SILICON
300-2040	O RING	SILICON
300-2232	O RING	SILICON
300-2021	O RING	SILICON
102532-1	GASKET	ASBESTOS
203243-1	DISC INSERT	POLYAMIDE-IMIDE

a. SILICON RUBBER

The silicon Rubber Orings have a qualified life greater than 40 years based upon the calculations performed on pages 4 and 5.

b. ASBESTOS

From E600-5, Wyle Laboratories has reported that ASBESTOS is not age sensitive.

aps.
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BY	DATE	SUBJECT	SHEET NO. C14 of 18
CHECKED BY	DATE		JOB NO.

C. Polyamide-Imide

From the calculation performed on page 12, no significant age degradation will occur to this material when exposed to 122F for 40 years.

aps.
WE CARE HOW YOU LIVE

BY	DATE	SUBJECT	SHEET NO. C15 of 18
CHECKED BY	DATE		JOB NO.

76Q-010

Model	DESIGN Temp	System	MAX SERVICE TEMP	MAX AMBIENT
70010-2	300F	SG	122F	122F

PART No.	DESC	MATERIAL	
300-2029	O RING	Silicon	
300-2007	O RING	Silicon	
300-2132	O RING	Silicon	
300-2030	O RING	Silicon	
300-2011	O RING	Silicon	
301-0002	O RING	Silicon	
102378-1	Seal Ring	Polyimide	
069-0002	Spacer	Nylon	This component is used as a spacer around the unthreaded section of 3 cover screws and provides no safety function

(a) Silicon

From the calculations provided on pages 4 and 5 of this analysis, the Silicon O rings are qualified for a minimum of 40 years.

aps.
WE CARE HOW YOU LIVE

BY	DATE	SUBJECT	SHEET NO. C16 of 18
CHECKED BY	DATE		JOB NO.

b. Polyimide

From page B-9 of EPRI NP-1558 dated Sept. 1980 provides an activation energy of 1.57 eV. Using the data provided in Conax report IPS-325 (E035A-314-2) where two separate aging tests were performed for Kapton (See page 17) the equations for the Arrhenius plots were:

A. $LN(t) = 10,613.69058(1/K) - 12.58824$

B. $LN(t) = 15,065.74938(1/K) - 20.12968$

The activation energy for each of the above equations are:

A. $\frac{Ea}{Kb} = 10,613.69058$

$Ea = 10,613.69058 * 8.617 \times 10^{-5}$

$Ea = 0.91458$

B. $\frac{Ea}{Kb} = 15,065.74938$

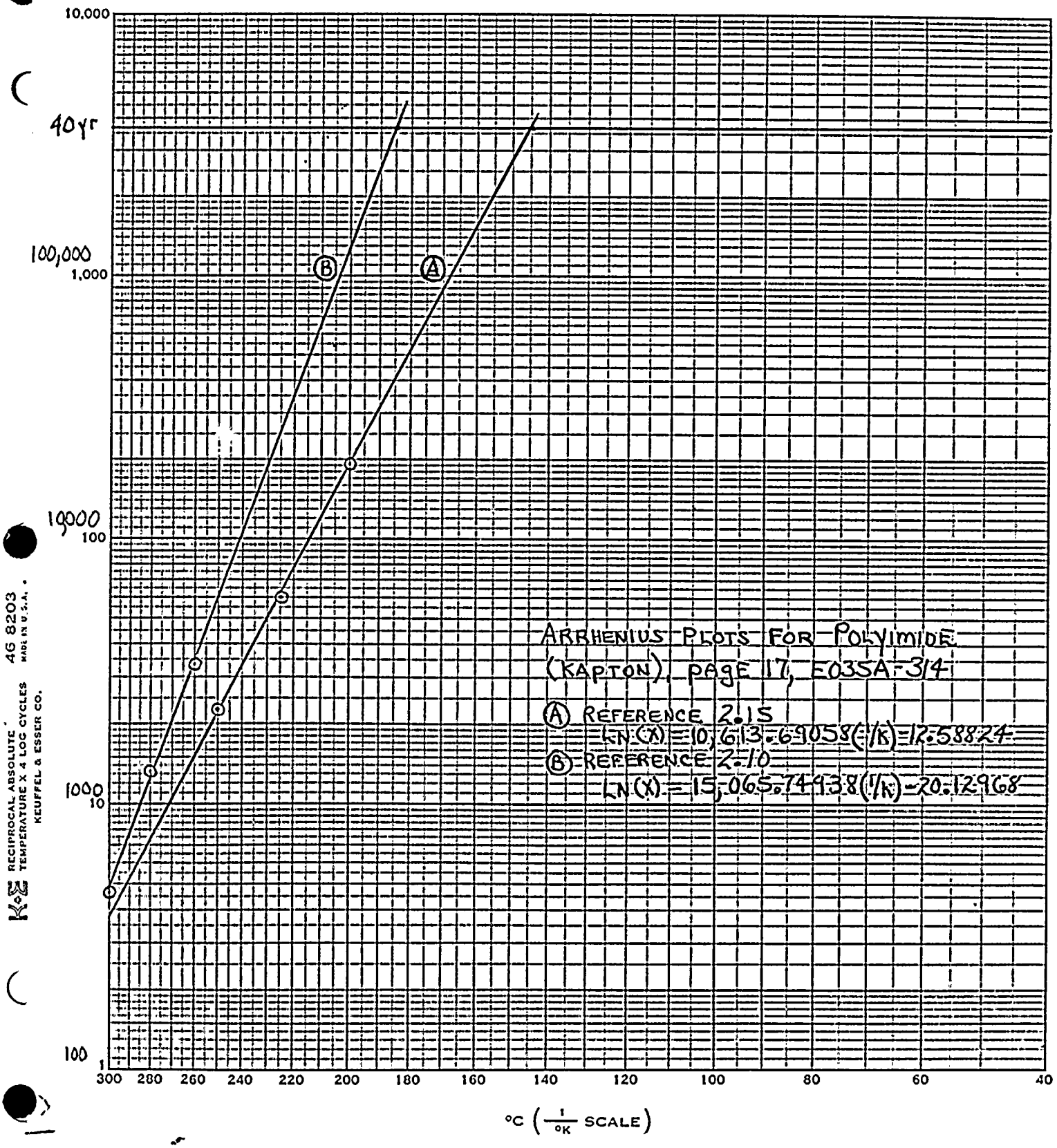
$Ea = 15,065.74938 * 8.617 \times 10^{-5}$

$Ea = 1.2982$

The continuous service temperature over 40 yrs which would reach the same end point criteria (dielectric failure) as performed during the aging is

A. $°C = \frac{10,613.69058}{\ln(350,400) + 12.58824} - 273$

$°C = 145°C$


10,000
40yr
100,000
1,000
10000
100
1000
10
100
1
300 280 260 240 220 200 180 160 140 120 100 80 60 40
°C (1/°K SCALE)
B
A
ARRHENIUS PLOTS FOR POLYIMIDE (KAPTON), PAGE 17, E035A-314
(A) REFERENCE 2.15
LN(X) = 10,613.69058(1/K) - 12.58824
(B) REFERENCE 2.10
LN(X) = 15,065.74938(1/K) - 20.12968
RECIPROCAL ABSOLUTE TEMPERATURE X 4 LOG CYCLES
KEUFFEL & ESSER CO.
46 8203
MADE IN U.S.A.

aps.
WE CARE | HOW YOU LIVE

BY	DATE	SUBJECT	SHEET NO. C 18 of 18
CHECKED BY	DATE		JOB NO.

B. $°C = \frac{15,065.74938}{\ln(350,400) + 20.12968} - 273$

$°C = 185°C$ calculated for B 12/28/83 — greater for B 12/28/83

It can be seen that either continuous 40yr. service temperature is much ~~less~~ than the 122F (50°C) that will be experienced by the equipment.

To determine the expected life of polyamide at 50°C (323K) the most conservative equation will be used (equation A).

A. $\ln(t) = 10,613.69058\left(\frac{1}{K}\right) - 12.58824$

$\ln(t) = 10,613.69058\left(\frac{1}{323}\right) - 12.58824$

$\ln(t) = 20.271$

$t = e^{20.271} = 6.3649 \times 10^8 \text{ hrs} = 72,659 \text{ yrs}$

The polyimide will therefore obtain $\frac{40}{72,659} \times 100\% =$ 0.055% degradation to failure or retain 100% - 0.055% = 99.945% of its original properities after 40 years at 50°C.

8146359 EST 1713 FEB/15/1984

TARGTROCK FDLE

ZCZC ANPT 3133; PHOENIX, AZ: FEBRUARY 15, 1984
5102246410

TARGET ROCK CORPORATION
1966E BROADHOLLOW RD.
EAST FARMINGDALE, NY 11735

ATTN: MR. THOMAS D. CROWLEY
BT
ANPT-3133-JTB/MLR

SUBJECT: ENVIRONMENTAL QUALIFICATION OF TRC
PRESSURE RELIEF VALVES
FILE: 13-JM-691

REFERENCE: TELEPHONE CONVERSATION BETWEEN THOMAS CROWLEY,
MARTIN RAINES AND ED GOUVIER OF FEBRUARY 15, 1984.

GENTLEMEN:

THIS IS TO CONFIRM THE REFERENCED CONVERSATION CONCERNING ENVIRONMENTAL QUALIFICATION OF TRC SAFETY RELIEF VALVES.

APS EXPLAINED THAT AS PART OF THE EQUIPMENT QUALIFICATION EFFORT, THE NUCLEAR REGULATORY AGENCY HAD REQUESTED THAT WE SUEMIT THREE MECHANICAL ENVIRONMENTAL REPORTS FOR REVIEW OF WHICH TRC SAFETY RELIEF VALVES, PURCHASED UNDER 13-JM-691, WERE SELECTED. APS STATED THAT AS PART OF THE REORT SUPPLIED BY TRC (RPT. NO. 3580A), WE HAD PERFORMED AN ADDITIONAL AGING ANALYSIS TO SUPPLEMENT THE TRC DATA. THE RESULTS INDICATED A QUALIFIED LIFE OF FORTY YEARS MINIMUM AS OPPOSED TO THE FIVE YEARS STATED IN SECTION 6.0, PAGE 15 OF 19, TRC RPT. 3580A. THIS DISCREPANCY PROMPTED THE NRC TO REQUEST THAT APS OBTAIN CONCURRENCE FROM TRC FOR THE APS CALCULATIONS.

IT WAS FURTHER DISCUSSED THAT APS MAKES A DISTINCTION BETWEEN QUALIFIED LIFE AND DESIGN LIFE. FOR SITUATIONS WHERE THE RECOMMENDED REPLACEMENT INTERVAL (DESIGN LIFE) IS LESS THAN THE QUALIFIED LIFE, APS MAKES EVERY EFFORT TO COMPLY WITH SUPPLIER RECOMMENDATIONS. HOWEVER, IF LIMITATIONS ON AVAILABLE MANPOWER OR TIME CONSTRAINTS PREVENTED REPLACEMENT WITHIN THE RECOMMENDED TIME FRAME, THIS WOULD NOT RENDER THE EQUIPMENT UNQUALIFIED AND OPEN APS TO A POTENTIAL NRC VIOLATION OR FINDING.

IT WAS ALSO DISCUSSED THAT PERIODIC OPERABILITY TESTING COUPLED WITH DETAILED SURVEILLANCE OF SELECTED "WORSE CASE" VALVES COULD ESTABLISH OPERABILITY OF THE REMAINING VALVES WHOSE AGE DEGRADABLE COMPONENTS REMAINED IN PLACE IN EXCESS OF THE DESIGN LIFE OR REPLACEMENT INTERVAL BUT LESS THE QUALIFIED LIFE.

APS COMMITTED TO TRANSMIT A COPY OF THE CALCULATIONS REVIEWED BY THE NRC VIA FEDERAL EXPRESS AND REQUESTED TARGET ROCK CORPORATION TO PROVIDE THEIR OPINIONS/RECOMMENDATIONS PRIOR TO OUR REQUIRED RESPONSE DATE OF MARCH 4, 1984 TO THE NRC.

IF YOU REQUIRE FUTHER INFORMATION, PLEASE CONTACT MARTIN RAINES AT (602) 943-7200, EXT. 6054. FOR YOUR CONVENIENCE, OUR TELEX NUMBER IS 668308-AZ PUBSVC PHX.

VERY TRULY YOURS,

E. E. VAN BRUNT, JR.
APS VICE PRESIDENT, NUCLEAR
ANPP PROJECT DIRECTOR

EEVBJR/MLR/DH

CC: A. C. ROGERS
J. T. BARROW
E. J. GOUVIER
T. F. QUAN
V. L. KEDANIS

NNNNEND

TARGTROCK FDLE
T

PART 3

DRAWINGS

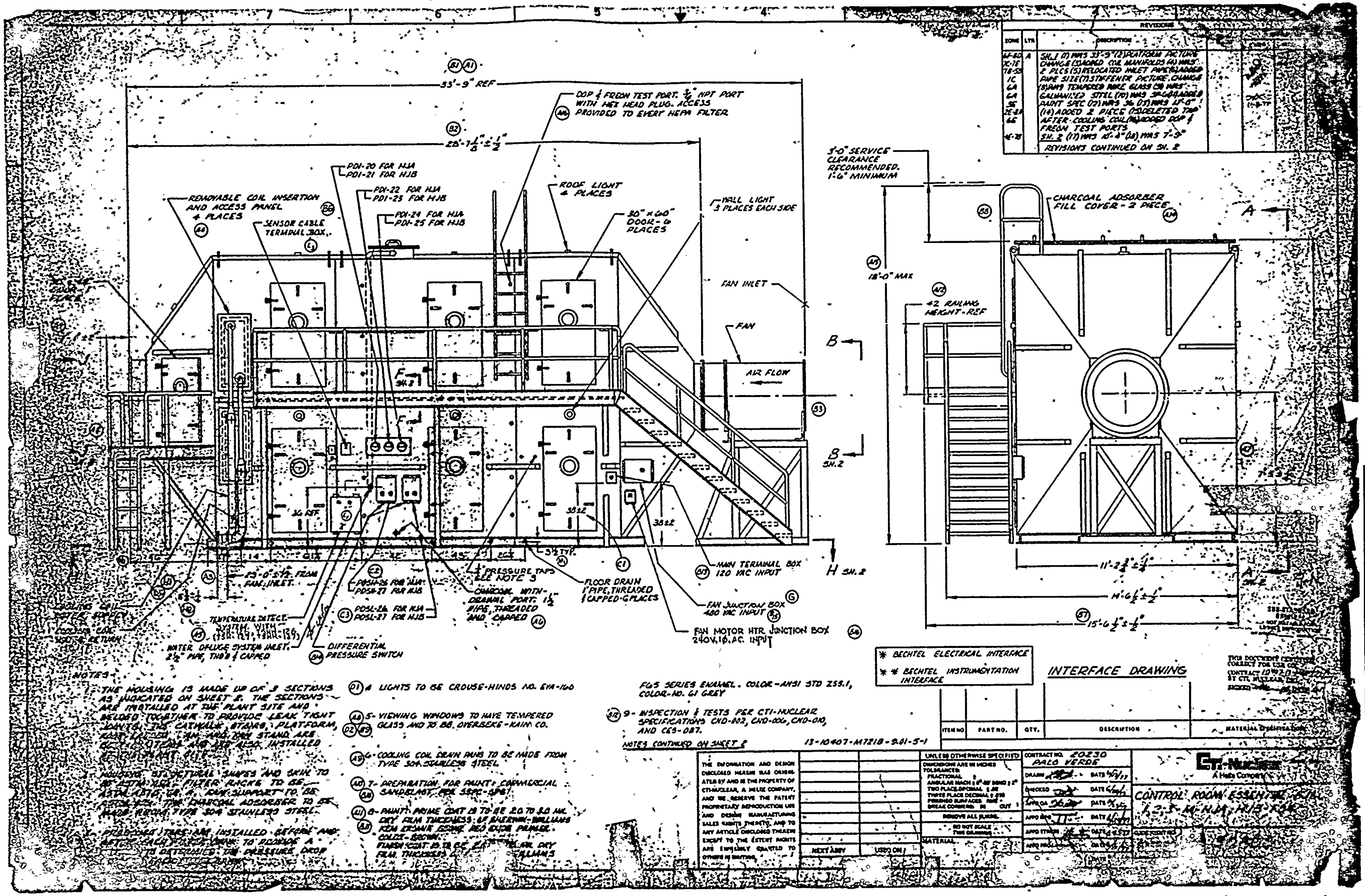
POOR ORIGINAL

TI APERTURE CARD

UNCONTROLLED DRAWINGS
THIS DRAWING MAY BE AFFECTED BY DOCUMENTS IDENTIFIED ON THE DAILY NOTIFICATION LIST (DNL) AND THE FIELD REVISION LOG (FRL).

