3.5 MISSILE PROTECTION

Where possible, the Seismic Category I and safety-related structures, equipment, and systems are protected from missiles generated by internal rotating or pressurized equipment through basic station component arrangement so that, if equipment failure occurs, the missile does not cause the failure of these structures, equipment, or systems. Where it is impossible to provide protection through plant layout, suitable physical barriers were provided to isolate the credible missile or to shield the critical system or component. Also, redundant Seismic Category I components are suitably protected so that a single missile cannot simultaneously damage a critical system component and its backup system. Table 3.2-1 provides a tabulation of safety-related structures, systems, and components, along with their applicable seismic category and quality group classification.

Section 3.12 - Separation Criteria for Safety-Related Mechanical and Electrical Equipment provides a detailed discussion of protection from missiles, such as equipment separation and redundancy, to preclude damage to the systems necessary to achieve and maintain a safe plant shutdown.

3.5.1 MISSILE SELECTION AND DESCRIPTION

3.5.1.1 Internally Generated Missiles (Outside Primary Containment)

There are two general sources of postulated missiles outside the primary containment:

a) Rotating component failure missiles

b) Pressurized component failure missiles

3.5.1.1.1 Rotating Component Failure Missiles

The systems located outside the primary containment have been examined to identify and classify potential missiles. The basic approach is to ensure design adequacy against generation of missiles, rather than to allow missile formation and then containing their effects.

Catastrophic failure of rotating equipment, such as pumps, fans, and compressors leading to the generation of missiles, is not considered credible. Massive and rapid failure of these components is incredible because of the conservative design, material characteristics, inspections, quality control during fabrication and erection, and prudent operation as applied to the particular component. The analysis of turbine missiles is discussed in Section 3.5.1.3.

It has been concluded that large, massive rotating components, such as the various ECCS pumps and motors, fans, and compressors outside the primary containment, do not have sufficient energy to move the masses of their rotating parts through the housings in which they are contained.

Similarly, it is concluded that the HPCI and RCIC turbines cannot generate missiles. Overspeed tripping devices ensure that the HPCI and RCIC turbines will not reach runaway speed where component failure could take place.

However, even with this conservative design, the RCIC and HPCI turbines are located in separate compartments so that any turbine missile will affect only one division of equipment.

This is also true for other large rotating safety-related equipment, such as pumps, fans, and compressors. Redundant equipment is normally located in different areas of the plant or separated by walls, so that a single missile from a rotating mass will not damage both redundant systems.

3.5.1.1.2 Pressurized Component Failure Missiles

The following potential internal missile donors from pressurized equipment were investigated:

a) High Energy Piping

Pressurized components in systems where service temperature exceeds 200°F or service pressure exceeds 275 psig were evaluated as to their potential for becoming missiles. Pipe whip restraints were provided at possible breakpoints of these high energy lines, which may impact on safety-related equipment or structures (see Section 3.6).

Additional attention has been given to ensure that safety relief valves and valve headers are not credible missiles. All SRV headers are restrained in accordance with the pipe whip criteria described in Section 3.6 to ensure that in the event of a circumferential type break of the header, no missile would result.

The safety relief valves are attached to welded, Schedule 160 sweepolet fittings on the headers. The design of this attachment includes all dynamic loads that may be associated with the SRV discharge.

The SRV header is designed and built to the conservative requirements of the ASME Section III, Class 1, Code and as such is subject to the ASME Section XI Inservice Inspection requirements. This inspection plus the RCPB leak detection capability would provide early indication of any possible failure in this area.

Therefore, it is concluded that the likelihood of missiles from high energy piping, which may impact on safety-related equipment, is remote.

b) Valve Bonnets

Valves of ANSI 900 psig rating and above, constructed in accordance with Section III of the ASME Boiler and Pressure Vessel Code, are pressure seal bonnet type valves. For pressure seal bonnet valves, valve bonnets are prevented from becoming missiles by the retaining ring, which would have to fail in shear, and by the yoke, which would capture the bonnet or reduce bonnet energy.

The bonnet bolts preload the pressure seal gasket so the valve will be sealed when it is not under pressure. When pressurized, the valve is sealed by process fluid pressure and the bonnet bolts are under no load. All ASME III Class I, 900 # bonnet-seal type valves were analyzed per ASME B & PV Code, Section III. Standard calculation pressure used in these analyses was given by Figure NB-3545.1-2 for weld-end valves.

