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SUBJECT: Forwards draft response to NRC Question 130.050 (turbine missile study) & revised FSAR pages.All encl info will be incorporated into Amend 23.

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January 13, 1982
G02-82-33
SS-L-02-CDT-82-013

Docket No. 50-397

Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Schwencer:

Subject: NUCLEAR PROJECT NO. 2
NRC QUESTION 130.050
TURBINE MISSILE STUDY

Enclosed are sixty (60) copies of the draft response to NRC Question 130.050 and revised WNP-2 FSAR pages. This response shows the results of the turbine missile study for WNP-2.

All enclosed information will be incorporated into the WNP-2 FSAR in Amendment 23.

Very truly yours,

G. D. Bouchey, Deputy Director
Safety & Security

CDT/jca
Enclosures

cc: R Auluck - NRC
WS Chin - BPA
R Feil - NRC Site

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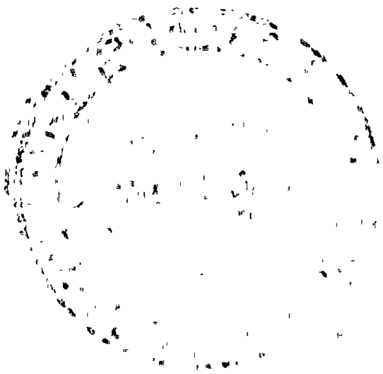


Q. 130.050
(Q220.001)
(3.5.1)

You state in Section 3.5.1.3 of the FSAR that the reorientation of the turbine generator building to limit potential missile strike is not considered. Rather, the barrier capability of the massive radiation shielding structures, characteristic of BWRs, is utilized to control postulated turbine missile hazards, and probability studies provide the assurance that the chance of missile strike is remote.

Describe your probability studies with emphasis on the chance of turbine missile strike and penetration of the structural barrier. If in your analysis the value of P3 is assumed as 1.0, please so indicate.

Response:

WNP-2 has completed a turbine missile study consisting of a probabilistic approach to missile strikes and damage.*

*Revised FSAR page changes attached.

3.5.1.3 Turbine Missiles

The orientation of the turbine generator building with respect to other structures was established prior to the promulgation of Regulatory Guide 1.115, Rev. 0, (Reference 3.5-5). Consequently, the reorientation of the turbine generator building to limit potential missile strike is not considered. Rather, the barrier capability of the massive radiation shielding structures, characteristic of BWR's, is utilized to control postulated turbine missile hazards, and probability studies provide the assurance that the chance of missile strike is remote.

3.5.1.3.1 Turbine Placement and Orientation

Figure 3.5-33 delineates the turbine-generator layout relative to safety related plant structures and turbine missile target areas. The probable missile ejection zones, ± 25 degrees to the horizontal plane of the end turbine disks, are clearly shown. An elevation view is included in Figure 3.5-34 to further portray target zones.

3.5.1.3.2 Missile Identification and Characteristics

Turbine missiles are postulated to originate from low pressure turbines of Westinghouse design at 193% catastrophic overspeed. Westinghouse (Reference 3.5-6) concludes that the high pressure turbine does not generate missiles. Due to a large margin between the high pressure spindle bursting speed and the maximum speed at which the steam can drive the unit with all the admission valves fully open, the probability of spindle failure is practically zero. The minimum bursting speed of the high speed rotor, based on minimum specified mechanical properties of the rotor material, is 300% of the rated speed. The maximum speed to which the unit may accelerate is 193% of rated speed. At this speed the highest stressed low pressure turbine disc will fracture. The fracture fragments will, upon failure, damage the turbine to the extent that additional overspeed will not be possible (Reference 3.5-6).

Replace with attached

The characteristic properties of these missile segments are pictured in Figure 3.5-35. The mass, shape, cross-sectional area, and ranged turbine exit speeds are presented in Table 3.5-3. These specifications, in conjunction with the mathematical models and experimental tests used in the selection of missiles, are treated in a Westinghouse document covering the effects of a high pressure turbine rotor fracture and low pressure turbine disc fractures at design and catastrophic overspeed (Reference 3.5-6).

3.5.1.3.3 Low Trajectory Missiles

In the design of a BWR station, an extensive amount of reinforced concrete is used for radiation shielding. As well as providing a biological shield, this concrete provides structural barriers for essential systems against postulated low trajectory missiles.

Table 3.5-4 summarizes the cumulative concrete barriers separating critical shutdown systems from postulated turbine missiles.

The criteria used in determining turbine missile energies is contained in the 1978 Westinghouse report (Reference 3.5-6).

The northernmost RHR heat exchanger is exposed to a possible turbine missile. This RHR unit is redundant to a more highly protected RHR heat exchanger on the southern side of the reactor building between elevations 548 feet and 606 feet. Furthermore, the missile trajectories necessary to impact the RHR heat exchangers are not directly in the plane of the turbine disks. Consequently, low trajectory turbine missiles cannot impair safe shutdown because the concrete barriers and the redundancy feature provide protection of the essential systems.