Also Available On Aperture Card

24X



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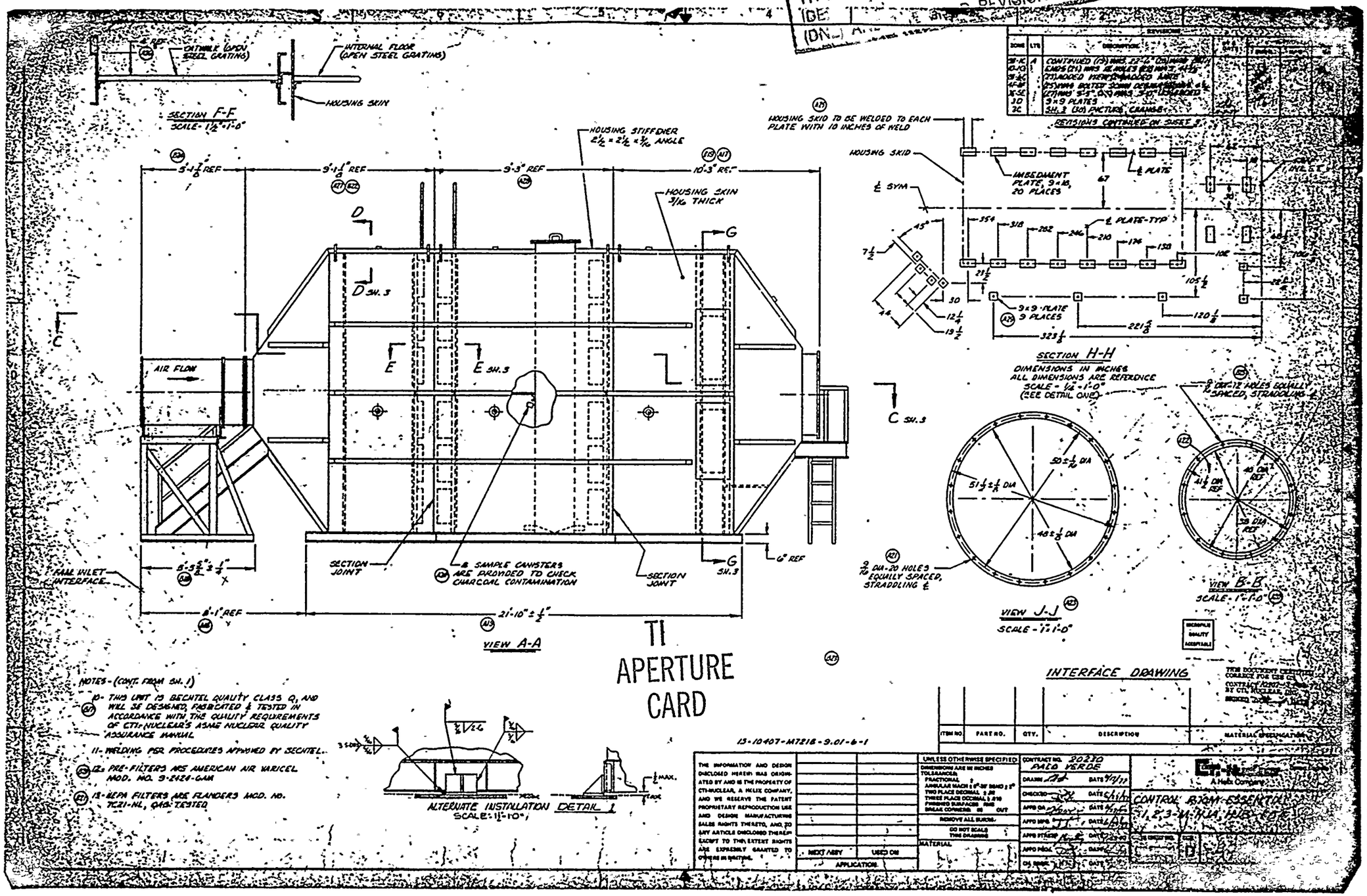

UNCONTROLLED DRAWINGS

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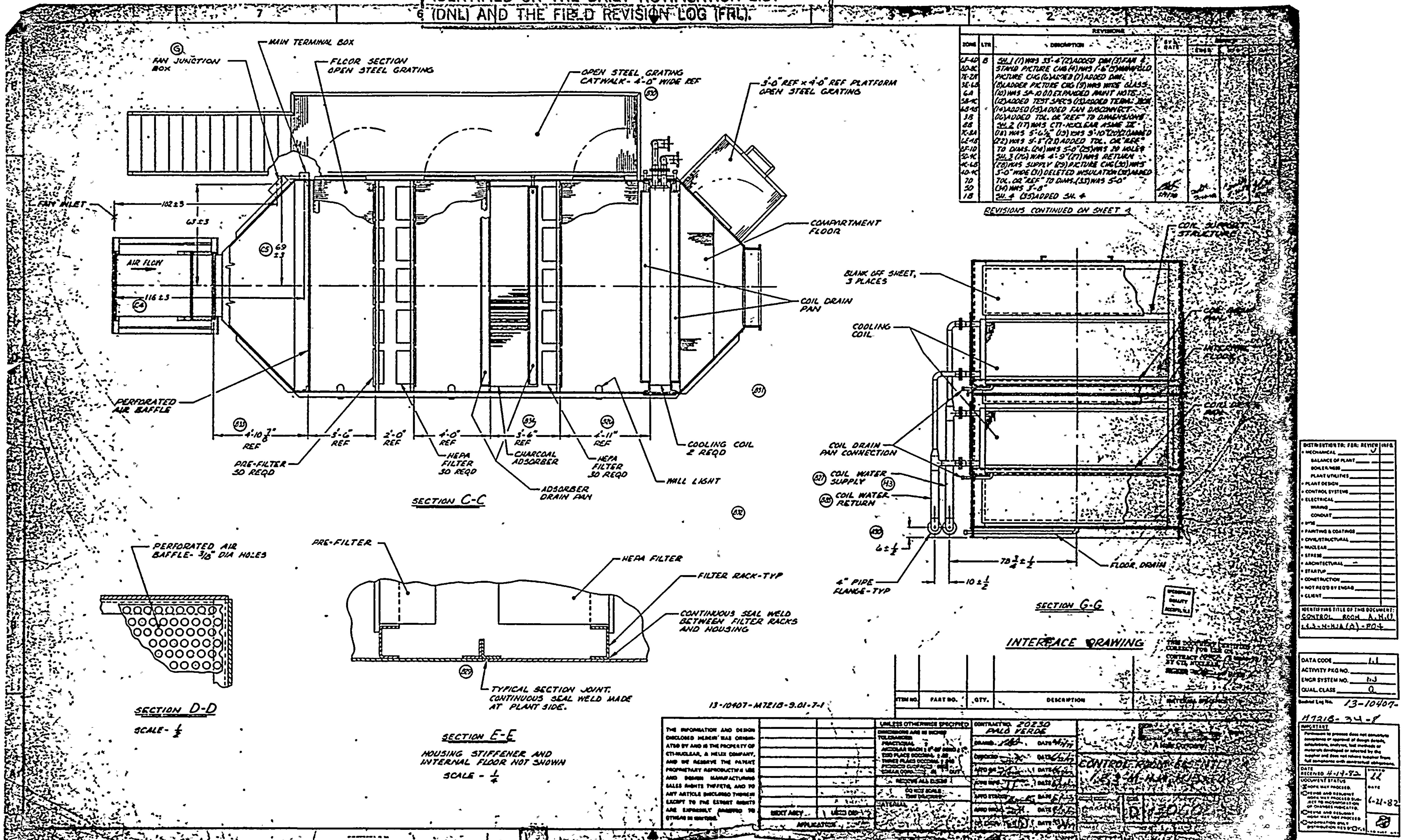

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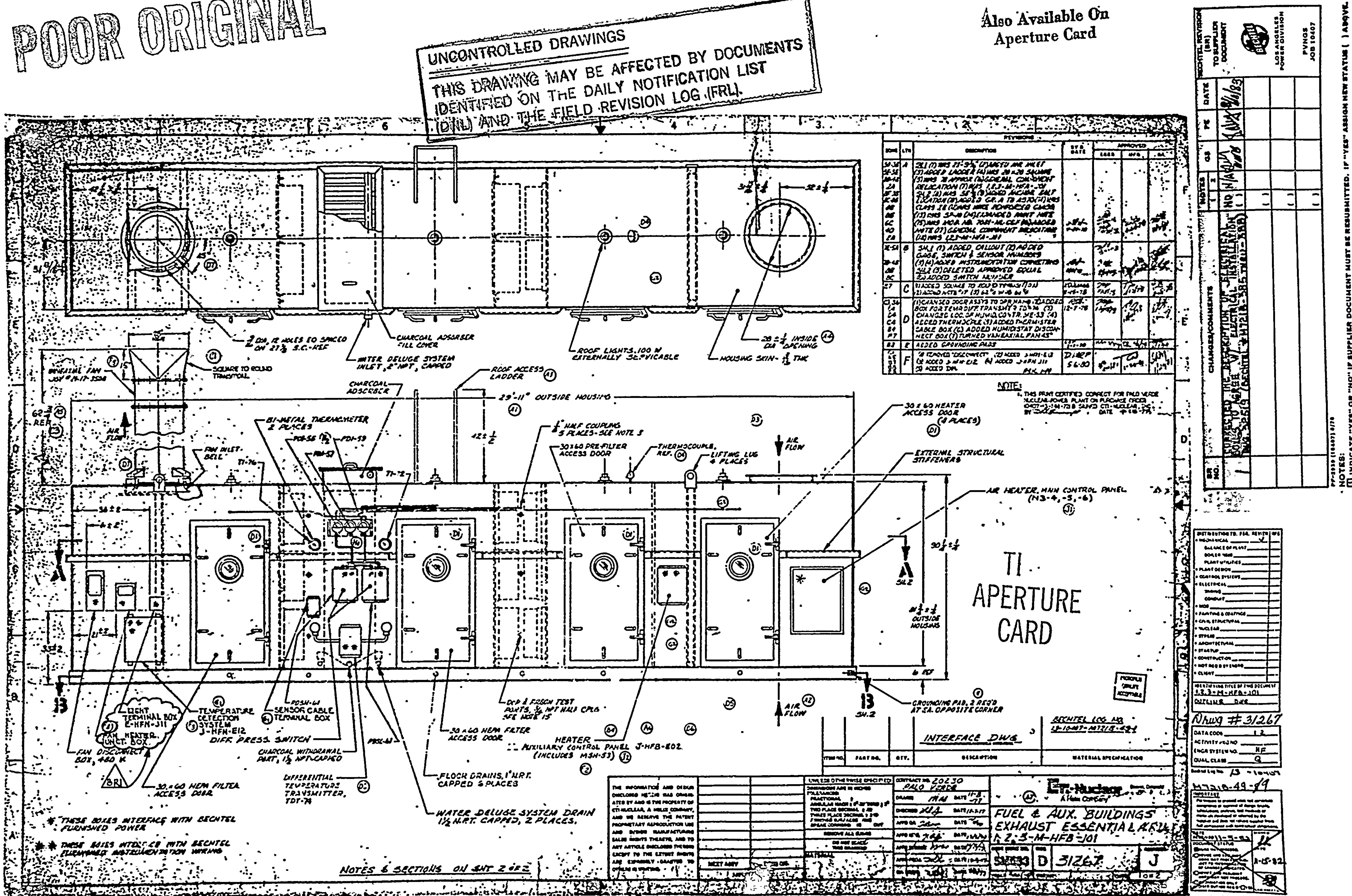
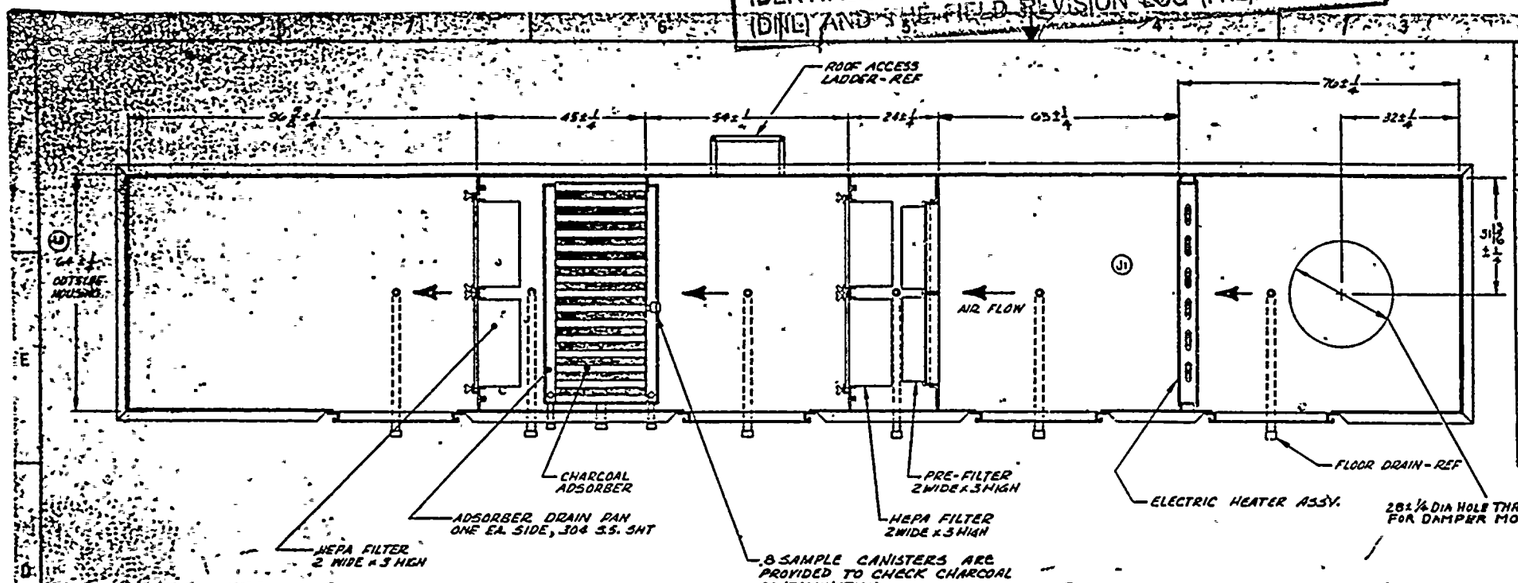
Also Available On Aperture Card