Using the typical pressure seal valve shown in Figures 3.5-9 and 3.5-10 as an example, the total thrust load on the retaining ring and valve body was calculated. The results are listed in Table 3.5-7. The results show both the retaining ring and valve body meet the NB-3227 requirement while using a calculation pressure which is much higher than the normal operating pressure of the valve.

The majority of valves inside containment have massive valve operators which are supported by the yoke. For these valves, the valve operators act as an additional limitation to the yoke becoming a missile.

For a yoke clamp to fail, one would have to assume that the retaining ring fails completely and instantaneously so that the bonnet could strike the yoke. The yoke is normally under no load and complete failure of the yoke clamp is not considered credible.

Because of the highly conservative design of the retaining ring of these valves, bonnet ejection is highly improbable and hence, bonnets are not considered credible missiles.

Most valves of ANSI rating 600 psig and below are valves with bolted bonnets. Valve bonnets are prevented from becoming missiles by limiting stresses in the bonnet-to-body bolting material by requirements set forth in the ASME Boiler and Pressure Vessel Code, Section III, and by designing flanges in accordance with applicable code requirements. Even if bolt failure were to occur, the likelihood of all bolts experiencing simultaneous complete severance failure is remote. The widespread use of valves with bolted bonnets and the low historical incidence of complete severance failure of bonnets confirm that bolted valve bonnets need not be considered as credible missiles.

c) Valve Stems

Valve stems are not considered potential missiles if at least one feature in addition to the stem threads is included in their design to prevent ejection. Valves with backseats are prevented from becoming missiles by this feature. In addition, air or motor-operated valve stems will be effectively restrained by the valve operators.

d) Temperature Detectors

Temperature or other detectors installed on piping or in wells are evaluated as potential missiles if a single circumferential weld would cause their ejection. This is highly improbable, since a complete and sudden failure of a circumferential weld is needed for a detector to become a missile. In addition, because of the spatial separation of redundant safety-related equipment, a small missile such as a detector, assuming the circumferential weld fails completely, is not likely to hit redundant safety-related equipment.

e) Nuts and Bolts

Nuts, bolts, nut and bolt combinations, and nut and stud combinations have little stored energy and thus are of no concern as potential missiles.

f) Blind Flanges

Bolted blind flanges are not considered credible missiles because of the extremely unlikely occurrence of all bolts experiencing simultaneous complete severance failure as discussed in (b) above.

g) Safety Relief Valve and Main Steam Isolation Valve Accumulators

Pressurized ASME III vessels such as SRV and MSIV accumulators are not considered credible missiles. These accumulators are operated at a maximum pressure and temperature of 150 psig and 150°F. These vessels have low stresses and operate in the "moderate energy" range and therefore, any failures would be a slow type and not of concern for missile generation.

3.5.1.2 Internally Generated Missiles (Inside Containment)

There are three general sources of postulated missiles inside the primary containment:

a) Rotating component failure missiles

b) Pressurized component failure missiles

c) Gravitationally generated missiles

3.5.1.2.1 Rotating Component Failure Missiles

The most significant pieces of rotating equipment in the primary containment are the recirculation pumps and motors. GE Licensing Topical Report NEDO-10677, submitted to the NRC contained a discussion of the potential overspeed of a recirculation pump due to LOCA blowdown flow past the pump impeller and the possible results of such overspeed. That report also presents a decoupler concept to protect the pump motor under such conditions.

In a letter to the NRC dated November 6, 1975, GE wrote that an analytical study has shown that a decoupling device is not needed, and that the NEDO-10677 report should be rescinded.

The following results were outlined in the GE letter to the NRC:

a) If a break were to occur in the pump discharge pipe, either a guillotine or longitudinal break, the maximum calculated resultant pump speed would be 110 percent of rated. In this analysis, the flow choking at the volume diffuser inlet area in the pump casing determined the differential feed and volumetric flow rate used to predict pump speed during blowdown. Longitudinal breaks up to one pipe cross-sectional area were considered.

b) For a longitudinal break in the pump suction pipe, the maximum calculated pump speed in the reverse direction would be 140 percent of rated. This speed does not result in mechanical motor damage. Longitudinal breaks up to one pipe cross-sectional area were considered.

c) For a guillotine suction pipe break the maximum calculated pump speed in the reverse direction is 710 percent of rated, which is a destructive overspeed of the motor. However, the initial torque for this event is 40 times the rated motor torque and this is sufficient to decouple the motor from the pump by mechanical failure of the pump to motor shaft. Mechanical failure is calculated to occur at 5 to 10 times the rated motor torque with or without a decoupler device in the drive train. Thus, an inherent self-decoupling would exist for this case.