3.5.1.3.4 High Trajectory Missiles

A probabalistic approach is adopted in order to assess the possibility of damage to systems required for safe shutdown or of accidents which could result in potential offsite exposure due to high trajectory missiles. The probability of this occurring is represented by combined probabilities of:

$P_4 = P_1 \cdot P_2 \cdot P_3$

where:

P_1 = turbine failure probability

P_2 = probability of a missile striking a structure or component required for safe shutdown or whose failure could result in release of radioactivity

P_3 = significant damage to the structure or component probability

P_4 = combined overall probability

The terms and assumptions applicable to this analysis follow the procedures outlined by S. H. Bush in the report "Probability of Damage to Nuclear Components due to Turbine Failure", November 1972 (Reference 3.5-7).

a. Turbine failure probability is directly related to proprietary design, fabrication, inspection, and testing specifications (3.5.1.3.6, 3.5.1.3.7). The above procedures for Westinghouse are superior to those utilized on a total sample of turbines encompassing all manufacturers since the inception of the nuclear age. Failure probablities based on all turbogenerating facilities do not adequately portray the Westinghouse turbines in WNP-2. The most representative data pertaining to turbine failure is derived from plant operating experience with Westinghouse turbines. The cited Westinghouse reports indicate the turbine failure probabilities, P_1, when the turbine is equipped with analog or digital electrohydraulic control systems, to be 1.6×10^{-10}/unit/year for design overspeed and 1.7×10^{-6}/unit/year for destructive overspeed (Reference 3.5-15).

b. The probability of structural penetration and resultant damage to critical components upon impact, P_3, is assumed to equal 1 since less than 3 feet of structural materials shield targets from high trajectory missiles (Reference 3.5-7).

3.5.1.3 Turbine Missiles

Regulatory Guide 1.115 (Reference 3.5-5), initially issued in 1976, required applicants for construction permits and operating licenses to demonstrate an acceptably low probability of damage to essential systems from postulated turbine missiles, either through appropriate placement and orientation of the turbine, or by use of structural barriers. Subsequently, a study was performed by Burns and Roe, Incorporated for the WNP-2 plant which concluded that the radiation shielding walls on the operating floor in the turbine building, and the reinforced concrete walls housing essential systems in the reactor building and control building, provide adequate protection against postulated turbine missiles.

In December 1979, the Washington Public Power Supply System (Reference 3.5-24) and other utilities were advised by the NRC of a potential problem concerning cracking in low pressure turbine discs manufactured by Westinghouse. In February 1980, a disc on the Westinghouse low pressure turbine at the Yankee Rowe plant failed, and although none of the disc fragments penetrated the turbine shell, there was extensive damage to the turbine. Investigations by Westinghouse at various operating plants has indicated the observed cracking in Westinghouse turbines can be attributed to a stress-corrosion mechanism.

To account for this potential failure mechanism in turbine-missile probability calculations, Westinghouse developed a methodology for estimating the probabilities of disc rupture as a function of crack initiation, crack propogation with time, and critical crack depth (Reference 3.5-21). Using this methodology, Westinghouse provided a probability study, giving missile generation probabilities for each low pressure turbine disc on WNP-2, based on actual material properties of the disc, as a function of turbine operating time between inservice inspections. Probabilities are also calculated for missile formation due to fatigue failure, but this failure mode is shown to be much less likely than failure due to stress corrosion cracking.

Using the missile generation probabilities (Reference 3.5-23) and missile weights, velocities, and geometries (Reference 3.5-22) provided by Westinghouse, missile strike and damage probabilities for safety-related targets in the WNP-2 plant were calculated. It is concluded that the probability of damage to safety-related systems is acceptably low, due to: (a) the protection provided by reinforced concrete structural barriers, and (b) periodic inspections of turbine discs during refueling outages to detect and monitor cracks, with associated corrective action as required.

3.5.1.3.1 Safety-Related Targets

Target areas which are evaluated for capability to protect safety-related equipment, components, and systems from postulated turbine missiles consist of the following:

a. Vertical Targets

1. reactor building north exterior wall
2. control room north wall
3. north wall of vertical cable chase, between reactor building and control room.

b. Horizontal Targets

1. reactor building refueling floor
2. roof over vertical cable chase
3. floor slab above control room

3.5.1.3.2 Turbine Placement and Orientation

Figure 3.5-33 shows the turbine generator layout relative to safety-related plant structures and turbine missile target areas. Also shown on this drawing is the reinforced concrete shield wall which acts as a barrier for protection of some safety-related targets from postulated low trajectory turbine missiles. A cross-sectional view through the turbine building and reactor building is shown in Figure 3.5-34 to indicate relative elevations of the turbine and target areas. See Figure 1.2-5 for a general arrangement drawing of the turbine building, reactor building, and control building at the turbine operating floor elevation.

3.5.1.3.3 Missile Identification and Characteristics

Postulated missiles from the high pressure turbine are shown, in Reference 3.5-22, to have insufficient energy to penetrate the casing at normal operating speed. At 20% overspeed (120% of normal, or rated speed), high pressure turbine missiles are postulated to penetrate the casing, but at velocities too low to reach safety-related targets. The minimum bursting speed of the high pressure turbine rotor, based on minimum specified mechanical properties of the rotor material, is 300% of the rated speed.

The maximum speed at which the unit may rotate is 193% of rated speed. At this speed the highest stressed low pressure turbine disc would fracture, damaging the turbine to the extent that additional overspeed would not be possible (Reference

exposure due to high trajectory missiles. The probability of this occurring is represented by combined probabilities of:

$$P_4 = P_1 \cdot P_2 \cdot P_3$$

where:

P_1 = missile generation probability

P_2 = probability of a missile striking a structure or component required for safe shutdown or whose failure could result in release of radioactivity

P_3 = probability of significant damage to the structure or component

P_4 = combined overall probability

The terms and assumptions applicable to this analysis follow the procedures outlined by S. H. Bush in the report, "Probability of Damage to Nuclear Components due to Turbine Failure", November 1972 (Reference 3.5-7).