M-HFB-J01

8403090014-17

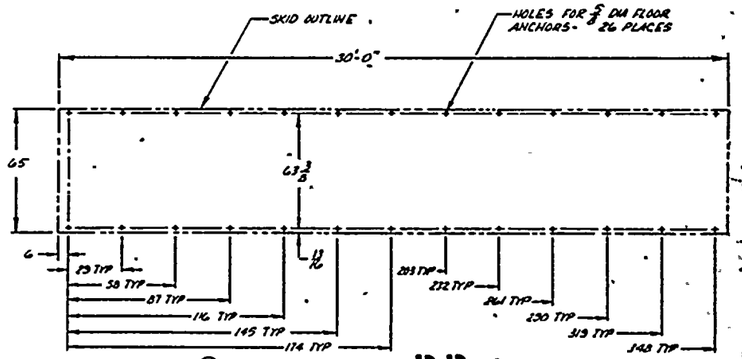


SECTION A-A

ZONE	LTR	REVISIONS DESCRIPTION	DATE	CHK'D	APPROVED MECH.	ELEC.
	A	SEE SHEET 1				
	B	SEE SHEET 1				
	C	SEE SHEET 1				
	D	SEE SHEET 1				
	E	SEE SHEET 1				
	F					
	G	(1) REMOVED HIGH TEMPERATURE CONTROL BOX & ADDED SENSOR CABLE TEMP. BOX, ADDED TEMP. DETECTION SYSTEM. (2) REMOVE THERMISTOR CABLE RACK, THERMISTOR CABLE BOX, HUMIDITY CONTROLLER & HUMIDISTAT DISCONNECT BOX. REPLACE CTI HEATER WITH NUTHERM AIR HEATER. STRESS: 9158 PE: PK 4-5-81	R. JOLLY 3-10-81 RMC 4-13-81		4-15-81	
	H	(1) REVISED TUBING SCHEMATIC TO MATCH DWG D 32513 (2) PDI 55 WAS PDI 59 PDI 59 WAS PDI 55 PE. PJX 9-30-82 S7288331	PJX 9-30-82		11-4-82	
DLW 10/5/82	J	J1 "MAIN CONTROL PANEL" WAS AUX. CONTROL BOX J2 MSH-53 WAS MSH-83, AUX. CONTROL PANEL J-HFB-E02 WAS CONTROL BOX J-HFH-E13 P.E. [illegible] STAMP 7/8 11-1-82	DJG 11-1-82			

NOTES:

1. THE HOUSING IS FABRICATED & SHIPPED AS A SINGLE UNIT W/ THE CHARCOAL ADSORBER IN PLACE. THE FAN, FILTERS & CHARCOAL WILL BE SHIPPED LOOSE.
2. HOUSING STRUCTURAL SHAPES & SKIN TO BE ASTM A36; FILTER RACKS TO BE ASTM A570, GR. A. THE CHARCOAL ADSORBER & HEATER FRAME TO BE TYPE 304 S.STL.
3. SAMPLE TAPS ARE INSTALLED BEFORE & AFTER EACH FILTER BANK TO PROVIDE A METHOD OF DETERMINING THE BYPASS DOOR THROUGH EACH FILTER BANK.
4. FAN WITH FLOW SWITCH, PDSL-61, IS PROVIDED TO PROTECT THE HEATERS IN CASE OF FAN FAILURE.
5. HEATER TUBES FOR FINNED ELEMENTS WILL NOT BE COPPER OR COPPER PLATED AS SPECIFIED IN SECT. 9-5.2.1.2. OF THE TECHNICAL REQUIREMENTS. TUBES WILL BE INCONEL, ASTM-B168. HEATERS WILL BE QUALIFIED TO IEEE. CLASS 1E.
6. LIGHTS TO BE CROUSE-HINDS NO. EVA-160
7. VIEWING WINDOWS TO HAVE TEMPERED GLASS & TO BE BY OVERBEKE-KAIN CO.
8. PREPARATION FOR PAINT: COMM. SANDBLAST PER SSPC SP-6
9. PAINT: PRIME COAT TO BE 2.0 TO 3.0 MIL DRY FILM THICKNESS OF SHERWIN-WILLIAMS KEM-KROMIK B50N2 RED OXIDE PRIMER. COLOR-BROWN. FINISH COAT IS TO BE 2.0 TO 2.5 MIL DRY FILM THICKNESS OF SHERWIN-WILLIAMS F65 SERIES ENAMEL. COLOR-ANSI STD Z55.1, COLOR NO. 61 GREY
10. INSPECTION & TESTS PER CTI-NUCLEAR SPEC'S CND-00E, CND-000, CND-010 AND CES-087
11. THIS UNIT IS BECHTEL QUALITY CLASS Q AND WILL BE DESIGNED, FABRICATED AND TESTED IN ACCORDANCE WITH THE QUALITY REQUIREMENTS OF CTI-NUCLEAR'S ASME NUCLEAR QUALITY ASSURANCE MANUAL.
12. WELDING: PER PROCEDURES APPROVED BY BECHTEL.
13. HEPA FILTERS ARE FLANDERS MOD. NO. 7C21-NL, QAS TESTED.
14. PRE-FILTERS ARE AMERICAN AIR VARICEL MOD. NO. 9-2424-6AM.
15. ALL HALF COUPLINGS THAT ARE NOT CONNECTED WILL HAVE HEX HD. PLUGS & THDS WILL BE SEALED W/ TEFLON TAPE.
16. KA. THIS DRAWING FOR MECHANICAL ARRANGEMENT. IT WILL BE REVISED TO SHOW ELECTRICAL INTERFACES.
17. CZ. ALL INSTRUMENTS SHALL BE TAGGED AS PER APPENDIX 4N PAGES 4N1-5-2-6-2 AND DWG. 13-V-225-001.



SECTION B-B
ANCHOR BOLT LOCATION
TOL. ± 1/2
SCALE: 1/8"-1'-0"

INTERFACE DWG

ITEM NO.	PART NO.	QTY.	DESCRIPTION	MATERIAL SPECIFICATION

BECHTEL LOG NO. 13-10407-M7218-50-1

DISTRIBUTION TO: FOR REVIEW / INFO
- MECHANICAL
- BALANCE OF PLANT
- BOILER NSSS
- PLANT UTILITIES
- PLANT DESIGN
- CONTROL SYSTEMS
- ELECTRICAL
- WIRING
- CONDUIT
- HVAC
- PAINTING & COATINGS
- CIVIL STRUCTURAL
- NUCLEAR
- STRESS
- ARCHITECTURAL
- START UP
- CONSTRUCTION
- NOT REQ'D BY ENGRG.
- CLIENT

IDENTIFYING TITLE OF THIS DOCUMENT: 1,2,3-M-HFB-J01 OUTLINE DWG

MICROFILM QUALITY ACCEPTABLE

DATA CODE 1.2
ACTIVITY PKG NO.
ENGR SYSTEM NO. HE
QUAL CLASS Q
Bechtel Log No. 13-10407

M7218-50-7
IMPORTANT
Permission to proceed does not constitute acceptance of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full responsibility for such matters.

DATE RECEIVED 11-5-82
DOCUMENT STATUS
- WORK MAY PROCEED
- REVISE AND RESUBMIT WORK MAY PROCEED AS NOTED INCORPORATION OF CHANGES INDICATED
- REVISE AND RESUBMIT WORK MAY NOT PROCEED
- INFORMATION ONLY DISTRIBUTION AS PER CVI

DATE 11-15-82

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
FRACTIONAL ±
ANGULAR MACH ± 0°-30' BEND ± 1°
TWO PLACE DECIMAL ± .02
THREE PLACE DECIMAL ± .010
MACHINED SURFACES 125 BREAK CORNERS .03 " OUT
REMOVE ALL BURRS.
DO NOT SCALE THIS DRAWING
MATERIAL

CONTRACT NO. 20230 PALO VERDE

DRAWN	MM	DATE 11-7-77
CHECKED	[illegible]	DATE 12-2-77
APPD QA	[illegible]	DATE 12-2-77
APPD MFG	[illegible]	DATE 12-2-77
APPD STRESS	[illegible]	DATE 12-2-77
APPD ENGR	[illegible]	DATE 12-2-77
CH. ENGR.	[illegible]	DATE 12-2-77

NEXT ASSY 1 APPLICATION

CTI-Nuclear Denver, Colorado
A Helix Company

FUEL & AUX. BUILDINGS EXHAUST ESSENTIAL A.F.U. 1,2,3-M-HFB-J01

CODE IDENT NO.	SIZE	DRAWING NO.	REV.
6M563	D	31267	J

SCALE [illegible] SHEET 2 of 2

THIS DOCUMENT CERTIFIED CORRECT FOR USE ON CONTRACT 20230-M-HFB-7218 BY CTI NUCLEAR, INC. SIGNED [illegible] DATE 3-10-83

I CERTIFY THAT THE IMAGE CONTAINED ON THIS FILMS WAS MADE IN THE NORMAL AND REGULAR COURSE OF BUSINESS ON THE DATE STATED BELOW AND THAT IT IS AN ACCURATE REPRODUCTION OF THE DOCUMENT SUBMITTED TO MICROFILMING.
DATE 11-15-82 CAMERA OPERATOR [illegible] SECTION SUPERVISOR [illegible]

M-HFB-J01

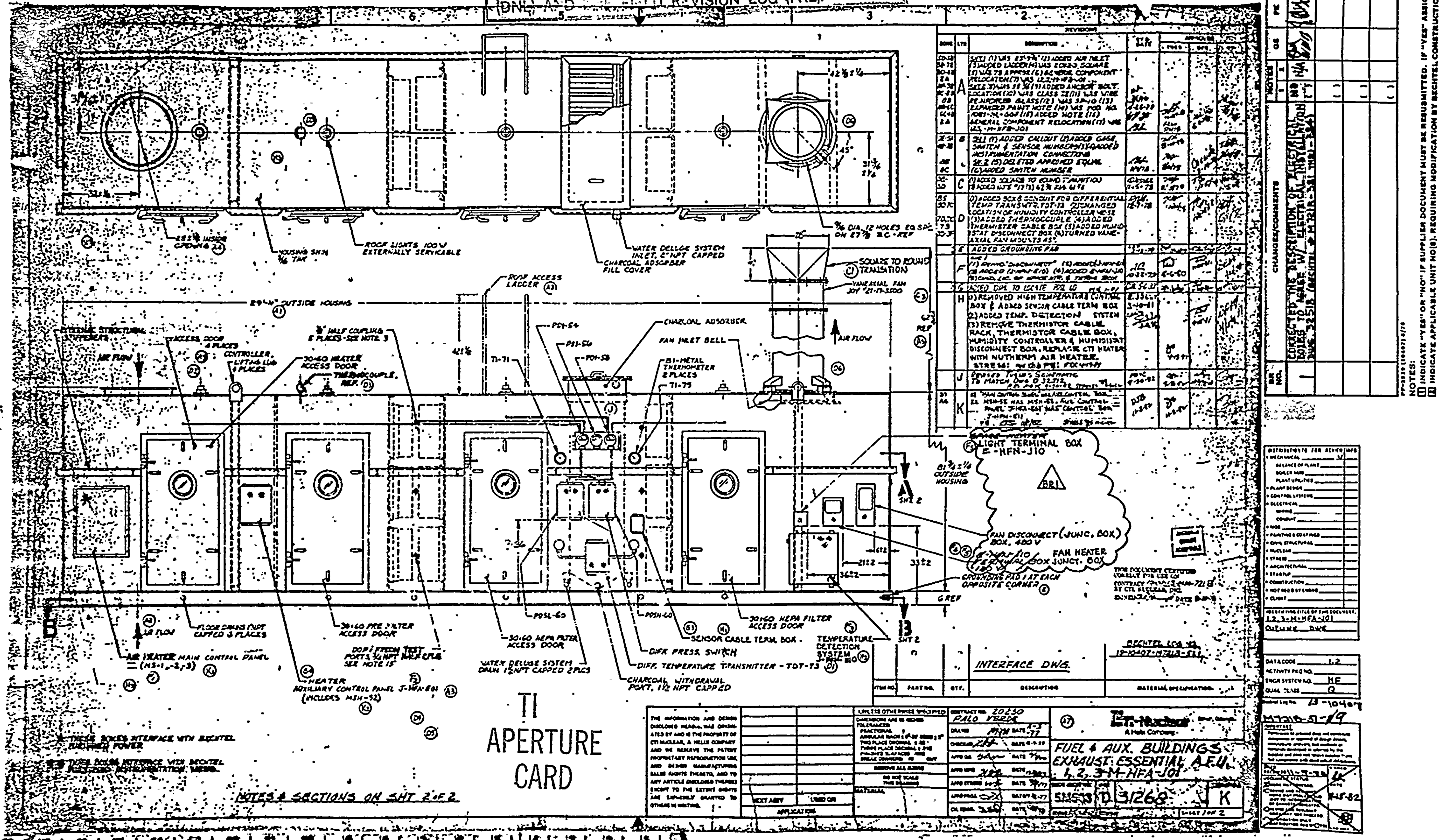
8403090014-18

POOR ORIGINAL

UNCONTROLLED DRAWINGS

THIS DRAWING MAY BE AFFECTED BY DOCUMENTS IDENTIFIED ON THE DAILY NOTIFICATION LIST (DNL) AND THE FIELD REVISION LOG (FRL)