On November 19, 1976, the NRC wrote GE a letter stating that applicants must file a formal application for amendment of their construction permit or operating license before they would be released from their commitment to installed the decoupler.

The letter also stated that "any such application to delete the decoupler from a boiling water reactor design must include a thorough safety evaluation setting for the reasons why a recirculation pump decoupler is no longer necessary."

GE has completed such a safety analysis report on a generic basis, in a letter from E.A. Hughes (GE) to R.C. DeYoung (NRC), January 18, 1977, "GE Recirculation Pump Potential Overspeed."

It is concluded in the above letter that destructive pump overspeed can result in certain types of missiles. A careful examination of shaft and coupling failures shows that the fragments will not result in damage to the containment or to vital equipment.

(1) Low Energy Missiles (Kinetic energy less than 1,000 ft-lbs):

Low energy level missiles may be created at motor speed of 300% of rated, through failure of the end structure of the rotor. The structure consists of the retaining ring, the end ring, and the fans. Missiles potentially generated in this manner will strike the overhanging ends of the stator coils, the stator coil bracing, support structures, and two walls of one-half inch thick steel plate. Due to the ability of these structures to absorb energy, it is concluded that missiles would not escape this structure. It is at this point frictional forces would tend to bring the overspeed sequence to a stop.

(2) Medium Energy Missiles (kinetic energy less than 20,000 ft-lbs):

In the postulated event that the body of the rotor were to burst, medium energy missiles could be created. The likelihood that these missiles would escape the motor is considered less than the likelihood of escape for the low-energy missiles described above, due to the additional amount of material constraining missile escape, such as the stator coil, field coils, and stator frame directly adjacent to the rotor.

(3) The Motor as a Potential Missile:

Since bolting is capable of carrying greater torque loads than the pump shaft, pump bolt failure is precluded. Since pump shaft failure decouples the rotor for the overspeed driving blowdown force, only those cases with peak torques less than that required to fail the pump shaft (five times rated) will have the capability to drive the motor to overspeed. When missile generation probabilities are considered along with a discussion of the actual load-bearing capabilities of the system, it is evident that these considerations support the conclusion that it is unrealistic that the motor would become a missile.

It is concluded that the other rotating components inside the containment such as fans and chillers do not have sufficient energy to move the masses of their rotating parts through the housings in which they are contained.

In addition, redundant safety-related components are located in different areas of the containment, so that a rotating component failure missile will not damage both redundant components.

3.5.1.2.2 Pressurized Component Failure Missiles

A discussion of the potential for missile generation from the failure of pressurized components, e.g. valve stems, valve bonnets, and temperature element assemblies, is presented in Subsection 3.5.1.1.2. That discussion is also applicable to pressurized components inside containment.

3.5.1.2.3 Gravitationally Generated Missiles

Components necessary for the operation and safety of the reactor are designed to remain in place and functioning during all design basis conditions. Equipment which is not necessary for operation, startup testing, or safety is removed from the containment or seismically supported and secured in place prior to operation to ensure that it will not become a missile during plant operation or during a safe shutdown earthquake. Therefore, during reactor operation and following a LOCA, all equipment inside containment is secured. During maintenance when such equipment is returned to the containment or made operational, administrative and procedural methods will be used to ensure that significant damage is not caused to safety equipment even when the reactor is in the shutdown condition.

3.5.1.3 Turbine Missiles

An analysis was performed to evaluate the probability of damage from postulated turbine missiles to safety-related components. The probability of unacceptable damage due to turbine missiles (P4) has been calculated to be less than 1.00 E-7 per unit per year (see reference 3.5-20)

The NRC has established in NUREG 1048, Appendix U (reference 3.5-19) an acceptable methodology for establishing maintenance and inspection schedules for specific turbine systems including the original General Electric main turbines installed at Susquehanna. As a result of a retrofit of the main turbines with Siemens turbines, the missile probability analysis outlined in Reference 3.5-20 has been applied. This methodology also supports and maintains the established maintenance and inspection program outlined in Section 10.2.3.6 for the installed turbine.