3.5.1.3.4.1 Missile Generation Probability (P_1)

The probability of a low pressure turbine disc, or associated blade ring fragment becoming a missile following disc rupture and penetration of the turbine casing is provided by Westinghouse in Reference 3.5-23. P_1 probabilities are given for each disc on each low pressure turbine, as a function of inspection interval (i.e., turbine operating time between inspections for cracks), for stress corrosion cracking. In the analysis which produced these P_1 values, it is assumed that a crack initiates at the beginning of service life or immediately after an in-service inspection during a refueling outage. For a given disc, the probability of rupture due to stress corrosion is the probability that there exists a crack in the disc bore whose depth is equal to or greater than a calculated critical crack depth. The critical crack depth is calculated using standard fracture mechanics methodology, and is based on actual material properties for the disc, and normal operating temperatures for the turbine. Data from field inspections are used to estimate the probability of the existence of cracks in the various disc types, and crack growth rates. Using appropriate probability distributions for crack growth rates and critical crack depth, a numerical analysis technique is used to calculate the probability of disc rupture. This value is a function of

3.5-6). Therefore, high pressure turbine missiles are not considered.

Postulated low pressure turbine missiles are assumed to result from either fatigue failure or stress corrosion cracking. The probability of fatigue failure resulting in missile generation is several orders of magnitude lower than the probability of stress corrosion failure, at either rated speed or 20% overspeed. Therefore, only missile generation probabilities associated with stress-corrosion cracking are used to determine strike and damage probabilities.

Each low pressure turbine consists of a double flow rotor assembly, an outer cylinder, two inner cylinders, and blade rings. The rotor assembly consists of a shaft with ten shrunk-on discs made of low alloy steel and two shrunk-on couplings. Missiles from discs and blade ring fragments are assumed to occur in either 90° or 120° segments. The geometry, weights, and exit velocities of the postulated missiles are provided by Westinghouse, for both 90° and 120° segments at rated speed, 20% overspeed, and destructive overspeed conditions. In the strike and damage probability assessment, the destructive overspeed condition is not considered because of the reliability of the turbine overspeed protection system, described in 3.5.1.3.5 and 10.2.

Strike and damage probabilities for the 20% overspeed condition were calculated, and shown to be substantially less than strike and damage probabilities at the rated speed condition, due to the significantly lower missile generation probabilities at 20% overspeed. Calculated turbine missile damage probability for the WNP-2 plant is therefore based only on the rated speed condition, since this introduces no significant error and simplifies the computation. Strike and damage probabilities for both the 90° segments and 120° segments were calculated, for both horizontal and vertical targets. It was shown that strike and damage probabilities are maximized using 90° segments for vertical targets and 120° segments for horizontal targets. This is because the horizontal targets at WNP-2 are more likely to be hit, up to a point, by lower velocity missiles, and the 120° segments have lower exit velocities than the 90° segments. This assumption was therefore incorporated into the analysis for conservatism, and to simplify the computation.

3.5.1.3.4 Strike and Damage Probability

A probabilistic approach is adopted in order to assess the possibility of damage to systems required for safe shutdown or of accidents which could result in potential offsite

$$\Delta\phi = \frac{g}{V2} \cdot \text{Sec}\,\Psi \cdot \Delta X \bigg/ \left(1 - 2\,\text{Sin}^2\phi' \pm \left(\left(\tan^2\phi' - \frac{2gz}{v^2}\cdot \text{Sec}^2\phi'\right)^{-\frac{1}{2}} \cdot \right.\right.$$

$$\left.\left.\tan\phi' \cdot \left(1 - \frac{2gz}{v^2}\right) - 2\,\text{Sin}\,\phi' \cdot \text{Cos}\,\phi' \cdot \left(\tan^2\phi' - \frac{2gz}{v^2} \cdot \text{Sec}^2\phi'\right)^{\frac{1}{2}}\right)\right)$$

$$\Delta\Psi = \frac{\Delta Y \cdot \text{Cos}\phi'}{R}$$

Where:

ϕ = vertical component of the ejection angle

ψ = horizontal component of the ejection angle

$\Delta\phi$ = variation in ϕ

$\Delta\psi$ = variation in ψ

R = horizontal distance from turbine disc to target element

X = distance from turbine centerline to target element

v = missile exit velocity

g = acceleration of gravity

z = elevation of target element centerline

Δ z = height of target element (vertical targets)

Δ Y = width of target element (horizontal or vertical targets)

Δ x = length of target element (horizontal targets)

$\phi' = \tan^{-1}\left(\tan\phi \cdot \frac{X}{R}\right)$

The probability distributions for both the horizontal and vertical components of the ejection angle are assumed to be uniform over the range of possible values. For the horizontal

the inspection interval during which it is assumed a crack initiates and propogates. Energy absorption techniques are used to evaluate whether a given disc or fragment is contained within the turbine casing upon rupture, or if it penetrates, what the exit velocity is.

3.5.1.3.4.2 Strike Probability (P_2)

The target areas are divided into target elements. For targets within the range of the postulated turbine missile there are two possible trajectories to the midpoint of each target element - a high trajectory and a low trajectory. Even though Regulatory Guide 1.115 states that high-trajectory turbine missiles may be neglected, they are included in the strike and damage probability calculation for WNP-2 since they were found to contribute significantly to the final result.

