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DOSE AND DOSE RISK CAUSED BY NATURAL PHENOMENA — PROPOSED POWDER METALLURGY CORE MANUFACTURING FACILITY

Project 85-SR-028

SUMMARY

The offsite radiological effects from high velocity straight winds, tornadoes, and earthquakes have been estimated for a proposed facility for manufacturing enriched uranium fuel cores by powder metallurgy techniques. Projected doses range up to 30 mrem/event to the maximum offsite individual for high winds and up to 85 mrem/event for very severe earthquakes. Even under conservative assumptions on meteorological conditions, the maximum offsite dose would be about 20% of the DOE limit for accidents involving enriched uranium storage facilities. The total dose risk is low (2×10^{-2} mrem/yr to the maximum individual and 9×10^{-3} man-rem/yr to the local population) and is dominated by the risk from earthquakes.

BACKGROUND

A new facility has been proposed for manufacturing enriched uranium fuel cores by powder metallurgy (PM) techniques. Specified amounts of U_3O_8 powders of various enrichments, which have been ground and sized to a controlled particle size distribution, will be blended with aluminum powder and compacted into a core whose dimensions will fit the aluminum components used for the existing fuel tube coextrusion process. Thus, the PM process will replace the current casting method of producing billet cores. Basic technical data and process requirements are given in Reference 1.

Structural specifications are not yet sufficiently developed to permit a detailed analysis of expected damage from severe natural phenomena. However, the PM facility is expected to be housed in a new building constructed to "high resistance" specifications.* The new building will be located in M Area just north of existing Building 321-M.

ASSESSMENT OF DAMAGE AND RADIOACTIVE RELEASE

In this study, a damage assessment for the powder metallurgy (PM) facility was made for three types of severe natural phenomena: high velocity straight winds, tornadoes, and earthquakes. In the assessment, the relative extent of building damage was estimated for each intensity level of each of the natural phenomena considered. Following the approach in Reference 2, the fractional release of radioactivity was assumed to be equal to the fractional extent of building damage. Separate assessments were made for the general building structure and for the storage vault.** Details of the methods used for assessing damage to the facility are given in Appendix A.

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* New buildings at SRP are constructed to one of three classifications of structural resistance to specified loads: Standard, High Resistance, and Maximum Resistance. High Resistance construction is designed to withstand application of expected gravity loads, wind loading from a 106 mph wind (100-year mean recurrence interval), and high seismic load ("Uniform Building Code" method of analysis as specified in DOE 6430).

** For example, the analysis indicates that structural damage to the powder metallurgy building will begin to occur at wind speeds of 106 mph and will increase as wind speed increases, approaching total damage at wind speeds greater than 280 mph. The storage vault is assumed to withstand a 280 mph wind; however, damage is projected to occur at higher wind speeds and complete destruction is assumed for wind speeds of 400 mph or greater.

The amount of uranium oxide in process or stored in the PM facility at any time will depend upon the amount of oralloy and recycled uranium that is being processed and the extent to which uranium has been recycled. The maximum inventory of ground U_3O_8 powder in process is assumed to be 40 kg (equivalent to eight cores). An additional 250 kg of ground U_3O_8 powder is assumed to be stored in the vault. Ten percent of the ground U_3O_8 powder is assumed to be respirable (i.e., less than 10 μm diameter).*

Typical isotopic blends selected to bound the range of uranium mixtures expected at startup of the PM facility and after continued recycling through the year 2000 were examined in this analysis.** In all blends, a conservative value of 1.5% was assumed for the isotopic concentration of U-234 because of the relatively high activity of this isotope. Because of this assumption, the radiological activity of the uranium oxide was essentially constant at 0.10 Ci/kg for the range of isotopic compositions considered.

The projected releases for different intensity categories of straight winds, tornadoes, and earthquakes are given in Tables 1, 2, and 3. These tables also show the probability of occurrence, in events per year of each intensity category.

RADIOLOGICAL EFFECTS

Estimated consequences to members of the public from radiological releases from the proposed PM facility following severe straight winds, tornadoes, and earthquakes were calculated by the methods of Reference 2 and are summarized in this section. In this document, dose refers to a 50-year dose commitment to the lung of the maximally exposed offsite individual or to the average individual in the local population (local population is defined as the population which receives greater than 95% of the dose from the first pass inhalation pathway).

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* The vault will contain unground U_3O_8 powder also, but this powder is assumed to contain no particles of respirable size.