Also Available On Aperture Card



TI APERTURE CARD

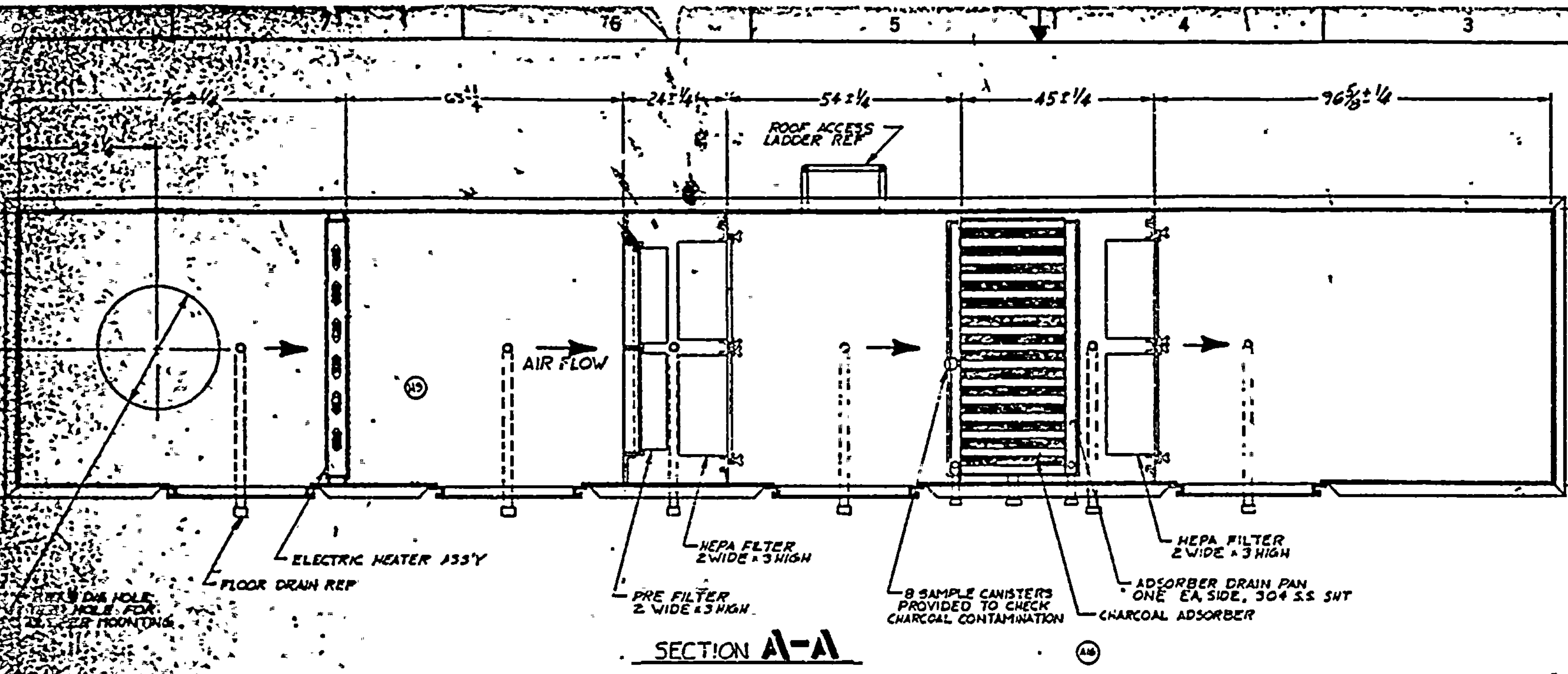
M-HFA-J01

8403090014-19

POOR ORIGINAL

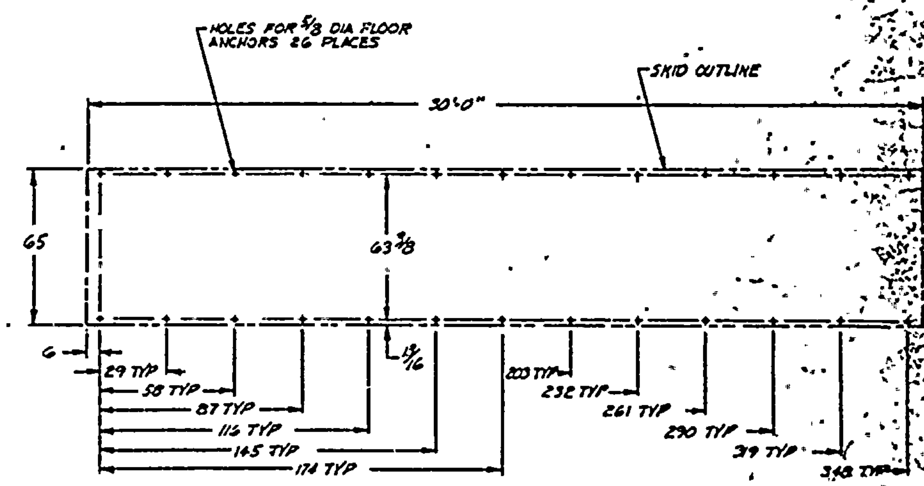
Also Available On Aperture Card

ZONE	LTR	DESCRIPTION	BY & DATE	APPROVED ENGR	APPROVED MFG
	A	SEE SHT 1			
	B	SEE SHEET 1			
	C	SEE SHEET 1			
	D	SEE SHEET 1			
	E	SEE SHEET 1			



SECTION A-A

TI APERTURE CARD



SECTION B-B
ANCHOR BOLT LOCATION
TOL. ± 1/8
SCALE: 3/8"=1'-0"

1. HOUSING IS FABRICATED & SHIPPED AS A SINGLE ... THE CHARCOAL ADSORBER IN PLACE. THE ... FILTERS & CHARCOAL WILL BE SHIPPED LOOSE.
2. ... STRUCTURAL SHAPES & SKIN TO BE ASTM A36. ... TO BE ASTM A570, GR A. THE CHARCOAL ... HEATER FRAME TO BE MADE FROM TYPE ...
3. ... ARE INSTALLED BEFORE & AFTER EACH ... TO PROVIDE A METHOD OF DETERMINING ... DROP THROUGH EACH FILTER BANK.
4. ... FLOW SWITCH, PDSL-60, IS PROVIDED ... PROTECT THE HEATERS IN CASE OF FAN FAILURE.
5. ... TUBES FOR FINNED ELEMENTS WILL NOT ... COPPER OR COPPER PLATED AS SPECIFIED IN ... 4-5.5.2.1.2 OF THE TECHNICAL REQUIREMENTS. TUBES WILL BE MONEL, ASTM-B165. ... WILL BE QUALIFIED TO IEEE, CLASS 1E.
6. ... TO BE CROUSE-HINDS NO. EVA-160
7. VIEWING WINDOWS TO HAVE TEMPERED GLASS & TO BE BY OVERBEKE-KAIN CO.
8. PREPARATION FOR PAINT: COMMERCIAL SANDBLAST PER SSPC SP-6
9. PAINT: PRIME COAT TO BE 2.0 TO 3.0 MIL DRY FILM THICKNESS OF SHERWIN-WILLIAMS KEN-KROMIK B50NE RED OXIDE PRIMER. COLOR-BROWN. FINISH COAT IS TO BE 2.0 TO 2.5 MIL DRY FILM THICKNESS OF SHERWIN-WILLIAMS F65 SERIES ENAMEL. COLOR-ANSI STD Z55.1, COLOR NO. 61 GREY
10. INSPECTION & TESTS PER CTI-NUCLEAR SPEC'S CND-002, CND-004, CND-010 AND CES-087
11. THIS UNIT IS BECHTEL QUALITY CLASS Q AND WILL BE DESIGNED, FABRICATED AND TESTED IN ACCORDANCE WITH THE QUALITY REQUIREMENTS OF CTI-NUCLEAR'S ASME NUCLEAR QUALITY ASSURANCE MANUAL.
12. WELDING PER PROCEDURES APPROVED BY BECHTEL.
13. HEPA FILTERS ARE FLANDERS MOD. NO. 7C21-NL, QAS TESTED
14. PRE-FILTERS ARE AMERICAN AIR VARICEL MOD. No. 9-2424-6AM.
15. ALL HALF COUPLINGS THAT ARE NOT CONNECTED, WILL HAVE HEX HD. PLUGS & THDS WILL BE SEALED W/TEFLON TAPE.
16. THIS DRAWING FOR MECHANICAL ARRANGEMENT. IT WILL BE REVISED TO SHOW ELECTRICAL INTERFACES.
17. ALL INSTRUMENTS SHALL BE TAGGED AS PER APPENDIX 4N PARA 4N-6.2.6.2 AND CRA. 13-J-235-001

INTERFACE DWG

BECHTEL LOG NO.
13-10407-M721B-52.1

ITEM NO.	PART NO.	QTY.	DESCRIPTION	MATERIAL SPECIFICATION

NEXT ASSY | USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR MACH ± 0°-30' BEND ± 2°
TWO PLACE DECIMAL ± .02
THREE PLACE DECIMAL ± .010
FINISHED SURFACES
BREAK CORNERS: IN OUT
REMOVE ALL BURRS
DO NOT SCALE THIS DRAWING
MATERIAL

CONTRACT NO. 20250 PALO VERDE
DRAWN MM DATE 11-4-77
CHECKED DATE
APPD QA DATE
APPD MFG DATE
APPD STRESS DATE
APPD PROJ DATE 12-4-77
CH. ENGR. DATE

CTI-Nuclear, A Helix Company, Denver, Colorado

FUEL & AUX. BUILDINGS EXHAUST ESSENTIAL A.F.U.
1, 2, 3-M-HFA-J01

CODE IDENT NO. 5M583 | SIZE D | 31268 | REVISION K
SHEET 2 OF 2

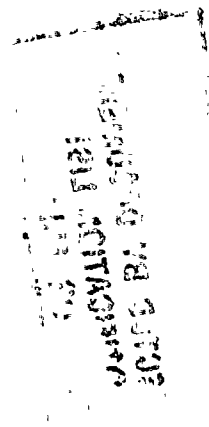
DATA CODE 1,2
ENGR SYSTEM NO. HF
QUAL. CLASS Q
Bechtel Log No. 13-10407-M721B-52-7

IDENTIFYING TITLE OF THIS DOCUMENT: 1,2,3-M-HFA-J01 OUTLINE DWG

DATE RECEIVED 11-5-82

M-HFA-J01

8403090014 -20

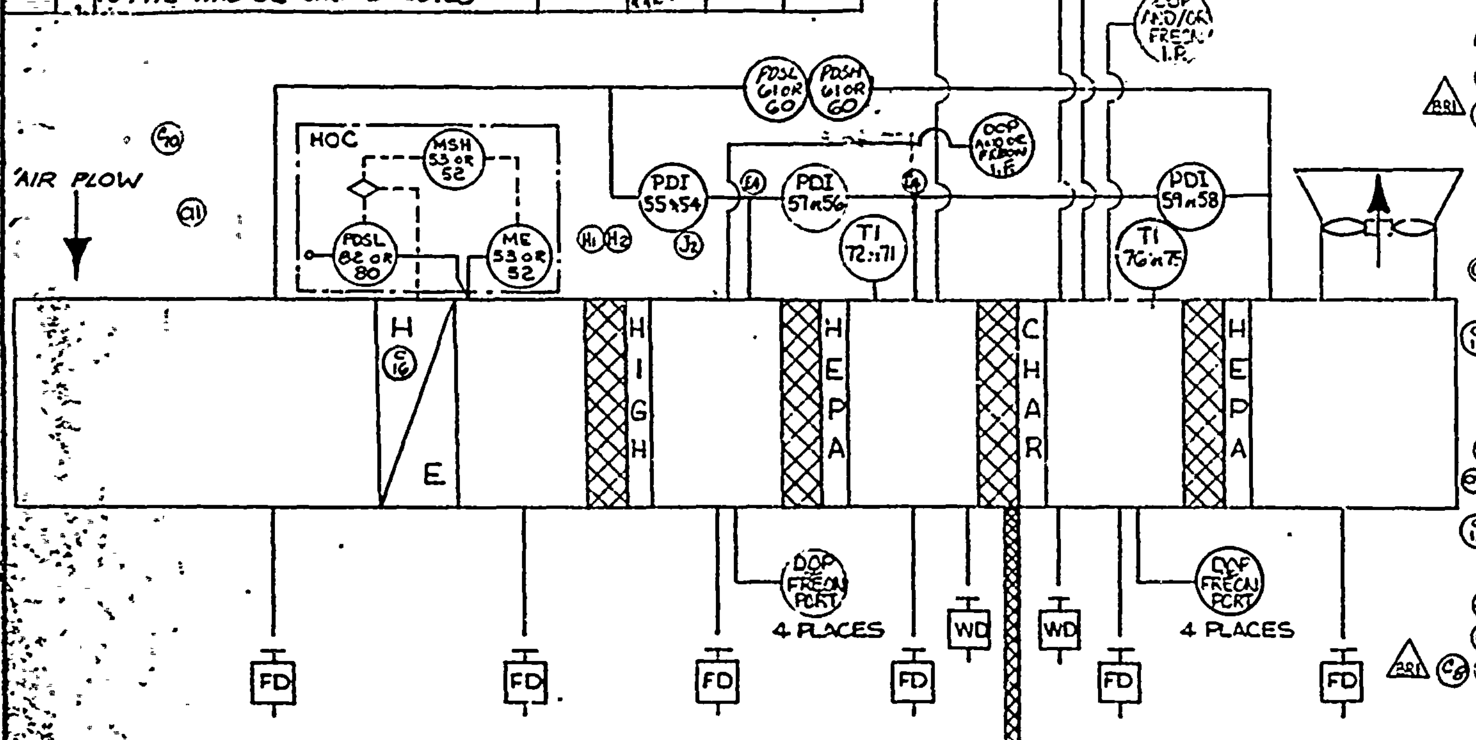


TI APERTURE CARD

Also Available On Aperture Card

ZONE	LTR	DESCRIPTION	BY & DATE	APPROVED ENGR.	MFG.	QA
	C	(1) 82 WAS 81 (2) ADDED 80,79 (3) ADDED PDSL-60 (4) ADDED PDSL-61 (5) 8.6 WAS 5.5 (6) 4.4 WAS 4.0 (7) WAS PDSH. 60 (8) WAS PDSHL 61 (9) CORR. NOTE PER DWGS. (10) CORR. DWG. (11) RELOCATE PDSL80 & PDSL82, ME52, ME53, MSH52, MSH53 (12) ADD NOTE 1 (13) DELETE HOC (14) ADD HCA (15) ADD TE81, TE 81A - TE82, TE82A (16) HE WAS GE CALROD COILS	AR 10-25-79			4/15/81