For a given missile velocity, as provided by Westinghouse in Reference 3.5-22 for each disc and blade ring fragment, the horizontal and vertical components of the ejection angle are computed for each trajectory. Because the target elements are 2-dimensional, there can be some variation in the horizontal and vertical components of the ejection angle. These variations can be expressed in terms of the dimensions of the target elements. Both the components of the ejection angle and their variations can then be expressed in terms of known missile and target element parameters, as follows:

Vertical Targets

$$\phi = \tan^{-1}\left(\frac{R}{X}\cdot\left(\frac{V^2}{Rg} \pm \left(\left(\frac{V^2}{Rg}\right)^2 - \left(1 + \frac{2V^2Z}{R^2g}\right)\right)^{\frac{1}{2}}\right)\right)$$

$$\Psi = \tan^{-1}\left(\frac{\left(R^2-X^2\right)^{\frac{1}{2}}}{X}\cdot \text{Cos}\ \phi\right)$$

$$\Delta\phi = \frac{\frac{V^2}{R^2g}\cdot\left(\left(\frac{V^2}{Rg}\right)^2 - \left(1 + \frac{2V^2Z}{R^2g}\right)\right)^{-\frac{1}{2}}\cdot \Delta Z}{\frac{X}{R} + \frac{R}{X}\cdot\left(\frac{V^2}{Rg} \pm \left(\left(\frac{V^2}{Rg}\right)^2 - \left(1 + \frac{2V^2Z}{R^2g}\right)\right)^{\frac{1}{2}}\right)^2}$$

$$\Delta\Psi = \text{Cos}\ \phi' \cdot \frac{X}{R^2}\cdot\Delta Y$$

Horizontal Targets

ϕ = (same as for vertical targets)

Ψ = (same as for vertical targets)

component, the assumed range is from +5° to -5° measured from the perpendicular to the turbine axis for interior discs and blade ring fragments, and from +5° to +25°, or -5° to -25° for the end discs and fragments on each low pressure turbine. For the vertical component of the ejection angle, the assumed range is 120° for a 120° segment, and 90° for a 90° segment (i.e., uniform probability distribution over a full 360° of arc, for each of three 120° segments, or each of four 90° segments, per disc). The strike probability for target element i and missile j is:

$$P1_j \cdot P2_{ij} = [P(\phi)\cdot\Delta\phi\cdot P(\psi)\cdot\Delta\psi]_{\text{low trajectory}}$$

$$+ [P(\phi)\cdot\Delta\phi\cdot P(\psi)\cdot\Delta\psi]_{\text{high trajectory}}$$

where:

$P(\phi)$ = probability of ϕ, per unit angle

$P(\psi)$ = probability of ψ, per unit angle

The overall strike probability for M missiles and N targets is:

$$P1\cdot P2 = 1 - \prod_{i=1,j=1}^{N,M} (1 - P1_j \cdot P2_{ij})$$

Since $P1_j \cdot P2_{ij}$ is small, the above expression can be approximated by:

$$P1\cdot P2 = \sum_{i=1}^{N} \sum_{j=1}^{M} P1_j \cdot P2_{ij}$$

3.5.1.3.4.3 Damage Probability (P_3)

For reinforced concrete targets housing safety-related equipment, the damage probability is conservatively assumed to be 1 if backface scabbing or spalling occurs. This is conservative because concrete fragments will not necessarily strike safety-related components, nor have sufficient energy to disable safety-related components they may happen to strike, and redundancy in components and systems will normally ensure safe shutdown even if a struck component were to be disabled. In addition, in this analysis the worst possible orientation of the missile upon impact with the target is conservatively assumed. If backface scabbing does not occur, P3 is assumed to be 0. Backface scabbing

is calculated to occur using the modified NDRC formula (Reference 3.5-25). For some target elements the postulated missile must pass through a reinforced concrete barrier before it strikes a target element. For such missile/barrier interactions the modified NDRC formula is used to calculate whether or not perforation occurs, and if so, the residual velocity of the missile using the formula:

$$V_r = (V_i^2 - V_p^2)^{1/2}$$

where:

V_r = residual missile velocity after perforation

V_i = incident missile velocity

V_p = incident missile velocity required to just perforate the barrier, calculated using the modified NDRC formula

Any turbine missile striking the Northwest corner of the reactor building refueling floor is assumed to land directly in or bounce into the spent fuel pool. This is unacceptable from the standpoint of damage to stored fuel and resulting radiologic release, so P_3 is assumed to be 1 for any such strike.

The overall damage probability for M postulated missiles and N target elements is then calculated by:

$$P4 = P1 \cdot P2 \cdot P3 = \sum_{i=1}^{N} \sum_{j=1}^{M} P1_j \cdot P2_{ij} \cdot P3_{ij}$$

This computation is carried out by computer, and the results, i.e., damage probability as a function of inservice inspection interval (quantified in terms of turbine operating time), are shown on Figure 3.5-53. Inservice inspections for crack detection and monitoring of crack propogation will be performed during refueling outages at a frequency corresponding to an acceptably low turbine missile damage probability or, alternatively, at a frequency corresponding to an upper limit on postulated crack depth, using fracture mechanics methodology to postulate crack growth rates and critical crack size. Inspection frequency will be established following NRC review of Westinghouse topical reports on this matter, prepared on behalf of the Westinghouse Turbine Owners' Group.

c. The geometric strike probability, P_2, is a significant factor. Several parameters can significantly lower this strike probability. The worst case which can be expected is as large as $P_2 = 10^{-1}$ (Reference 3.5-7).

1) P_2 will be reduced when the turbine discs are not directly aligned to safety related components. If the angle of incidence, α, is greater than 10° between the plane of the disc and the structure or component, the probability of strike is reduced to at least 10^{-2}.

2) The target size (e.g., fuel pool, RHR heat exchanger, radwaste and control room, diesel generators, cable spreading room) is influential in quantifying P_2. By definition, the ratio of the total target area to the overall postulated missile impact area determines P_2 (Reference 3.5-7).