The turbine inspection program frequencies implemented in Section 10.2.3.6 are supported by the probabilistic approach outlined in references 3.5-19 and 3.5-20. This approach shifts emphasis in the turbine missile damage calculations from the strike and damage portion to the missile generation portion. Turbine missile damage is a product of these two factors.

By managing turbine reliability through maintenance and inspection, the probability of generating a turbine missile can be determined.

The intent of the maintenance and inspection program is to ensure that the probability of generating a turbine missile (PI) is maintained to less than 1.00 E-5 per unit per year for an unfavorably oriented turbine with respect to the reactor building. Susquehanna's turbines are unfavorably oriented. The analysis supporting the program takes into account specific turbine wheel operating conditions, material properties, periodic maintenance and inspection results, and related system operating conditions. As a result, the main turbine maintenance and inspection program can facilitate evaluations of the effects of changes in parameters used as inputs to determining the probability of generating a turbine missile. Should any of these parameters change, the frequency changes to the maintenance and inspection program can be determined and adjusted accordingly. With this method, effects from changes to input parameters can be evaluated. Table 3.5-10, Turbine System Reliability Criteria reflects the recommendations from Table U.1 in reference 3.5-19 for an unfavorably oriented main turbine. By managing the probability of generating a missile to less than 1.00 E-5 (PI), the overall probability of turbine damage (P4) is maintained at less than or equal to 1.00 E-7 per unit per year.

Schedules for future inspection of low pressure turbine rotors with shrunk-on-disks will be based on this probabilistic approach and the analysis established in reference 3.5-19.

<u>3.5.1.3.1 Turbine Placement and Orientation</u>

The safety-related structures are those in which a single strike by a postulated turbine missile could result in a loss of the capability to function in a manner necessary to meet the requirements of 10CFR100.

At Susquehanna SES, these are the reactor buildings, diesel generator buildings, the control structure, and the ESSW pumphouse.

<u>3.5.1.3.2 Missile Identification and Characteristics – Unit 1</u>

The turbines at Susquehanna are manufactured by Siemens. Each unit consists of a tandem compound, six-flow, non-reheat, 1800 rpm turbine, directly connected to a synchronous generator.

Siemens has performed an analysis (Reference 3.5-20) to determine the characteristics of the missiles that can be expected as a result of a turbine burst. The most significant cause of a turbine missile is a burst-type failure of one or more bladed disks of an LP rotor. Relatively massive and strong turbine casings (Reference 3.5-20) would contain failures of other rotors including the HP and generator rotor.

3.5.1.3.3 Probability Analysis

The probability of turbine missile damage is expressed as:

P4 = P1 x (P2 x P3) (Eq. 3.5-1)

where:

P4 = probability of unacceptable turbine missile damage, per year

P1 = probability of a turbine failure resulting in the ejection of a missile, per year

P2 = probability that a missile will strike a barrier that houses a critical plant component, given that a missile has been ejected from the turbine, and

P3 = probability that a missile will spall the struck barrier, thus damaging an essential critical plant component, given that a missile has been ejected from the turbine and has struck the barrier.

P1, P2 and P3 are evaluated using a methodology the NRC has established in NUREG 1048, Appendix U (reference 3.5-19).

This methodology ensures that the probability of generating a turbine missile (PI) is maintained to less than 1.00 E-5 per unit year for an unfavorably oriented turbine with respect to the reactor building. Susquehanna’s turbines are unfavorably oriented.

The value for P2 x P3 is assigned 1.00 E-2 for an unfavorably oriented turbine. NRC experience and simple estimates based on gross plant layouts formed the basis for this value (reference 3.5-19),

The P4 is obtained by multiplying P2x P3 by P1. Since P2 x P3 has been assigned 1.00 E-2 and P1 is less than 1.00 E-5, the limit for P4 is 1.00 E-7.

3.5.1.4 Missiles Generated by Natural Phenomena

Only tornado-generated missiles are considered. Table 3.5-4 lists the missiles considered in the design. Table 3.5.4a lists the missles considered in the design of the Diesel Generator 'E' Building. The structures designed for tornado-generated missiles are listed in Table 3.3-2.