** Isotopic compositions ranged as follows:

U-235	34-57%
U-236	28-47%
U-238	13-18%
U-234	1.5%

Straight Winds*

Projected doses (and dose risks) to the offsite public resulting from radiological releases associated with high velocity straight winds are given in Table 4. The doses and dose risks are based on releases and event probabilities shown in Table 1. The PM building is expected to withstand straight wind speeds up to 106 mph with no significant damage or release of contents. Particulate dispersion was estimated by multiplying the χ/Q value for the 108 mph wind given in Reference 2 by the inverse ratio of wind speeds.** Under these conditions, the maximum dose to an offsite individual from high velocity straight winds is 0.23 mrem/event and is associated with wind speeds of about 400 mph. The maximum population dose would be about 1.2 man-rem/event (Table 4).

Tornadoes

Projected offsite doses (and dose risks) from tornadoes ranging from 140 mph maximum wind speed to over 400 mph are given in Table 5. The powder metallurgy building is expected to withstand tornadic winds of less than 140 mph with no significant damage or release of contents. The doses and dose risks are based on releases and event probabilities given in Table 2. Particulate dispersion in tornadoes was estimated by the methods used in Reference 2 based on the work of Pepper.[3] Under these conditions, the maximum dose to an offsite individual from tornadoes is 30 mrem/event and is associated with tornadic wind speeds of about 400 mph (Fujita Scale F-7). The maximum population dose would be about 14 man-rem/event (Table 5).

Earthquakes

Projected offsite doses (and dose risks) from earthquakes ranging from a peak ground acceleration (PGA) of 0.045 gravity (g) to over 0.76 g are given in Table 6. The powder metallurgy building is expected to withstand earthquake intensities (PGA) up to 0.045 g with no significant damage or release of contents. The doses and dose risks are based on releases and event probabilities given in Table 3. Particulate dispersion was estimated assuming average meteorological conditions.† Under these conditions, the

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* In this area, high velocity straight winds are associated with severe thunderstorms.

** For example, $\chi/Q)180 \text{ mph} \simeq 1.6 \times 10^{-8} \text{ s/m}^3 \times \frac{108}{180} = 9.6 \times 10^{-9} \text{ s/m}^3$.

† Offsite doses for "accident" meteorological conditions (i.e., conditions not exceeded more than 5% of the time) would be greater by about a factor of 17 than doses shown in Table 6.

maximum dose to an offsite individual from earthquakes is 85 mrem/event and is associated with earthquakes of peak ground acceleration of 0.76 g (modified Mercalli Scale X) or greater. The maximum population dose would be about 42 man-rem/event.

Comparison of Calculated Doses with Exposure Limits

The maximum doses to an offsite member of the public calculated for releases from the proposed PM facility during severe natural phenomena are compared with limiting exposure guidelines in Table 7. As seen in this table, the SRP Technical Standard for release of radioactivity from SRP would be exceeded only for very severe earthquakes. Even under conservative meteorological conditions (see footnote to p. 6), the maximum offsite dose from an earthquake would be a small fraction (20%) of the DOE limits for accidents involving enriched uranium storage facilities.

Offsite Dose Risk Summary

Dose risk, the product of dose consequence per event and probability of an event, was calculated for each intensity level of the three types of natural phenomena considered. Summation of these dose risks gives an overall summary of the risk involved from severe natural phenomena (see Table 8). As shown in the table, the dose risk from earthquakes, though small (2×10^{-2} mrem/yr to the maximum individual and 9×10^{-3} man-rem/yr to the local population), greatly exceeds the dose risk from high velocity winds and dominates the overall risk. This is because the probability of severe earthquakes is greater by several orders of magnitude than equivalently damaging intensities of straight winds and tornadoes.

REFERENCES

1. Technical Data Summary, **Powder Metallurgy Billet Fabrication Facility.** DPSTD-82-70, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC (October 1982).

2. W. L. Marter and W. L. Poe. **Dose and Dose Risk Caused by Natural Phenomena — Proposed Process Control Laboratory.** DPST-82-341, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC (February 1982).

3. D. W. Pepper. **Dispersion of Radioactive Pollutant in a Tornadic Storm.** DP-1556, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC (May 1981).