Based on destructive overspeed values for $P_1 = 1.7 \times 10^{-6}$, $P_2 = 10^{-1}$ (worst case), and $P_3 = 1$, the total cumulative probability, P^4, is approximately 10^{-7}. This approach represents a conservative lower bound for the probability of damage to safety related systems subjected to postulated high trajectory missiles. As such, high trajectory missiles do not constitute a hazard.

3.5.1.3.5 Turbine Overspeed Protection System

A single failure in the overspeed sensing and turbine trip systems will not prevent overspeed protection from operating. The turbine generator is equipped with a digital electo-hydraulic control system. The turbine control system includes steam admission valves, emergency stop valves, crossover intercept valves, and initial pressure regulator. Further description of existing systems are available in 10.2.

3.5-11 Regulatory Guide 1.14, Rev. 1, "Reactor Coolant Pump Flywheel Integrity", August 1975.

3.5-12 Miller, D. R. and Williams, W. A., Tornado Protection for the Spent Fuel Pool, General Electric Company, APED-5696, November 1968.

3.5-13 "Protection Against Pipe Breaks Outside Containment", Burns and Roe, Inc., Hempstead, New York, Report No. WPPSS-74-2-R3, April, 1974.

3.5-14 "A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects" R.P. Kennedy, Nuclear and Systems Sciences Group, Holmes and Narver, Inc., September 1975.

3.5-15 "Analysis of the Probability of the Generation and Strike of Missiles from a Nuclear Turbine" March, 1974 by Westinghouse Electric Corporation Steam Turbine Division Engineering.

3.5-16 NUREG-75/087, USNRC Standard Review Plan, Section 3.5.1.6, November 1975.

3.5-17 Oldfield, G. V., WPPSS, personal communication with Lou Rosgen, Control Tower Chief, Tri-Cities Airport, Federal Aviation Administration, January 14, 1980.

3.5-18 Oldfield, G. V., WPPSS, personal communication with Bill Granston, Area Specialist, Seattle Air Route Traffic Control Center, Federal Aviation Administration, January 15, 1980.

3.5-19 Seattle Sectional Aeronautical Chart, 18th Edition, U.S. Department of Commerce, NOAA, Washington, D. C., January 24, 1980.

3.5-20 "List of Accidents Showing Impact Severity and Angle in Third Display, U. S. Civil Aviation, 1978", National Transportation Safety Board, Washington, D.C.

Insert attached

Insert to Page 3.5-27:

3.5-21 "Methodology for Calculating the Probability of a Missile Generation from Rupture of a Low Pressure Turbine Disc", Westinghouse Electric Corporation, CT-24076, Revision 1, July 1980.

3.5-22 "Turbine Missile Report (HP296-LP281-LP281-LP-281)", Westinghouse Electric Corporation, CT-24869, Revision 0, December 1980.

3.5-23 "Turbine Missile Report, Results of Probability Analysis of Disc Rupture and Missile Generation", Westinghouse Electric Corporation, CT-24870, Revision 1, March 1981.

3.5-24 "Cracking in Low Pressure Turbine Discs", IE Information Notice No. 79-37, letter from R. H. Engelken, NRC, to N. O. Strand, Washington Public Power Supply System, dated December 28, 1979.

3.5-25 "Structural Analysis and Design of Nuclear Plant Facilities", Chapter 6 (Design Against Impulse and Impact Loads), ASCE Manuals and Reports on Engineering Practice No. 58, 1980.

TABLE 3.5-3

LOW PRESSURE

TURBINE MISSILE CHARACTERISTICS

	WEIGHT(LBS.)	EXIT VELOCITY (FT/SEC)	EXIT ENERGY (FT-LB) LARGEST FRAGMENT LEAVING HOUSING (10^6)
DISC 1	3521	277	4.2
DISC 2	3611	564	17.8
DISC 3	2741	449	8.6
DISC 4	2747	548	12.8
DISC 5	3683	653	24.4

This Table shows the over-all width and projected impact areas of any Disc Quadrant.

	A_1 (ft^2)	A_2 (ft^2)	A_3 (ft^2)	W(ft)	L(ft)
DISC 1	5.39	2.78	3.63	6.08	2.64
DISC 2	4.77	2.55	3.28	6.08	2.72
DISC 3	2.00	1.74	3.30	6.00	2.80
DISC 4	2.40	1.96	3.60	5.80	2.70
DISC 5	3.03	2.52	4.00	5.14	2.33