3.5.1.5 Site Proximity Missiles

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

START – HISTORICAL INFORMATION

3.5.1.6 Aircraft Hazards

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

3.5.1.6.1 Airport Operations

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

3.5.1.6.2 Aircraft Crash Probability

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

3.5.1.6.3 Critical Target Area for the Plant

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

3.5.1.6.4 Striking Probabilities

The probability that an aircraft might strike the Susquehanna SES, resulting in a potential nuclear safety hazard, is the product of:

the annual traffic (number of aircraft) (3.5.1.6.1)

the crash probability (events per mi^2) (3.5.1.6.2)

the applicable target area (mi^2) (3.5.1.6.3)

SECURITY-RELATED INFORMATION. TEXT WITHHELD UNDER 10 CFR 2.390

END – HISTORICAL INFORMATION

Based on the low event probability, aircraft hazards are eliminated as a design basis concern for Susquehanna SES.

3.5.2 SYSTEMS TO BE PROTECTED

3.5.2.1 Missile Protection Design Philosophy

Systems that are reviewed for missile protection are listed in Subsection 3.12.2.

For internally generated missiles, protection is provided through basic station component arrangement so that, if equipment failure occurs, the missile does not cause the failure of a Seismic Category I structure or any safety-related system. Where it is impossible to provide protection through station layout, suitable physical barriers are provided whose function is either to isolate the missile or to shield the critical system or component. In addition, redundant Seismic Category I components are suitably protected so that a single missile cannot simultaneously damage a critical component and its backup system.

3.5.2.2 Structures Designed to Withstand Missile Effects

Seismic Category I structures are designed to withstand postulated external or internal missiles which may impact them. Table 3.3-2 is a list of the structures designed to withstand external tornado-generated missiles, and the safety-related equipment which they protect. The missiles are listed in Table 3.5-4 for all tornado-resistant structures except the Diesel Generator 'E' Building. Table 3.5-4a lists the missiles used in the design of the Diesel Generator 'E' Building.

An investigation of the capability of plant safety-related structures, systems, and components has shown that exterior walls and roofs of Class I structures housing safety-related systems and components are adequate to withstand the 1-inch steel rod and the utility pole listed in Table 3.5-4.

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

SECURITY-RELATED INFORMATION.
TEXT WITHHELD UNDER 10 CFR 2.390

3.5.3 BARRIER DESIGN PROCEDURES

The structure and barriers are designed in accordance with the procedures detailed in Reference 3.5-5. The procedures include:

a) Prediction of local damage (penetration, perforation, and spalling) in the impact area including estimation of the depth of penetration

b) Estimation of barrier thickness required to prevent perforation

c) Prediction of the overall structural response of the barrier and portions thereof to missile impact.

The use of a ductility ratio higher than 10 but less than the allowables given in Reference 3.5.5 will be governed by the following conditions:

(1) Reinforced concrete barriers

The allowable displacement of reinforced concrete flexure members can be based on an upper limit for plastic hinge rotation r_θ as follows:

$$r_\theta = 0.0065 \frac{d}{c} \leq 0.07$$

where

d = distance from compression face to centroid of tensile steel reinforcement (inch)

c = distance from compression face to the neutral axis at ultimate strength (inch)

This condition is given in section C.3.5 of Appendix C and commentary to Appendix C of ACI 349-76. The design of the diesel Generator 'E' Building is based on ACI 349-80.

(2) Steel barriers

To insure the ability of a steel beam to sustain fully plastic behavior and thus to possess the assumed ductility at plastic hinge formation, it is necessary that the elements of the beam section meet minimum thickness requirements sufficient to prevent local buckling failure.

The conditions to preclude local buckling as given in AISC Manual are satisfied.

3.5.4 REFERENCES

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3.5-2 GE Memo Report "Hypothetical Turbine Missiles - General Discussion" (March 13, 1973).

3.5-3 GE Memo Report "Hypothetical Turbine Missiles - Probability of Occurrence" (March 14, 1973).

3.5-4 D.C. Gonyea, "An Analysis of the Energy of Hypothetical Wheel Missiles Escaping from Turbine Casings," GE Technical Information Series No. DF73SL12 (February, 1973).

3.5-5 "Design of Structures for Missile Impact," BC-TOP-9A, Rev. 2, Bechtel Power Corporation, San Francisco, California (September, 1974).

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3.5-12 Barber, R.B., Steel Rod/Concrete Slab Impact Test (Experimental Simulation), Bechtel Corp., (October, 1973).

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3.5-16 GE Letter "Integral LP Rotor Differences," B.E. Nadler to M.J. Barberetta (October 11, 1985).

3.5-17 U.S. Nuclear Regulatory Commission, "Standard Review Plan 3.5.1.4, Rev. 2," NUREG-0800, (July, 1981).