ZONE	LTR	REVISIONS DESCRIPTION	BY & DATE	APPROVED ENGR	MFG	QA
	A	(1) ADDED HFA INSTRUMENT LIST (2) ADD HTC AND I.P. TO COMMON LIST (3) ADDED (4) WAS PDS-61 (5) WAS PDS	11-18-78			
B4-2 D2-A1	B	TDT-73 & 74 WAS FISHER TYPE PM 512. ADDED HTC, TSH & TSHH.	6/20/79	6/20/79	6-21-79	6-21-79
D-2 A-4	D	(1) REMOVED TSHH 80,79 (2) REMOVED TSHH-HIGH TEMP. ALARM	A.R. 2-18-82			2/18/82



INSTRUMENTATION HFA UNITS

- PDSL-80 — HEATER AIRFLOW SWITCH N.O. CLOSE @ 0.05 WG
- PDSL-60 (N.O.) / PDSH-60 (N.C.) — DIFFERENTIAL PRESSURE SWITCH (PDSH OPENS @ 8.6" & PDSL CLOSES @ 3" WATER GAGE) DPDT
- TI-71 — BI-METAL THERMOMETER 30° TO 130° RANGE ASHCROFT NO. 50B160R-060-30/130
- TI-75 — BI-METAL THERMOMETER 30° TO 130° RANGE ASHCROFT NO. 50B160R-060-30/130
- TDT-73 — TEMPERATURE DIFFERENTIAL TRANSMITTER ROCHESTER SC-1374.
- HE — ELECTRIC HEATER — NUTHERM 26 KW
- PDI-54 — DIFFERENTIAL PRESSURE GAGE 0 TO 2.0 WATER GAGE
- PDI-56 — DIFFERENTIAL PRESSURE GAGE 0 TO 4.0 WATER GAGE
- PDI-58 — DIFFERENTIAL PRESSURE GAGE 0 TO 15 WATER GAGE
- ME 52 — MOISTURE ELEMENT - CLOSES @ 70% R.H.
- MSH 52 — MOISTURE SWITCH - HIGH LEVEL NORMALLY OPEN, CLOSES @ R.H. ≥ 70%
- TSH-79 — CHARCOAL FILTER HIGH TEMP. PREALARM @ 265°F
- TSHH-79 — CHARCOAL FILTER HIGH TEMP. ALARM @ 310°F

INSTRUMENTATION HFB UNITS

- PDSL-82 — HEATER AIRFLOW SW. N.O. CLOSE AT 0.05 WG
- PDSL-61 (N.O.) / PDSH-61 (N.C.) — DIFFERENTIAL PRESSURE SWITCH (PDSH OPENS @ 8.6" & PDSL CLOSES @ 3" WATER GAGE) DPDT
- TI-72 — BI-METAL THERMOMETER 30° TO 130° RANGE ASHCROFT NO. 50B160R-060-30/130
- TI-76 — BI-METAL THERMOMETER 30° TO 130° RANGE ASHCROFT NO. 50B160R-060-30/130
- TDT-74 — TEMPERATURE DIFFERENTIAL TRANSMITTER ROCHESTER SC-1374.
- HE — ELECTRIC HEATER — NUTHERM 26KW
- PDI-55 — DIFFERENTIAL PRESSURE GAGE 0 TO 2.0 WATER GAGE
- PDI-57 — DIFFERENTIAL PRESSURE GAGE 0 TO 4.0 WATER GAGE
- PDI-59 — DIFFERENTIAL PRESSURE GAGE 0 TO 15 WATER GAGE
- ME 53 — MOISTURE ELEMENT CLOSES @ 70% RH
- MSH 53 — MOISTURE SWITCH - HIGH LEVEL NORMALLY OPEN, CLOSES @ R.H. ≥ 70%
- TSH80 — CHARCOAL FILTER HIGH TEMP. PREALARM @ 265°F
- TSHH80 — CHARCOAL FILTER HIGH TEMP. ALARM @ 310°F

ITEM NO	PART NO.	QTY.	DESCRIPTION	MATERIAL SPECIFICATION

COMMON TO HFA & HFB UNITS

FD — CAPPED FLOOR DRAIN; 1" N.P.T.
WD — WATER DELUGE DRAINS; CAPPED 1½" N.P.T.

DOP & FREON TEST PORTS — ¼ N.P.T. COUPLING PLUGGED WITH HEX. HD. PLUGS.
DOP & FREON I.P. — INJECTION PORTS; 2" N.P.T. CAPPED
PDSL-60, PDSH-60 ARE IN SERIES AS ARE PDSL-61 & PDSH-61. PDSL-80 & 82 COME WITH HEATER.
HOC - HEATER OVERTEMP CONTROL ASSEMBLY NUTHERM INTERNATIONAL # 1023-50457-33 BECHTEL No. M7218.533
HTC - HIGH TEMPERATURE CONTROL - ALARM AT 310°F, WARNING AT 265°F. LINER THERMOSTATIC DEVICE. SUPPLIES STANDARD FOR CUSTOMER SUPPLIED ANNUNCIATOR.
TSH - HIGH TEMP. WARNING
TSHH - HIGH TEMP. ALARM

WATER DELUGE 1½" DRY CAPPED PIPE

NOTES
1. EQUIPMENT PROVIDED BY NUTHERM INTERNATIONAL.

THIS DOCUMENT CERTIFIED CORRECT FOR USE ON CONTRACT 10407-RA-213 BY CTI. NUCLEAR, INC. SIGNED [signature] DATE 12/6/78

THE INFORMATION AND DESIGN DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF CTI-NUCLEAR, A HELIX COMPANY, AND WE RESERVE THE PATENT PROPRIETARY REPRODUCTION USE AND DESIGN MANUFACTURING SALES RIGHTS THERETO, AND TO ANY ARTICLE DISCLOSED THEREIN EXCEPT TO THE EXTENT RIGHTS ARE EXPRESSLY GRANTED TO OTHERS IN WRITING.

NEXT ASSY / USED ON

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES: PRACTICAL; ANGULAR MACH ±0°30' BEND ±2°; TWO PLACE DECIMAL ±.03; THREE PLACE DECIMAL ±.010; FINISHED SURFACES; BREAK CORNERS. REMOVE ALL BURRS. DO NOT SCALE THIS DRAWING. MATERIAL

CONTRACT NO. 20230 PALO VERDE
DRAWN L. Mattes DATE 4-7-77
CHECKED DATE 4-7-77
APPD QA DATE
APPD MFG DATE
APPD STRESS DATE
APPD PROJ DATE

CTI-Nuclear, Denver, Colorado — A Helix Company

PIPING AND INSTRUMENTATION DIAGRAM 1,2,3-M-HFA, HFB-J01

CODE IDENT NO. | SIZE C | 31274 | REVISION D

1 OF 2

DISTRIBUTION TO: FOR: REVIEW / INFO.

- MECHANICAL
- BALANCE OF PLANT
- BOILER/NSSS
- PLANT UTILITIES
- PLANT DESIGN
- CONTROL SYSTEMS
- ELECTRICAL
- WIRING
- CONDUIT
- MOS
- PAINTING & COATINGS
- CIVIL/STRUCTURAL
- NUCLEAR
- STRESS
- ARCHITECTURAL
- STARTUP
- CONSTRUCTION
- NOT REQ'D BY ENGRG.
- CLIENT

IDENTIFYING TITLE OF THIS DOCUMENT: P & I DIAGRAM 1,2,3-M-HFA(B)-J01 (FOR SHT. 2 SEE SEQ. 583)

DATA CODE 1.6
ACTIVITY PKG NO.
ENGR SYSTEM NO. HF
QUAL. CLASS Q
Bechtel Log No. 13-10407-M7218-53-910

IMPORTANT: Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligations.

DATE RECEIVED 11-17-82
DOCUMENT STATUS: WORK MAY PROCEED / REVISE AND RESUBMIT. WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED / REVISE AND RESUBMIT. WORK MAY NOT PROCEED / INFORMATION ONLY. DISTRIBUTION REQ'D (YES)
SIGNED / DATE 11-23-82

SUBSTANDARD ORIGINAL FOR LEGIBLE REPRODUCTION

BR NO.	CHANGES/COMMENTS	NOTES	QE	PE	DATE	BECHTEL REVIEW (BR) TO SUPPLIER DOCUMENT
1	IN INSTRUMENTATION LIST CHANGE CONTACTS FOR PDSH-60 & 61 TO NORM. CLOSED TO REFLECT AS-BUILT REF. 4 VAL-324	NO				LOS ANGELES POWER DIVISION PVNGS JOB 10407

NOTES:
(1) INDICATE "YES" OR "NO" IF SUPPLIER DOCUMENT MUST BE RESUBMITTED. IF "YES" ASSIGN NEW STATUS ( ) ABOVE.
(2) INDICATE APPLICABLE UNIT NO(S). REQUIRING MODIFICATION BY BECHTEL CONSTRUCTION.

UNCONTROLLED DRAWING
THIS DRAWING MAY BE AFFECTED BY DOCUMENTS IDENTIFIED ON THE DAILY NOTIFICATION LIST (DNL) AND THE FIELD REVISION LOG (FRL).

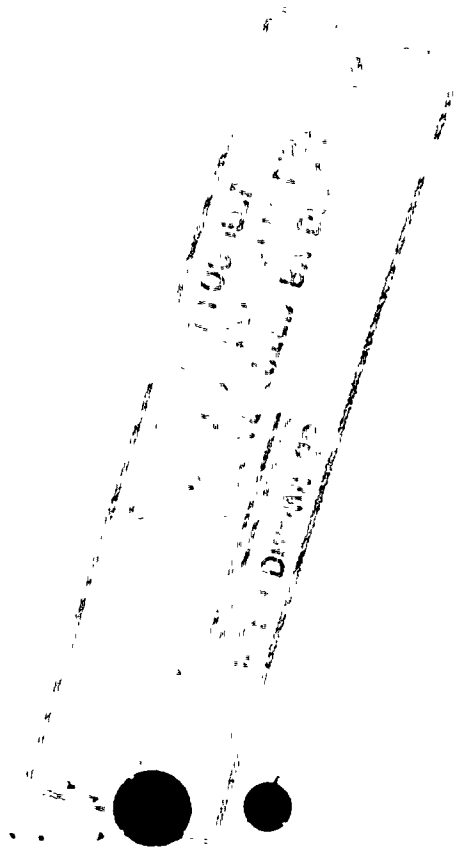
POOR ORIGINAL

18X

M-HFA(B)-J01

8403090014-21

I CERTIFY THAT THE IMAGE CONTAINED ON THIS FRAME WAS MADE IN THE NORMAL



BILL OF MATERIALS
M-HJA-F04
M-HJB-F04

NOTE: Only those pages which contain age degradable components are included

625

CTI NUCLEAR
Division of McDonnell Douglas Company

MATERIAL PROCUREMENT LIST

W.A. 60230 Drawing Title FINAL ASSEMBLY

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT	
	8	C31269	ACCESS LADDER		1
1-8		-1	PIPE, 1" SCH. 40 x 186 LG.	2	2
			ASTM-A120 OR A53		
1-9		-2	PIPE, 1" SCH. 40 x 24 LG.	2	2
			ASTM-A120 OR A53		
1-10		-3	PIPE, 1" SCH. 40 x 9 5/8 LG.	2	2
			ASTM-A120 OR A53		
1-11		-4	PIPE, 1" SCH. 40 x 17 1/2 LG.	2	6
			ASTM-A120 OR A53		
1-12		-5	PLATE, 1/8 THK x 2 x 4 1/2 LG. ASTM-A36	25	6
145	9		COOLING COIL, PER CTI-	44	
			NUCLEAR SPEC. "CES-071		2
	10	C31760	ACCESS COVER		2
1-14		-1	SHEET, 11GA. (.120) x 18 1/2 x 44 1/2 LG.	37	1
			ASTM-A570, GR.C		
145		-2	NEOPRENE, 1/4 THK. x 1 1/2 x 16 1/2 LG.	3	2
			ASTM-D1056, GR. SCE-43		
1-16		-3	NEOPRENE, 1/4 THK. x 1 1/2 x 40 1/2 LG.	3	2
			ASTM-D1056, GR. SCE-43		
147		-4	ADHESIVE, GOODYEAR PLIOBOND #20	42	A
148		-5	SEALANT, GOODYEAR RUBBER	43	A
			DOW CHEMICAL #732		

3

W.A. 60230 Drawing Title FINAL ASSEMBLY

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CENT	
	11	C-31217	ACCESS COVER		2
M-19		-1	SHEET, 11 GA. (.120) x 18½ x 44½ LG.	37	1
			ASTM-A570, GR. C		
M-20		-2	NEOPRENE, ¼ THK. x 1½ x 16½ LG.	31	2
			ASTM-D1056, GR. SCE-43		
M-21		-3	NEOPRENE, ¼ THK. x 1½ x 40½ LG.	31	2
			ASTM-D1056, GR. SCE-43		
M-22		-4	ADHESIVE, GOODYEAR PLIOBOND #20	42	
M-23		-5	SEALANT, SILICONE RUBBER	43	
			DOW CHEMICAL #732		
	12	C30999	COIL MANIFOLD, SUPPLY		1
	13	C30998	COIL MANIFOLD, RETURN		1
M-24	14		PRE FILTER, PER CTI-	33	9
			NUCLEAR SPEC. CES-087		
M-25	15		HEPA FILTER (QAS TESTED), PER	34	6
			CTI NUCLEAR SPEC. CES-092		
M-26	16	A28567	COMPRESSION SPRING (COMMON PART)	40	2
			PURCHASE PER PRINT		
M-27	17	A28903	MOUNTING CLAMP (COMMON PART)	132	24
			PURCHASE PER PRINT		
M-28	18		FLAT WASHER, ⅜ NOM. I.D.	127	24
			18-8 S.S.		
M-29	19	B28455	MOUNTING CLAMP HANDLE	32	24
			(COMMON PART)		
			PURCHASE PER PRINT		