A_1: DISC RIM PROJECTED IMPACT AREA

A_2: DISC END PROJECTED IMPACT AREA

A_3: DISC HUB PROJECTED IMPACT AREA

W: MAX DIMENSION OF DISC QUADRANT

L: RADIAL DIMENSION OF DISC QUADRANT

WESTINGHOUSE[6], 1975

REFER TO FIGURE 3.5-35

Deleted

Replace w/ the attached table

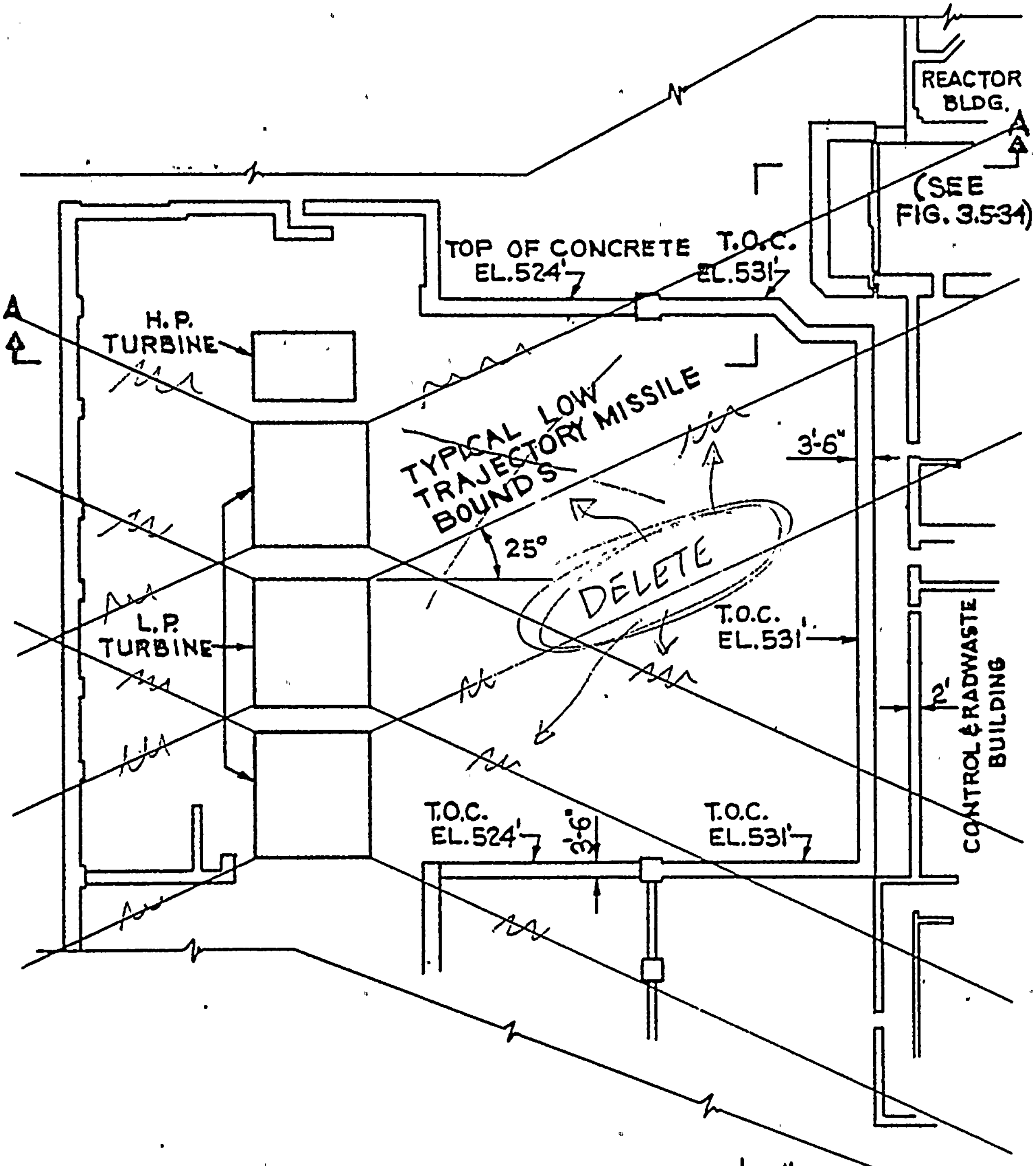
TABLE 3.5-4

MINIMUM VALUES OF WALL THICKNESSES

COMPONENT	MISSILE	WALLS	SLABS	OTHER	TOTAL IN FEET
PRESSURE VESSEL & ASSOCIATED DRYWELL PIPING	LTM	2'-3"+4+5			> 8
	HTM			Reactor Piping 6	6
RHR HEAT EXCHANGERS	LTM	2'-3"		1	3'-3"
	HTM	1.5			1.5
FUEL POOL	HTM	0	0	0	0
RADWASTE BUILDING	LTM	3.5+2			5'-5"
	HTM		2.5-6		2.5-6
CONTROL ROOM	LTM	3.5+2			5.5
STANDBY PUMP ROOMS	HTM		2		2