3.5-18 U.S. Nuclear Regulatory Commission, "Standard Review Plan 3.5.3, Rev. 1," NUREG-0800, (July, 1981).

3.5-19 NUREG-1048, Supplement No. 6, Safety Evaluation Report Related to the Operation of Hope Creek Generating Station, Appendix U, Probability of Missile Generation in General Electric Nuclear Turbines

3.5-20 EC-093-1023, Turbine Missile Probability Analyses for Susquehanna Unit 1 & 2.

TABLE 3.5-4

TORNADO-GENERATED MISSILE PARAMETERS
FOR ALL TORNADO-RESISTANT STRUCTURES
EXCEPT THE DIESEL GENERATOR 'E' BUILDING

Missile	Weight (lb)	Velocity (mph)
Wood plank, 4 in. x 12 in. x 12 ft, traveling end-on	108	300
Steel pipe, 3 in. dia., Schedule 40, 10 ft long, traveling end-on	76	100
Automobile flying through the air at not more than 25 ft above the ground and having contact area of 20 sq ft.	4000	50
Steel rod 1-inch diameter x 3 feet long	8	216
Utility pole 13-1/2 inch diameter, 35 feet long acting not more than 30 feet above the ground	1490	144

NOTE:

The vertical velocities will be considered equal to 80% of the horizontal velocities mentioned above.

TABLE 3.5-4a

TORNADO-GENERATED MISSILE PARAMETERS FOR DIESEL GENERATOR 'E' BUILDING

	Missile	Weight (lb)	Impact Velocity (fps)
A)	Wood plank, 4 in. x 12 in. x 12 ft, traveling end-on	108	440
B)	Steel pipe, 3 in. dia., Schedule 40, 10 ft long, traveling end-on	72	147
C)	Steel Pipe, 6 in. dia. Schedule 40, 15 ft. long	285	170
D)	Steel 12 in. diameter Schedule 40, 15 ft. long	750	155
E)	Steel rod 1-inch dia. x 3 ft. long	8	317
F)	Automobile flying through the air at not more than 25 ft. above the ground and having contact area of 20 sq. ft.	4000	195
G)	Utility pole 13.5 in. dia, 35 ft. long	1490	211

Note:

The vertical velocities will be considered equal to 80 percent of the horizontal velocities mentioned above.

Table 3.5-5

HISTORICAL INFORMATION

BERWICK AIRPORT MOVEMENT SUMARY

Security-Related Information
Table Withheld Under 10 CFR 2.390

Table 3.5-6

HISTORICAL INFORMATION

PLANT TARGET AREAS

Security-Related Information
Table Withheld Under 10 CFR 2.390

TABLE 3.5-7

CALCULATED STRESS FOR
BONNET-SEAL TYPE VALVES

Bearing Stress		
Zone[3]	Calculated Stress	Stress Limit
b-c d-e	17.05 ksi 19.54 ksi	28.3 ksi 30.7 ksi
Shearing Stress		
Zone	Calculated Stress	Stress Limit
a-b c-f	7.60 ksi 10.83 ksi	11.34 ksi 12.3 ksi

Note:

(1) Above results are based on calculation pressure - 2425 psi.

(2) Valve design pressure = 1500 psi

(3) Refer to Figure 3.5-10.

Table Rev. 1

TABLE 3.5-10
TURBINE SYSTEM RELIABILITY CRITERIA

CRITERION	PROBABILITY. YR^{-1} UNFAVORABLY ORIENTED TURBINE	REQUIRED ACTION
(A)	$P_1 < 10^{-5}$	This is the general, minimum reliability requirement for loading the turbine and bringing the system on-line.
(B)	$10^{-5} < P_1 < 10^{-4}$	If this condition is reached during operation, the turbine may be kept in service until the next scheduled outage, at which time the licensee is to take action to reduce P_1 to meet the appropriate A criterion (above) before returning the turbine to service.
(C)	$10^{-4} < P_1 < 10^{-3}$	If this condition is reached during operation, the turbine is to be isolated from the steam supply within 60 days, at which time the licensee is to take action to reduce P_1 to meet the appropriate (A) criterion (above) before returning the turbine to service.
(D)	$10^{-3} < P_1$	If this condition is reached at any time during operation, the turbine is to be isolated from the steam supply within 6 days, at which time the licensee is to take action to reduce P_1 to meet the appropriate (A) criterion (above) before returning the turbine to service.