Division of McDermott-Wallace Company

W.A. 60230 Drawing Title FINAL ASSEMBLY 1,2

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT	TE C
1-30	20		CHARCOAL, PER CTI-NUCLEAR	39	A
			SPEC. CES-055		
	21	C3213	HOPPER COVER		2
1-31		-1	PLATE, 12 GA x 31 3/8 x 64 1/4 LG.	21	1 E
			ASTM-A240 T304		
1-32		-2	ADHESIVE, GOODYEAR PLIOBOND #20	42	A
1-33		-3	DOOR HANDLE - B25925	193	2
			(COMMON PART)		
			PIPE-1/2" D. SCH 5 X 8 3/4 LG - ASME SA 376 OR SA 312		
1-34		-4	GASKET, NEOPRENE, CLOSED CELL	41	2
			1/4 THK. x 3 x 57 5/8 LG. ASTM-D1056		
			GR SCE 43		
1-35		-5	GASKET, NEOPRENE, CLOSED CELL, 1/4	41	2
			THK. x 3 x 29 5/8 LG. ASTM-D1056,		
			GR. SCE 43		
1-36		-6	SEALANT, SILICONE RUBEER	93	A
			DOW CHEMICAL #732		
1-37	22		PIPE CAP, 2 1/2 NPT, 3000#	9	3
			ASTM-A182 F304		
1-39	23		PIPE CAP, 2 NPT, 3000#	10	3
			ASTM-A182 F304		
1-39	24		PIPE CAP, 1 1/2 NPT, 3000#	11	1
			ASTM-A182 F304		
1-40	25		PIPE CAP, 1 NPT, 3000#	12	9
			ASTM-A182 F304		
1-41	26		PIPE PLUG, HEX. HD., 3/4 NPT	18	24
			3000# ASTM-A182 F304		

Division of McDermott-Wellman Company

W.A. 60230 **Drawing Title** FINAL ASSEMBLY

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	QUAN	TO G
	52		LOCKWASHER, HELICAL, 3/8 MED.	136	32
			18-8 S.S.		
	53		BOLT, HEX. HD. 1/4-20UNC x 1 1/4 LG.	180	424
			ASME-SA193, CL. B8		
	54		NUT, HEX. 1/4-20UNC ASME-SA194, GR.8	116	428
	55		LOCKWASHER, HELICAL, 1/4 MED.	162	428
			18-8 S.S.		
	56		BOLT, HEX. HD. 3/8-16UNC x 1 LG.	121	32
			ASTM-A193, CL. B8		
	57		NUT, HEX. 3/8-16UNC ASTM-A194, GR.8	112	28
	58		THERMOMETER ASHCROFT	150	1
			50 BI 60R-060-0/200°		
	59		GASKET, 1/8 THK. x 1 1/2 x 34 7/16 LG.	31	2
			CLOSED CELL NEOPRENE		
			ASTM-D1056, SCE 43		
	60		GASKET, 1/8 THK. x 1 1/2 x 124 1/2 LG.	81	2
			CLOSED CELL NEOPRENE		
			ASTM-D1056, SCE 43		
	61		ARC STUD, 1/4-20 UNC x 3/8 LG.	82	
			ASTM-A108, 1015-1020, ZINC PL.		4
	62		NUT, HEX. 1/4-20UNC, ASTM-A307	115	84
			ZINC PL.		
	63	B31384	NAME PLATE. SEE NOTE 8 OF	145	1 E
			DWG. B31254 PURCHASE PER		
			PRINT		

8.

Division of McDonnell-Douglas Company

W.A. 60230 **Drawing Title** FINAL ASSEMBLY 1

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT	
	64	B31385	NAME PLATE, SEE NOTE 8 OF DWG. D31254 PURCHASE PER PRINT	145	1
180	65		BOLT, HEX. HD., ⅜-16UNC x ¾ LG. ASTM-A307, ZINC PL.	122	12
181	66		LOCKWASHER, HELICAL, ⅜ MED. C.S., ZINC PL.	157	12
182	67		SHIM, SEE NOTE 7 OF DWG.	93	A
183	68		LOCKWASHER, HELICAL, ¼ MED. C.S., ZINC PL.	158	8
184	69	B-31780	PENETRATION SEAL	75	4
185	70	B-31787	RETAINING RING	163	4
186	71		HOSE CLAMP, McMASTER-CARR #5416K23	161	4
187	72		GASKET, FLEXITALLIC #CG-IG	155	4
188	73		BOLT, HEX. HD., ⅝-11UNC x 2½ LG. ASTM-A193, GR.B8	123	16
189	74		NUT, HEX., ⅝-11UNC, ASTM-A194 GR.8	117	16
190	75	B31380	NAME PLATE, SEE NOTE 8 OF DWG., D3K551 - PURCHASE PER PRINT	145	1
191	76		SEALANT, SILICONE RUBBER DOW CHEMICAL #732	93	A

CI-NUCLEAR

Division of McDowell-Wellman Company

MATERIAL PROCUREMENT LIST

W.A. 60230

Drawing Title FINAL ASSEMBLY

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT	
492	77		UNION TEE, SWAGELOK SS-400-3	174	2
493	78		GASKET, ⅛ THK. x 6½ I.D. x 8½ O.D.	156	4
			CLOSED CELL NEOPRENE		
			ASTM-D1056, SCE-43		
492	79	B32473	NAME PLATE, SEE NOTES 8 & 14	145	
			DWG., D31254 PURCHASE REF		1
			PRINT		
	80	B32744	ACCESS PANEL		1
		-1	PERFORATED SHEET, 10 GA.(.134)	106	1
			REF. x30"x36" ~ ⅜ DIA HOLES		
			9/16 CTRS. 40% OPEN AREA		
			ASTM-A569		
		-2	HANDLE - B25925	175	1
			(COMMON PART)		
			PIPE ½ SCH 5 X 8⅞ LG.		
			ASTM SA376 OR SA 312		

Division of McDonnell-Douglas Company

W.A. 60230 Drawing Title DOOR & FRAME

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	QTY	
312	1		11 GA. SHT. (.120), 33 3/8 x 91 3/8 LG.	7	1
			ASTM-A570, GR.C OR A569		
313	2		1/4 FLAT BAR, 1 x 47 3/4 LG.	167	2
			ASTM-A36		
314	3		1/4 FLAT BAR, 1 x 28 3/4 LG.	167	2
			ASTM-A36		
315	4		1/4 FLAT BAR. 1 x 26 3/4 LG.	167	2
			ASTM-A36		
316	5		SILICONE SPONGE RUBBER	171	2
			1/2 THK., 1 x 31 1/4 LG., ADHESIVE		
			BACKING, COHRLASTIC		
			R-10480, MED. GR.		
317	6		SILICONE SPONGE RUBBER	171	2
			1/2 THK., 1 x 36 LG., ADHESIVE		
			BACKING, COHRLASTIC		
			R-10480, MED. GR.		
318	7	B 33891	TUBE, 1 O.D. x .120 WALL x 2 5/8 LG,	97	6
			ASTM-A519, C.S., CD Steel		
			Tubing		
	8	C3333-1	DOOR DOG LOCKING ASSEMBLY		6
320		-1	OUTSIDE HANDLE (C33335)		1
		-2	INSIDE HANDLE (C32154)		1
321					
		-3	DOG BEVEL (830250)		1
322		-4			1

Division of McDowell-Wellman Company

W.A. 60230 Drawing Title DOOR & FRAME

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION		
	8	C33331 (CONT.)			
324		-5	FLANGE BEARING.		2
		6	GREASE FITTING Alemite #1952		1
325		-7	1/2-20 UNF x 5" LG ~ HEX HEAD		1
			BOLT. 1 1/4" THD LGTH. ASTM A193		
			GRADE B8 S.S.		
326		-8	1/2-20 UNF HEX NUT ASTM A194		1
			GR 8 SS		
		-9	3/16" DIA. x 3/4" LG. DOWEL PIN		16
327			ASTM A276 T304 CD SS		1
		-10	1/4" ID NOM Flat Washer 18-8 SS		4
328		-11	SILICONE GREASE Heavy		1
329			Corning Dow Corning III Compound		
330					
	9	B28726	HINGE ASSEMBLY		2
331		-1	BUTT FLANGE, B28728	200	1
			CASTING. ~ASTM-SA351, CF8		
332		-2	DOOR PIVOT. B28727	201	1
			STAINLESS STEEL CASTING		
			ASME-SA240, TP304 OR		
			SA351, GR.8 OR SA479 PER		
			DWG. MIL-STD-171(S.A)		
333		-3	CLEVIS PIN, 1/2 DIA. x 1 1/2 LG.	172	1
			McMASTER-CARR #98306A385		
334		-5	COTTER PIN, 1/8 DIA. x 1 LG.		1
			McMASTER-CARR #98311A250		

W.A. 60230 **Drawing Title** DOOR & FRAME

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT	Q
	9	B28726 (CONT.)			
1385		-6	EXPANSION PIN, 3/16 DIA. x 1 1/4 LG.	177	1
			McMASTER-CARR #98296A253		
1386	10	B31033	VIEW PORT (COMMON PART)	227	1
			PURCHASE PER PRINT		
1387	11		GASKET, NEOPRENE, 1/4 THK. x	156	1
			11 O.D. x 9 1/2 I.D., CLOSED CELL		
			ASTM-D1056, GR. SCE-43		
1388	12		ARC STUD, 1/4-20UNC x 3/4 LG.	82	6
			ASTM-A675, GR. 65		
1389	13		NUT, HEX., 1/4-20 UNC, ASTM-A307	115	6
1390	14		LOCKWASHER, HELICAL, 1/4 I.D.	158	6
			MED., C.S. ZINC PL.		
1391	15		ANGLE, 3 x 2 x 1/4, 34 LG.	[illegible]	2
			ASTM-A36		
1392	16		ANGLE, 3 x 2 x 1/4, 30 LG.	[illegible]	2
			ASTM-A36		
[illegible]	17		SEALANT, SILICONE RUBBER	[illegible]	[illegible]
			DOW CHEMICAL #732		
[illegible]	18		SILICONE SPONGE RUBBER	171	2
			1/8 THK., 1 x 12 3/8 LG., ADHESIVE		
			BACKING, COHRLASTIC		
			R-10480, MED. GR.		

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Division of McDonnell-Douglas Company

W.A. 60230 Drawing Title DOOR AND FRA

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	QTY	
		DOOR AND	FRAME ASS'Y QUANTITIES	EA	
L-399	3		SHEET 11GA. C120 X 33 3/8 X 65 3/8	37	
			ASTM-A570 GR. COR A569		
L-398	4		ANGLE 3" X 2" X 1/4 X 66" LG.	55	
			ASTM-A36		
L-397	5		FLAT BAR 1/4 X 1 X 26 3/8 LG ASTM A36	167	
L-400	6	B-31033	VIEWPORT PURCHASER POINT	227	
L-401	7		TUBE 10.D X 120 WT. X 3 1/16 LG	97	
			ASTM A-513 C.S. CD		
L-402	8		1/8 THICK X 1 X 30 3/8 SILICONE	171	
			SQUEEGE RUBBER WITH ADHESIVE		
			BACKING COURASTIC R-1040 OR.		
L-403	9		ARC STUD 1/4-20 UNC X 3/8 LG	80	
			ASTM A-276 GR. 65		
L-404	10		FLAT BAR 1/4 X 1" X 28 3/8 LG	167	
			ASTM-A36		
L-405	11		GASKET, NEOPRENE 1/4 X 11 OUT 9 1/2	154	
			I.D. CORD CELL. ASTM D1056 GR. 4A		
L-406	12		HEX NUT 1/4-20 UNC ASTM-A307	115	
L-407	13		LOCK WASHER HELICAL 1/4" MED	138	
			C.S. ZINC PL		
			FLAT BAR 1/4" X 1" X 59 1/4 LG	167	
L-408	14		ASTM-A36		

Division of McDonnell Douglas Corporation

W.A. 60230 **Drawing Title** DOOR AND B[illegible]

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	[illegible]	
409	15		ANGLE, 3" x 2" x [illegible] x 30½ ASTM A[illegible]	55	
410	16		½" THK x 1" x 31¾" SILICONE SPONGE	171	
			RUBBER WITH ADHESIVE BACKING		
			CONNLASTIC R-10480 OR [illegible]		
411	17		SEALANT, SILICONE RUBBER	43	
			DOW CHEMICAL #732		
412	18	B28826	HINGE ASS'Y		
413		-1	B28728 ASTM SA-351 CF8 CASTING	200	
			BUTT FLANGE		
414		-2	B28729 S. STL ASME SA-240 TYPE	200	
			304 OR SA-479 OR SA-351 CF8		
			CASTING PER DWG.-MIL-STD		
			171 (E4)		
415		-3	CLEVIS PIN 1-⅝" LG x ⅝", McMASTER-	[illegible]	
			CARR # 98306A305		
417		-5	COTTER PIN [illegible] McMASTER-	177	
			CARR 98311A090		
418		-6	[illegible] McMASTER	177	
			-CARR 98296A287		
	19	C 33351	Dog Ass'y		
		1	C 33335 Dog [illegible] handle	203	
		2	C 33354 [illegible] guide handle	204	
		3	B30250 Dog [illegible]	184	

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Division of McDonnell Douglas Corporation

W.A. 60230 Drawing Title Door & Frame Assy

ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT
	4		
	5	A33538 Flange Bearing	
	6	Grease Fitting Alemite #1952	
	7	½-20UNF x 5 Lg Hex Hd Bolt 1¼" Thd Lgth. ASTM A193 Grade B8 SS.	
	8	½-20UNF Hex Nut ASTM A194 Gr8 SS	
	9	3/16" DIA x 3/4" Lg Dowell Pin ASTM A276 T304 CD SS.	
	10	Type B Narrow Plain Washer ½ Nom ID x 1" OD x 18Ga 18-8 SS	
	11	Silicone Grease Heavy Consistency Dow Corning III Compound or Equal	

W.A. 60230 Drawing Title Electrical Instal

ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT
1		14 Awg wire Black Insulation TeFlon	
2	B 31666	Sensor Cable Terminal Box	
	1	A 404 NF Enclosure, Nema 4 - 4x4x3 Hoffman or Equal (Usgd)	
	2	3-141-MS-3-141 Terminal strip, 3 Circuit #6 Screw, with marker strip Black Phenolic	
	3	RD. Hd Mach Screw #8-32 UNC x 5/8 Lg Zinc P	
	4	Hex Nut #8-32 UNC Zinc P	
	5	Gasket, Neoprene 1/8" x 4 x 4 Closed Cell ASTM-D1056 Gr Sec 43	
	6	Adhesive, Pliobond #20 Goodyear	1
	7	Gasket Neoprene 1/8 x 4 x 5 1/2 Closed Cell ASTM D1056 Gr. Sec 43	
3	C 31719	Terminal Box	
	1	A 606 NF Enclosure, NEMA 4, 6x6x4 Hoffman or Equal	
	2	A-6Pla Panel, 4 7/8 x 4 7/8 Hoffman or Equal	

R = REQ ISSUED P = PR or PO PLACED I = MATL IN HOUSE

Division of McDonnell-Wellman Company

W.A. 60230 Drawing Title ELECTRICAL 1,253-M-MJA

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT	T
		D-316 (cont.)			
	10		½" Rigid Steel Conduit Galv.	240	7
	11	A 971-050-0Pnl-2	Temp Detect System Alison		
	12	K50-em 9K50-W	½" Unilet Cover, W/Gasket Appleton	172	
	13	HUB-150	1½ Watertight Hub w/Insul Throat Appleton	245	2
	14	1221GRY	LIGHT SWITCH SPDT 20A HUBBELL	160	1
	15	EVA-1ND	Light Assy, Exp Proof ½" Hubs	271	10
	16		Light Bulb, Extended Service	221	10
	17	A-2616	LIGHTING GASKET 1/4 THK NEOPRENE	151	H
	18		Wire Ring Tongue Lug #12 wire/¼" bolt R-1727 or Equal		A
	19		Wire Ring Tongue Lug #12 wire/¼" screw RCT 32K or Equal		
	20		Wire Ring Tongue Lug #12 wire/¼" screw RCT 36K or Equal		
	21	9000-45	FEMALE CONNECTOR Alison ELECTRONICS	195	1
	22	HUB-50	½" Watertight Hub w/Insul Throat Appleton	245	3
	23		NUT, HEX ¼-20UNC	115	

BILL OF MATERIALS
M-HFA-J01
M-HFB-J01

NOTE: Only those pages which contain age degradable components are included.