Note: LTM denotes low trajectory missile and HTM denotes high trajectory missile

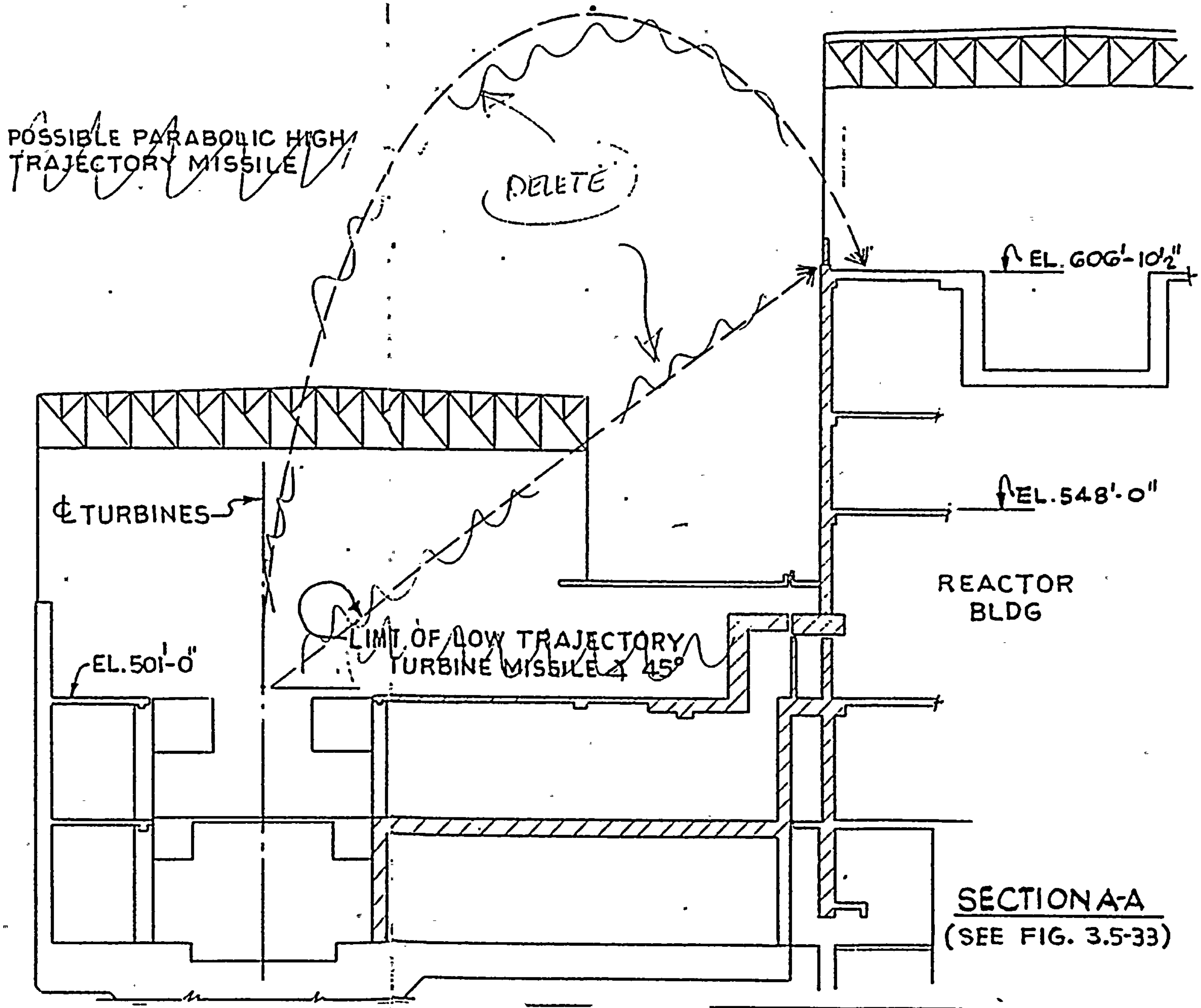
(Deleted)



OPERATING FLOOR PLAN AT EL. 501'-0"