THIS FIGURE HAS BEEN
REPLACED BY DWG.
A-17, Sh. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

Figure 3.5-6 replaced by dwg.
A-17, Sh. 1

FIGURE 3.5-6, Rev. 55

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THIS FIGURE HAS BEEN
REPLACED BY DWG.
A-21, Sh. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
Figure 3.5-7 replaced by dwg. A-21, Sh. 1 FIGURE 3.5-7, Rev. 55

AutoCAD Figure 3_5_7.doc

THIS FIGURE HAS BEEN
REPLACED BY DWG.
A-5, Sh. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

Figure 3.5-8 replaced by dwg.
A-5, Sh. 1

FIGURE 3.5-8, Rev. 48

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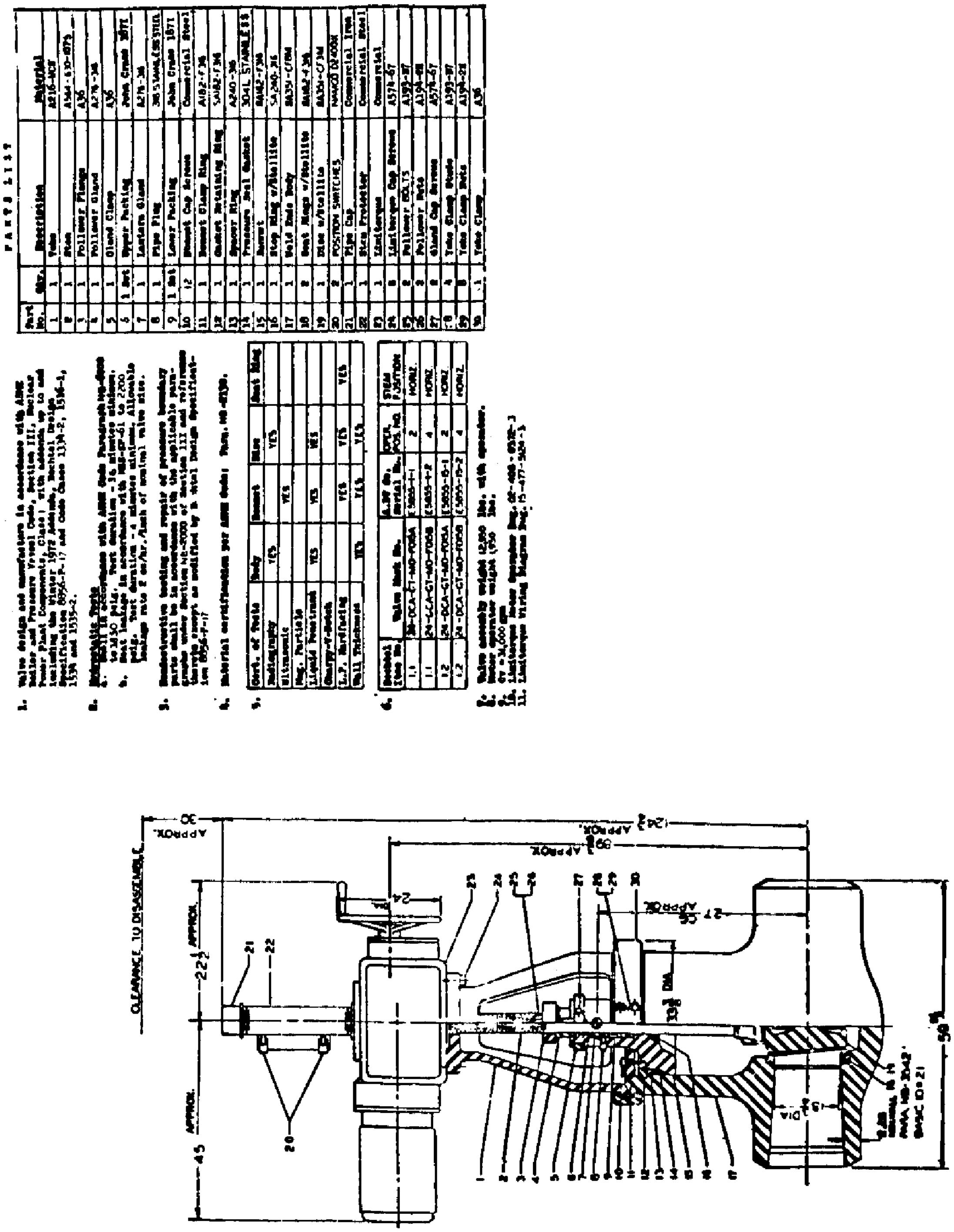