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CTI-NUCLEAR
Division of McDowell-Wellman Company

MATERIAL PROCUREMENT LIS

W.A. 60230

Drawing Title PRE FILTER RACK

ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT
1		Angle M/F 3/16" x 9 3/16" x 81 1/8 ASTM A36	
2		Angle M/F 3/16" x 3 9/16" x 48 7/8" ASTM A36	
3		Channel 2 5/8" x 2" x 48 1/2 Lg M/F 328551	
4		American Air Vacuu[illegible] Filter Frame 24" x 24" x 4" Galv STL	
5		Plate 3/16 x 2 5/8" x 7 7/8 Lg. ASTM A36	
6		Plate 3/16 x 2" x 7 5/8 Lg ASTM A36	
7		Drive Rivets Southco 38-138-04 91	
8		Drive Rivets Southco 38-138-03-91	
9	#732	Silicone Rubber Sealant Dow Chemical	

W.A. 60230 Drawing Title DOOR & FRAME ASSE

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT	TA
	1		DOOR & FRAME ASS'Y		
	2		DOOR & FRAME ASS'Y		
S-144	3		SHEET 11GA. (.120) x 33 3/8 x 63 3/8 ASTM-A 570, GR. C OR A 569	77	1
S-145	4		ANGLE, 3x2x 1/4 66 LG ASTM A -36	54	
S-146	5		FLAT BAR 1/4 x 1" x 26 5/8 LG ASTM-A36	82	2
S-147	6	B31033	VIEWPORT 11" O.D x 8" I.D x 1 1/8" BRONZE	91	1
S-148	7	B 33381	SLEEVE	46	
S-149	8		1/2 THK. x 1 x 30 3/8 SILICONE SPONGE RUBBER WITH ADHESIVE BACKING CORLASTIC R-10480 GR MED.	92	
S-150	9		ARC STUD 1/4-20 UNC x 3/4 LG ASTM-A 675, GR. 65	35	6
S-151	10		FLAT BAR, 1/4 x 1 x 28 3/4 LG ASTM-A36	82	2
S-152	11		GASKET NEOPRENE 1/4 x 11 O.D x 9 1/8 I.D. CLOSED CELL ASTM D1056 - GR SCE 43	93	1

R-PR ISSUED P-PR-PO PLACED I = MAT'L IN HOUSE A

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Division of McDermott-Wellman Company

MATERIAL PROCUREMENT LIST

W.A. 86230 Drawing Title DOOR & FRAME ASSE

	ITEM NO.	DRAWING NO	MATERIAL OR DESCRIPTION	CERT	T
5-153	12		HEX NUT 1/4 20-UNC ASTM-A 307	25	
5-154	13		MED. HELICAL LOCKWASHER, 1/4 C.S.	17	
5-155	14		FLAT BAR, 1/4 x 1 x 59 1/4 LG ASTM-A36	82	
5-156	15		ANGLE, 3 x 2 x 1/4, 30 LG ASTM-A36	54	
5-157	16		1/2 THK x 1 x 31 1/4 SILICONE SPONGE RUBBER WITH ADHESIVE BACKING COHRLASTIC R-10480 GR. MED	92	
5-158	17		SEALANT, SILICONE RUBBER DOW CHEMICAL # 732	94	A RE
	18	B28726	HINGE ASS'Y		
5-159		B28728-	BUTT FLANGE ASTM SA 351, CF8 PASSIVATE SAND CAST PER MIL-STD-171 (5.4.1)	95	
5-160		B28727	DOOR PIVOT ASME SA-240 TP 304 OR SA 479 OR SA 351 CF8 PASSIVATE SAND CAST PER MIL-STD-171 (5.4.1)	96	
5-161		9830GA385	CLEVIS PIN 1 3/4" LG x 1/2" McMASTER-CARR	97	
5-162		98311A490	COTTER PIN 1" LONG x 5/32"	98	

23 LITTON LEAK
Division of McDonnell Douglas Corporation

MATERIAL PROCUREMENT LIST

W.A. 30230 Drawing Title DOOR & FRAME ASSY

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT	TO O
-163		98296A263	EXPANSION PIN 1¼" LONG x 3/16" - McMASTER - CARR	99	
	19.	C30252	DOG ASSY		
-164		C30251	Outside Handle / C-33335	100	1
-165		C30247	Inside Handle / C-32154	101	1
-166		B30248	Lubricating Fitting Compound Silicone Grease Heavy Consistency	102	
-167		B30249	Grease Fitting Alemite #1952	103	1
-168		B30250	DOG BEVEL 2.50 x .75 x .68 CASTING ASME SA 351 CF-8 (304 SS)	104	1
-168A		A33538	Flange Bearing	105	1
-169			Hex Hd Bolt ½"-20 UNF 5" 1¼ Thds	106	5
-170			Dowel Pin 3/16 Dia x ¾ lg ASTM A276 GR 55	32	1
-171			Hex Nut ½"-20 UNF-3 SS	27	1

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Division of McDonnell-Douglas Company

MATERIAL PROCUREMENT LIST

W.A. 50230 Drawing Title ABSORBER COVER

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT	T
		C32599	ABSORBER COVER		
5-186	1		PLATE, 7/16 x 31 13/16 x 67 LG	62	
			304 SS ASME SA 240		
5-187	2	825925	HANDLE 1/2 SCH. 5 PIPE	78	
			x 8 3/4 LG - 304 SS ASME		
			SA-376 OR SA 312		
5-188	3		GASKET 1/4 x 3 x 60 LG	93	
			NEOPRENE, ASTM-D1056,		
			GR SCE-43		
5-189	4		GASKET 1/4 x 3 x 30 LG	93	
			NEOPRENE, ASTM-D1056,		
			GR SCE-43		
5-190	5		GASKET ADHESIVE	108	A
			GOODYEAR, PLIOBOND		R
			#20		

30 W.A. 60230 **Drawing Title** Electrical Ins...

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT
E-253	11	Type - UA	Flex. Liq. Tight Conduit w/gnd 1/2" Nom	
E-254	12	KB 50	Unilet Cover - 1/2" Appleton	
E-255	13	KB 100	Unilet Cover - 1" Appleton	
E-256	14	1221-GRY	Light Switch, Single Pole, 20 Amp. Service grade Hubbell	
E-257	15	FS-1-SDL FSK-1-TGFC	Gang Box w/ one Hub & Mtg lugs Appleton	
E-258	16	LTCB-50	Fitting Flex, Box Conn. 1/2" w/gasket & Bushing Crouse-Hinds	
E-259	17	LTCB-100	Fitting Flex, Box Conn. 1" w/gasket & bushing Crouse-Hinds	
E-260	18	EFCOR 17-50	Swivel Coupling 1/2"	
E-261	19	HUB-50	Rigid Conduit Hubs 1/2" Appleton or Equal	
E-262	20	HUB-100	Rigid Conduit Hubs 1" Appleton or Equal	
E-263	21		Hex Stud 1/4-20 UNC - [illegible] ASTM A193, 1018-1020 Zinc Pl.	
E-263	22		Hex Nut 1/4-20 UNC, ASTM-A307 Zinc Pl	
E-264	23		Flat Head Mach. Screw #10-24 UNC x 1 1/4 Lg. ASTM A307 Zinc Pl.	
E-265	24		Self Locking Nut #10-20 UNC ASTM-A307 Zinc Pl.	
E-266	25	R 30946	Light Ring Gasket 5 3/8" OD x 4 3/4 ID x 1/4 THK Neoprene Gasket ASTM-D 2000 Gr. SC-13	

R=PR ISSUED P-PR-PO PLACED I-MAT'L IN HOUSE A

32 W.A. 40230 Drawing Title Electrical Installation

	ITEM NO	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT
S-291			RD HD Mach. Screw. #6-32 UNC x 3/4 Lg C.S. Zinc R.	
S-292			Hex Nut #6-32 UNC, C.S. Zinc R.	
S-293	45	NU001001	Heater Element 26 KW., 480V, Nutherm	
S-294	46	1023-50454-23	Heater Control Panel Nutherm	
S-295	47	1028-50456-23	Air Heater Control Aux. Pnl Nutherm	
	48	C33166	Fan Junction Box, 16" x 14" x 6"	
S-340		A-1614NF	Electrical Box Hoffman	
S-341		A-16P14	Electrical Panel Hoffman	
S-342		16301-3	Underwriters Safety Device	
S-343			RH Mach. Screw, #6-32 UNC x 3/4" Lg C.S. Zinc R.	
S-344			Hex Nut, #6-32 UNC C.S. Zinc R.	
S-345			External Lockwasher #6 C.S. Zinc R.	
S-346	49	CO4-F038	Sealing Cement, for Explosion Proof Seals Appleton	
	50			
	51	B 21000	Sensor Cable Terminal Box	
S-353	52		Conc Stud 3/8-16 UNC x 3/4" Lg ASTM-A108 Gr. 1015-1020	
S-354	53		Hex Nut 3/8-16 UNC, Carbon Str. Zinc R.	

R=PR ISSUED P=PR-PO PLACED I=MAT'L IN HOUSE A

Drawing No. [illegible] 6230 — **Drawing Title** Electrical Installa[tion]

	ITEM NO.	DRAWING NO.	MATERIAL OR DESCRIPTION	CERT
	75	310-BC514	Wire Lug Bag "10 wires" / 5/8 Lug Tefzel	
	76	CL100	One Hole Conduit Clamp 1" Steel Appleton	
	77	78-D-1-N-1-N-4	Temperature Sensor Assy. Rosemount	
	78		Type SC 1930. R.T.D. Transmitter	
	79	A 1210NE	Enclosure, NEMA 4, 12"×10"×4 Hoffman	
	80	B 33608	Electrical Panel	
	81			
	82	B 33473-1	Nameplate (Instrument) See Note #2, Sp. 1 3×3/4×1/16 Engraving Stock	
	83	AD-34ABS	Blind Pop Rivet 3/32 D.A. Alum.	
	84	C 52921	HTR Frame Junction Box Cover 16 GA (.0595) SHT ASTM A240, T304 SS.	
	85	B 33171-1	Nameplate (Term. Box) .. [illegible] Cover 2"×3/4×1/16 Engraving Stock	
	86	C 33[illegible]	Fan Heater & Box 6"×6"×4"	
	87	ELMF-[illegible]-100	Elbow 90° Male-Female 1" Appleton	
	88	FD-50	Coupling 1/2" Conduit Appleton	
	89	ST-100	Fitting Flex, Straight 1" Appleton	
	90	[illegible] GKR-12	Quick [illegible] Appleton	

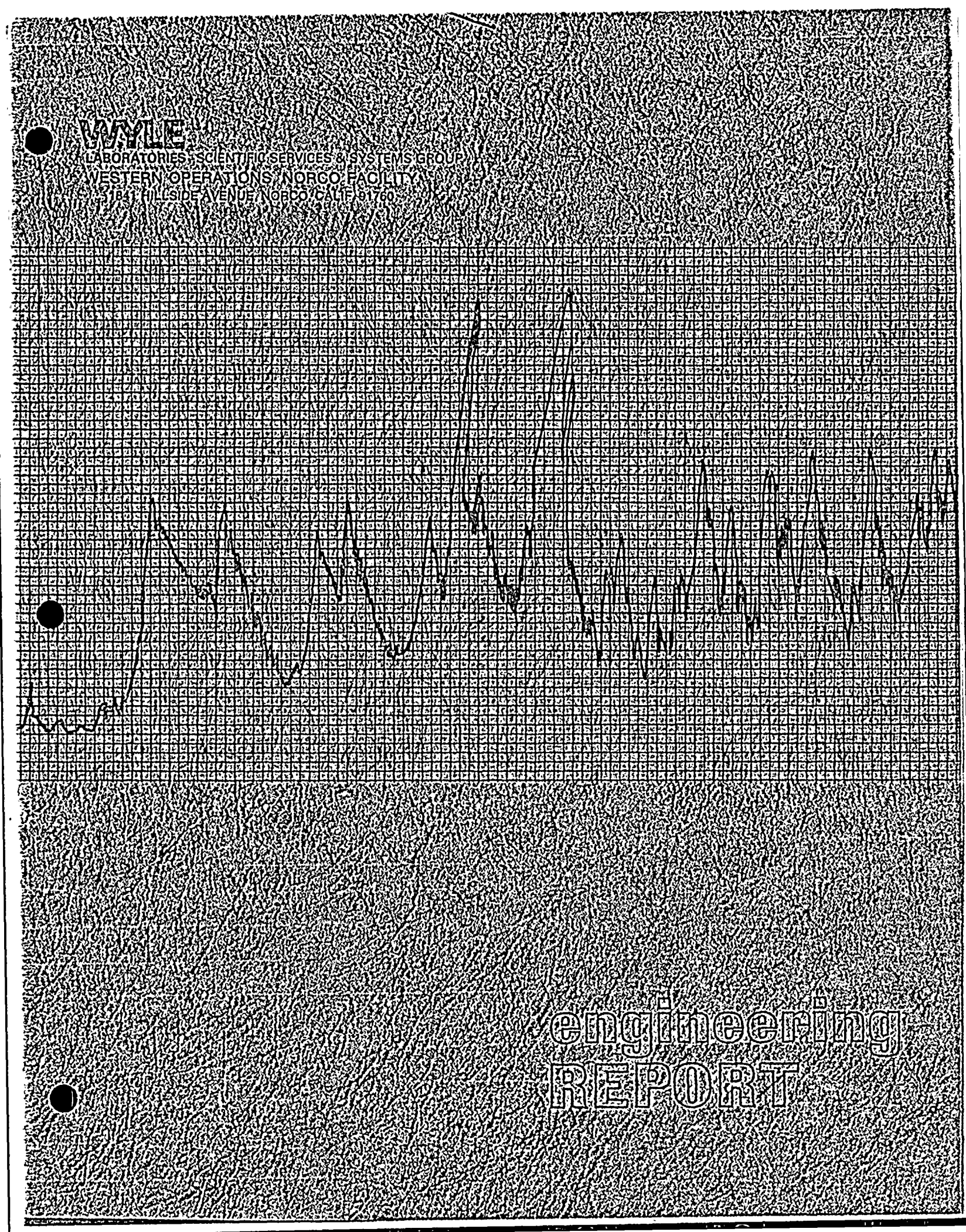
45
Division of McDowell-Wellman Company

W.A. 60230 **Drawing Title** [illegible] INSTALLATION 1, 2, 3, [illegible]