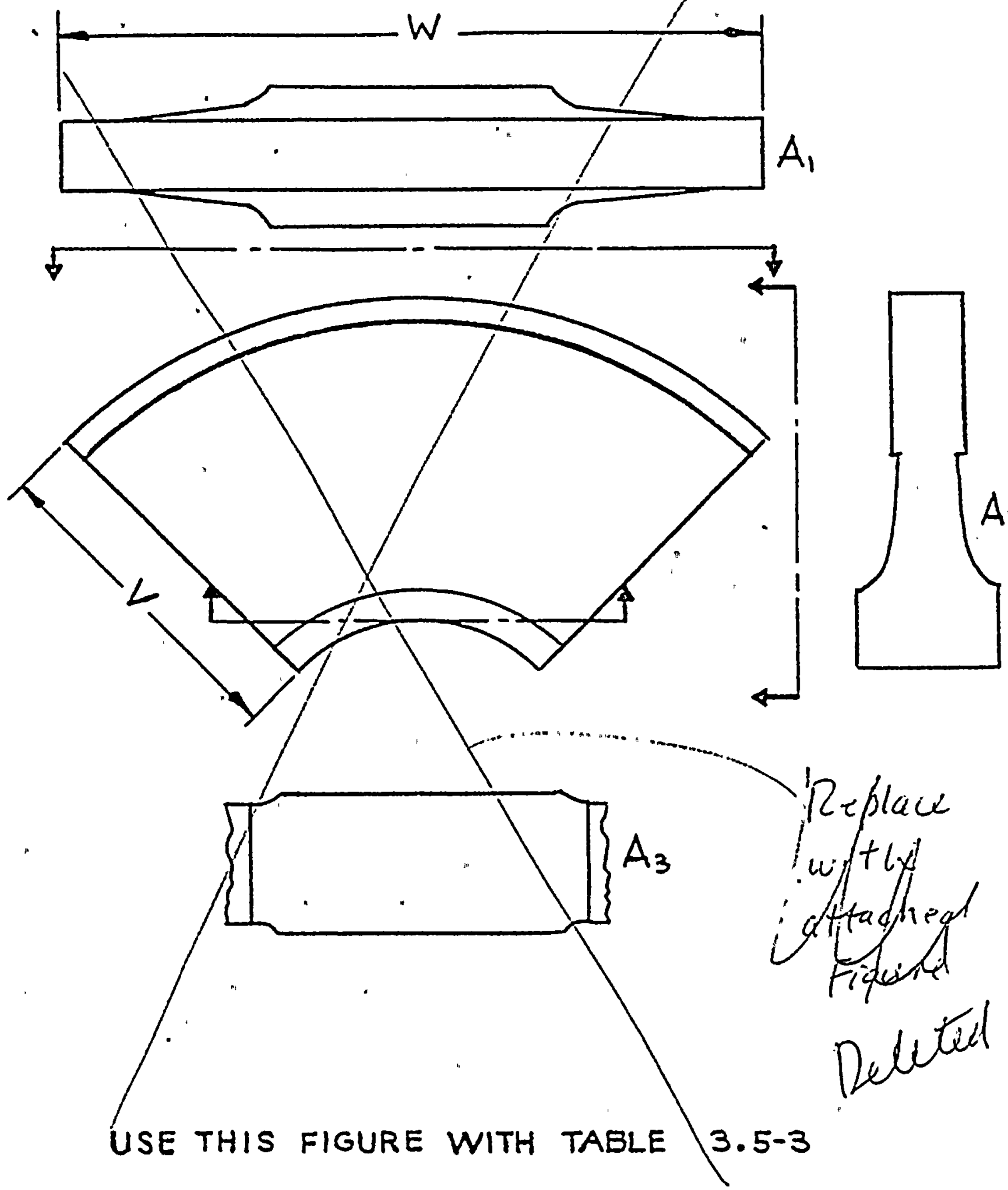
TURBINE GENERATOR PLACEMENT AND ORIENTATION

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	~~LOW TRAJECTORY MISSILES~~ ~~AT CATASTROPHIC FAILURE~~ ~~SPEEDS 181% DESIGN SPEED~~	FIGURE 3.5-33



TURBINE MISSILE TARGET LOCATION

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	~~TURBINE MISSILE BARRIERS~~	FIGURE 3.5-34



USE THIS FIGURE WITH TABLE 3.5-3

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	CHARACTERISTICS OF TURBINE GENERATOR MISSILES	FIGURE 3.5-35

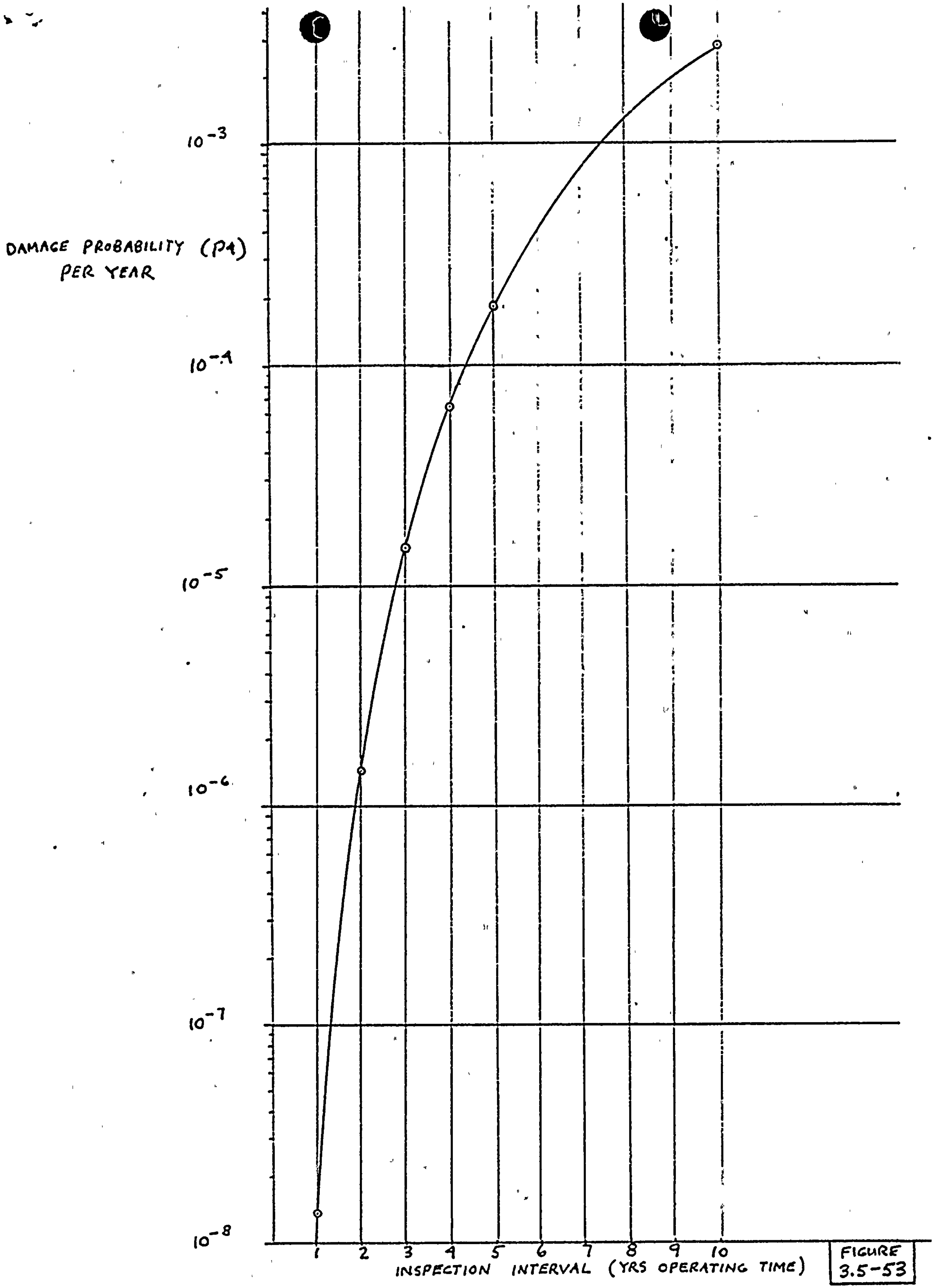

10^-3
10^-4
10^-5
10^-6
10^-7
10^-8
DAMAGE PROBABILITY (P4)
PER YEAR
1 2 3 4 5 6 7 8 9 10
INSPECTION INTERVAL (YRS OPERATING TIME)

FIGURE 3.5-53