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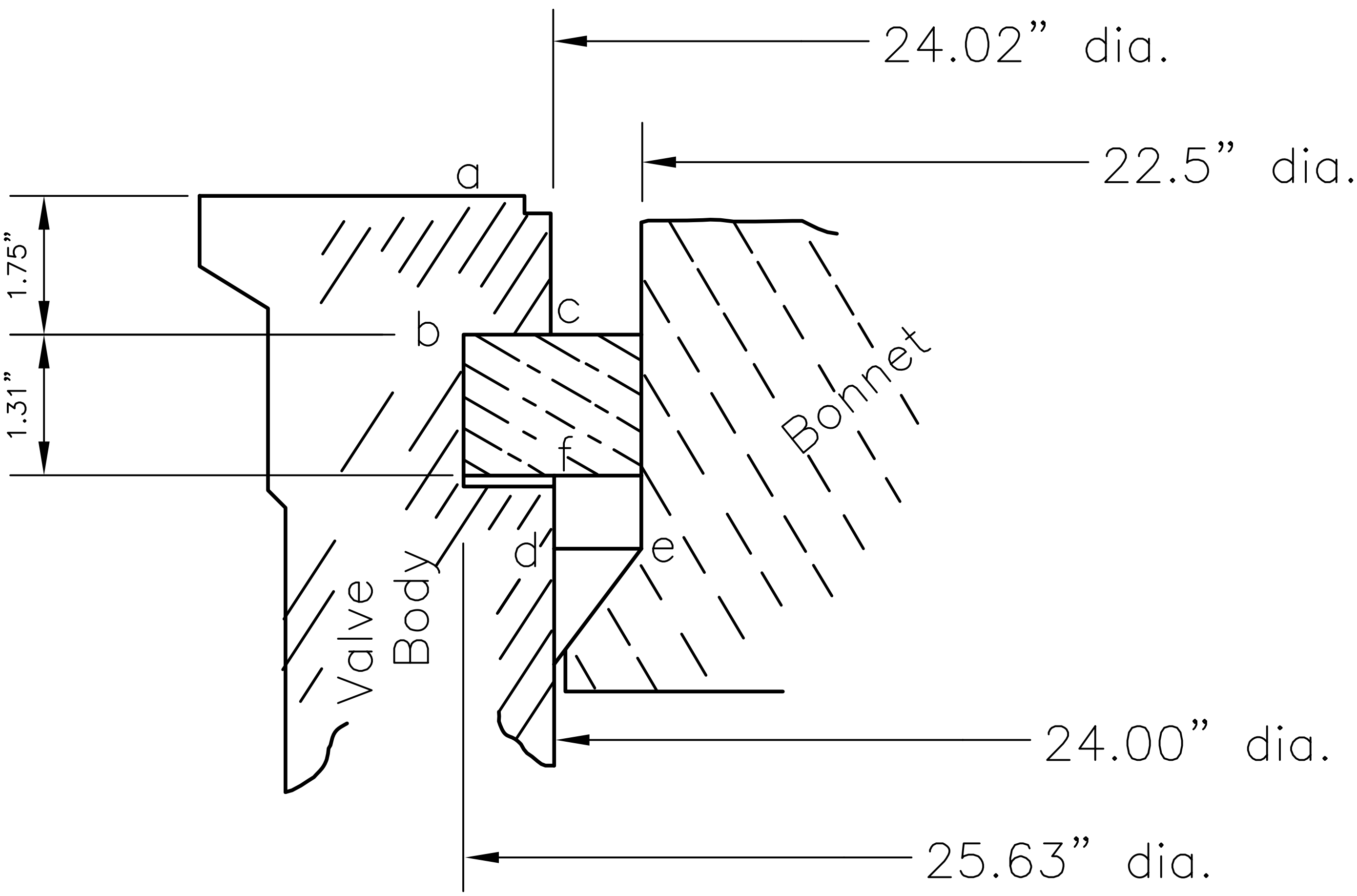
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

TYPICAL 900#
BONNET SEAL
TYPE VALVE

FIGURE 3.5-9, Rev. 47

Auto-Cad Figure Fsar 3_5_9.dwg



FSAR REV.65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

RETAINING RING DESIGN
FOR 900# BONNET-
SEAL TYPE VALVE

FIGURE 3.5-10, Rev. 47

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