ITEM NO.	DRAWING NO.		MATERIAL OR DESCRIPTION	CERT	TOTAL QTY.
	[illegible]		SENSOR CABLE TERMINAL BOX		
		1	ENCLOSURE NEMA [illegible] - 4X4X3		
			HOFFMAN OR EQUAL (16 GA) A404NF		1
		2	TERMINAL STRIP [illegible] CIRCUIT #6 SCREW,		1 ea.
			WITH MARKER [illegible]		
			BLACK PHENOLIC [illegible] 3-141 MS-3-141		
		3	RD [illegible] SCREW #[illegible]-32 [illegible]		2
		4	[illegible] #[illegible] ZINC [illegible]		2
	3-31666-[illegible]	5	GASKET, NEOPRENE [illegible] 3 X 4 [illegible] CELL		1
			ASTM-D1056 GR. SCE 43		
		6	ADHESIVE, PLIOBOND #20 GOODYEAR		1 OZ
	[illegible]	[illegible]	GASKET NEOPRENE, [illegible] CELL		1
			ASTM-D1056 GRADE 43		

submitted drawings
M72B-49, 50, 51, 52, 53, 32, 33, 34

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
WESTERN OPERATIONS NORCO FACILITY
1841 HILLSIDE AVENUE NORCO CALIF 91760



engineering REPORT

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ENGINEERING REPORT

Wyle Report No. 26407
Wyle Job No. NES 26407
Customer P.O. No. 10407-13-EM-600
Total Pages this Report 9
Date: 14 January 1983

Revision A
4/25/83

AGING ANALYSIS FOR NON-METALLIC COMPONENTS

ON

ESSENTIAL COOLING AIR FILTERATION UNITS

FOR

BECHTEL POWER CORPORATION

FOR USE IN

PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2 and 3

Fuel Building Essential Air Filteration Unit Bechtel Tag No's.	Control Building Essential Air Filteration Unit Bechtel Tag No's.
13-M-HFA-J01	13-M-HJA-F04
13-M-HFB-J01	13-M-HJB-F04

PREPARED BY: D. Ballmer 1/16/83
D. Ballmer

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J. Foglietta

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P. Danesh

QUALITY ASSURANCE: L Housteau 1-21-83
L. Housteau

REVISIONS

Rev.No.	Date	Pages Affected	Preparer	Reviewer	QA		Description of Changes
A	4/25/83	1,2,6 & 7	JPT 4/25/83	PD 4/25/83	4.25.83		Revised per customer comments.

TABLE OF CONTENTS

1.0 SCOPE

This document was prepared by Wyle Laboratories for Bechtel Power Corporation (BPC) for equipment to be used in Palo Verde Nuclear Generating Station, Units 1, 2 and 3.

1.1 Objective

The purpose of this report is to present an aging analysis of non-metallic components of Q-Class Essential Air Filtration Units furnished under Bechtel Purchase Order 10407-13-MM-721B (Fuel Bldg. unit 13-M-JFA/B-J01, Control Bldg. unit 13-M-JHA/B-F04) for use by the Arizona Public Service Company, Palo Verde Units 1, 2 and 3.

The aging analysis of non-metallic components was based on the criteria of susceptibility to time/temperature and radiation mechanisms.

Damage levels and calculated lives were determined solely on the individual effects of radiation and time/temperature related mechanisms.

Bechtel Power Corporation contract specific materials lists were provided for the purpose of evaluation (Ref. 1).

1.2 Applicable Qualification Standards and Documents

- Wyle Laboratories Western Test and Engineering Quality Assurance Manual 380, dated 1 August 1982.
- IEEE 323-1974, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Station."
- IEEE 627-1980, "Standard for Design Qualification of Safety Systems Equipment Used in Nuclear Power Generating Stations."
- Bechtel Power Corporation letter, document number B/Comp-P-42759, dated November 29, 1982. Subject: Arizona Nuclear Power Project Bechtel Job 10407.

1.3 Equipment Description

The equipment consists of the following:

1. Fuel Building Essential Cooling Air Filteration Unit Tag Numbers: 13-M-HFA-J01, 13-M-HFB-J01. Manufacturer: CTI Nuclear.
2. Control Building Essential Cooling Air Filteration Unit Tag Numbers: 13-M-HFA-F04, 13-M-JFB-F04. Manufacturer: CTI Nuclear.

2.0 DEFINITION OF SERVICE CONDITIONS

BPC has specified the following environmental service conditions (Ref. 1).

2.1. Fuel Building Essential Cooling Air Filteration Units
Tag No's. 130M0HFA/B-J01 (BPC Environmental Designator VI)

	Normal/Abnormal	Accident
Temperature (F)	104	104
Radiation (Rads gamma, 40 year integrated dose)	$<10^3$	10^5
Operational Time	40 years	30 days

2.2 Control Building Essential Cooling Air Filteration Units
Tag No's. 13-M-HFA/B-F04 (BPC Environmental Designator IV)

	Normal/Abnormal	Accident
Temperature (F)	104	104
Radiation (Rads gamma, 40 year integrated dose)	$<10^3$	$<10^3$
Operational Time	40 years	30 days

3.0 EVALUATION CRITERIA

3.1 Evaluation of Susceptibility to Radiation Degradation

The approach for evaluating the components for their radiation resistance is a three step process:

1. Review the individual materials of construction as provided on the Contract Specific Materials List.

2. Research Wyle Laboratories Aging Library for information on threshold levels, severe damage levels, degradation characteristics, and failure criteria.

3. Provide evaluation based on potential material degradation and ability to perform its design function after exposure to the specified radiation dosage.

It is recognized that metallic and non-organic materials are insensitive to radiation degradation at the specified dosage and hence the evaluation is only on the organic materials (Ref. 2).

3.0 EVALUATION CRITERIA (Cont'd)

3.2 Evaluation of Susceptibility to Time/Temperature Related Mechanisms

Components of the Cooling Air Filteration Units contain metallic, as well as non-metallic, materials. The deterioration due to thermal aging is judged to be insignificant for metallic and non-organic materials. Therefore, the aging of these components will be based on their organic materials.

For many organic materials, it is known that the degradation process can be defined by a single temperature-dependent reaction that follows the Arrhenius equation (Ref. 3 & 4):

$$k = A \exp(-(Ea/k_B T)) \quad (1)$$

where,

k = reaction rate
A = frequency factor
exp = exponent to base e
Ea = activation energy
k_B = Boltzmann's Constant (8.617×10^{-5} eV/K)
T = absolute temperature

It is further noted that, for many reactions, the activation energy can be considered to be constant over the applicable temperature range. Life is assumed to be inversely proportional to the chemical reaction rate (Ref. 3 & 5). In terms of life and after converting to Napierian base logarithms, equation (1) becomes:

$$\ln(\text{life}) = (Ea/k_B)\ (1/T) + \text{Constant} \quad (2)$$

Equation (2) has the algebraic form:

$$y = mx + b$$

where,

$y = \ln(\text{life})$

$x = 1/T$

$m = Ea/k_B$, constant for single dominant reactions

b = constant

The constants, m and b, can be estimated by fitting the experimental data in the form of ln(life) versus 1/T to the above simple linear relationship.

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Tag No's. 13-M-HFA/B-F04 (BPC Environmental Designator IV)

	Normal/Abnormal	Accident
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$x = 1/T$

$m = Ea/k_B$, constant for single dominant reactions

b = constant

The constants, m and b, can be estimated by fitting the experimental data in the form of ln(life) versus 1/T to the above simple linear relationship.

3.0 EVALUATION CRITERIA (Cont'd)

3.2 Evaluation of Susceptibility to Time/Temperature Related Mechanisms (Cont'd)

For example, Dow Corning #732 RTV Silicone Rubber with a failure criterion of 50% elongation:

$\ln(life) = 8956.8356(1/T) - 11.4998$

for a baseline temperature of 313K (104°F)

$life = 3.09 \times 10^3$ years

4.0 EVALUATION

The Summary Table lists non-metallic materials found in the Fuel Building Essential Cooling Air Filteration Unit (FBU) and the Control Building Essential Cooling Air Filteration Unit (CBU). For components with time/temperature-related aging mechanisms, aging will be based upon auditable aging data. When this data is unavailable, careful extrapolation and/or selective engineering judgment will be employed and identified in the section applicable to the specific material being evaluated. A

4.1 Silicone Rubber Sealant

Both units use Dow Corning #732 RTV Silicone Rubber Sealant. The radiation damage threshold for this silicone rubber is 1.3×10^6 rads (Ref. 6). This is 13 times greater than the requirement for the FBU and greater than 1300 times the requirement for the CBU. Therefore, the silicone rubber sealant is considered not age-sensitive to radiation under the specified service conditions.

Based on a 50% elongation failure criterion for the silicone rubber sealant, the activation energy is 0.77 eV with -11.4998 intercept (Ref. 7).

4.2 Silicone Sponge Rubber

The Cohrlastic R-10480 Low Compression Set Silicone Sponge Rubber (medium grade) with adhesive backing is used on both units as a gasket material. The adhesive backing is used for gasket mounting only, therefore, it is not addressed in this evaluation. The radiation damage threshold for silicone rubber is 1×10^6 rads (Ref. 8). This is 10 times greater than the requirement for the FBU and greater than 1000 times the requirement for the CBU. Therefore, the silicone rubber is considered not age-sensitive to radiation under the specified conditions.

Based on a 50% compression set failure criterion for the silicone rubber, the activation energy is 0.86 eV with -18.3986 intercept (Ref. 9).

4.0 EVALUATION (Cont'd)

4.3 Neoprene Gaskets

Both units use neoprene gaskets. The radiation damage threshold for Neoprene is 8×10^5 rads (Ref. 9). This is eight times greater than the requirement for the FBU and greater than 800 times the requirements for the CBU. Therefore, neoprene is considered not age-sensitive to radiation under the specified service conditions.

Compression set data for Neoprene is not available. The lowest available activation energy is 1.05 eV with -24.09326 intercept (Ref. 6), based on 25% loss of elongation failure criterion. A

4.4 Silicone Grease

The Dow Corning III Compound Silicone Grease (heavy consistency) is used on both the FBU and the CBU. This grease is used as a lubricant for the door assemblies and has no safety-related function. Also, vendor specifications call for a 90 day servicing schedule of this grease (Ref. 12). Therefore, an aging analysis is not required.

4.5 Ceramic Cement

The Appleton #C04-F038 Explosion Proof Sealing Cement is a ceramic cement with an inorganic granulated wool filler. The cement is used only on the Fuel Building Filteration Unit. Because all components of this cement are inorganic it is considered not age-sensitive under the specified service conditions of radiation and time/temperature effects.

4.6 Buna-N O-Rings

The Buna-N O-rings are found in the Parker Hanifin 1020-1030 Steel Stat-O-Seal. The Stat-O-Seal is used only on the Control Building Filteration Unit. The radiation damage threshold for Buna-N (nitrile rubber) is 2×10^6 rads (Ref. 6), which is greater than 2000 times the requirement for the Control Building Filteration Unit. Therefore, Buna-N is considered not age-sensitive to radiation under the specified service conditions.

The only compression set data available for the Buna-N O-rings is based on 90% compression set failure criterion, the activation energy is 0.68 eV with -14.2945 intercept (Ref. 13). A

4.7 Asbestos Gasket

The Flexitallic #CG-1G Gasket is used only on the Control Building Filteration Unit. The non-metallic component of the gasket is compressed asbestos. Because asbestos is an inorganic mineral compound it is considered not age-sensitive under the specified service conditions of radiation and time/temperature effects.

4.8 Nitrile Base Adhesive

The Goodyear Pliobond #20 All Purpose Adhesive is a nitrile rubber base adhesive. This adhesive material is used to hold the gasket in place during installation only and has no safety-related function (Ref. 14). Therefore, an aging anlaysis is not required.

5.0 SUMMARY TABLE

Non-Metallic Materials	Aging Mechanism		Calculated Life (Years)	Location*
	Radiation	Thermal		
Silicone Rubber Sealant	No	Yes	3.09×10^3	FBU/CBU
Silicone Sponge Rubber	No	Yes	84	FBU/CBU
Neoprene	No	Yes	322	FBU/CBU
Silicone Grease	N/A	N/A	90 Days**	FBU/CBU
Ceramic Cement	No	No	N/A	FBU
Buna-N Rubber	No	Yes	5	CBU
Asbestos	No	No	N/A	CBU
Nitrile Rubber Adhesive	N/A	N/A	N/A	FBU/CBU

*FBU is the Fuel Building Essential Cooling Air Filteration Unit
CBU is the Control Building Essential Cooling Air Filteration Unit

**Vendor recommended maintenance interval

6.0 REFERENCES

1. Bechtel Power Corporation, Bonano, D. Letter with attachments (B/Comp-P-42759) to R. Houser (Wyle Laboratories), November 29, 1982.

2. Kircher, J.F., and R. E. Bowman, "Effects of Radiation on Materials and Components, Effects of Radiation on Ceramic Materials, pp. 381 & 382, Library Code 484-81.

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6. King, R.W., "The Effect of Nuclear Radiation on Elastomeric and Plastic Materials," Battelle Memorial Institute Radiation Effects Information Center Report No. REIC-21 (September 1, 1961) Library Code 286-80.

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11. General Electric Co., Arrhenius Data for Wires and Cords from "Wires and Cords for Original Equipment Manufacturers," No. GEC-WCC-2 (n.d.) Library Code 185-79A.

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