TABLE 1

Straight Wind — Radioactivity Releases

Maximum Wind Speed mph	Probability Events/Year	Projected Release, Ci/Event		
		Process Area	Vault	Total
<106	–	0	0	0
106-120	1.5×10^{-3}	6.8×10^{-2}	0	6.8×10^{-2}
120-140	4.4×10^{-3}	3.3×10^{-1}	0	3.3×10^{-1}
140-160	7.6×10^{-5}	6.7×10^{-1}	0	6.7×10^{-1}
160-180	1.2×10^{-5}	1.1×10^{0}	0	1.1×10^{0}
180-200	1.9×10^{-6}	1.5×10^{0}	0	1.5×10^{0}
200-220	3.1×10^{-7}	2.0×10^{0}	0	2.0×10^{0}
220-240	4.5×10^{-8}	2.6×10^{0}	0	2.6×10^{0}
240-260	7.5×10^{-9}	3.1×10^{0}	0	3.1×10^{0}
260-280	1.3×10^{-9}	3.8×10^{0}	0	3.8×10^{0}
280-300	1.9×10^{-10}	4.1×10^{0}	1.9×10^{0}	6.0×10^{0}
300-320	3.2×10^{-11}	4.1×10^{0}	5.9×10^{0}	1.0×10^{1}
320-340	5.1×10^{-12}	4.1×10^{0}	1.0×10^{1}	1.4×10^{1}
340-360	8.2×10^{-13}	4.1×10^{0}	1.5×10^{1}	1.9×10^{1}
360-380	1.3×10^{-13}	4.1×10^{0}	1.9×10^{1}	2.3×10^{1}
380-395	1.7×10^{-14}	4.1×10^{0}	2.4×10^{1}	2.8×10^{1}
>395	5.8×10^{-15}	4.1×10^{0}	2.5×10^{1}	2.9×10^{1}

TABLE 2

Tornado — Radioactivity Releases

Maximum Wind Speed mph	Probability Events/Year	Projected Release, Ci/Event		
		Process Area	Vault	Total
<106	-	0	0	0
106-120	1.0×10^{-5}	0	0	0
120-140	9.0×10^{-6}	0	0	0
140-160	5.2×10^{-6}	2.2×10^{-1}	0	2.2×10^{-1}
160-180	2.6×10^{-6}	5.8×10^{-1}	0	5.8×10^{-1}
180-200	1.5×10^{-6}	9.0×10^{-1}	0	9.0×10^{-1}
200-220	6.5×10^{-7}	1.4×10^{0}	0	1.4×10^{0}
220-240	3.2×10^{-7}	2.1×10^{0}	0	2.1×10^{0}
240-260	1.7×10^{-7}	2.6×10^{0}	0	2.6×10^{0}
260-280	9.0×10^{-8}	3.2×10^{0}	0	3.2×10^{0}
280-300	5.1×10^{-8}	3.8×10^{0}	1.9×10^{0}	5.7×10^{0}
300-320	2.8×10^{-8}	4.1×10^{0}	5.9×10^{0}	1.0×10^{1}
320-340	1.4×10^{-8}	4.1×10^{0}	1.0×10^{1}	1.4×10^{1}
340-360	8.0×10^{-9}	4.1×10^{0}	1.5×10^{1}	1.9×10^{1}
360-380	4.2×10^{-9}	4.1×10^{0}	1.9×10^{1}	2.3×10^{1}
380-395	1.8×10^{-9}	4.1×10^{0}	2.4×10^{1}	2.8×10^{1}
>395	3.0×10^{-9}	4.1×10^{0}	2.5×10^{1}	2.9×10^{1}

TABLE 3

Earthquake — Radioactivity Releases

Intensity* (g)	Probability Events/Year	Projected Release, Ci/Event: Process Area	Vault	Total
<0.045	-	0	0	0
0.045-0.096	1.1×10^{-2}	2.1×10^{-1}	0	2.1×10^{-1}
0.096-0.15	1.2×10^{-3}	6.4×10^{-1}	0	6.4×10^{-1}
0.15-0.20	3.0×10^{-4}	1.1×10^{0}	1.0×10^{0}	2.1×10^{0}
0.20-0.25	1.1×10^{-4}	1.5×10^{0}	3.1×10^{0}	4.6×10^{0}
0.25-0.31	6.6×10^{-5}	1.9×10^{0}	5.4×10^{0}	7.4×10^{0}
0.31-0.41	4.4×10^{-5}	2.6×10^{0}	8.8×10^{0}	1.1×10^{1}
0.41-0.54	2.0×10^{-5}	3.6×10^{0}	1.4×10^{1}	1.7×10^{1}
0.54-0.63	6.5×10^{-6}	4.1×10^{0}	1.8×10^{1}	2.2×10^{1}
0.63-0.76	5.0×10^{-6}	4.1×10^{0}	2.3×10^{1}	2.7×10^{1}
>0.76	8.0×10^{-6}	4.1×10^{0}	2.5×10^{1}	2.9×10^{1}

* Peak ground acceleration

TABLE 4

Straight Wind — Doses and Dose Risks to Public

Maximum Wind Speed mph	Offsite Dose: Maximum Individual mrem/event	Offsite Dose: Population man-rem/event	Dose Risk: Maximum Individual mrem/year: Incremental	Dose Risk: Maximum Individual mrem/year: Cumulative	Dose Risk: Population man-rem/year: Incremental	Dose Risk: Population man-rem/year: Cumulative
<106	0	0	0	0	0	0
106-120	0.0019	0.0094	2.8×10^{-6}	2.8×10^{-6}	1.4×10^{-5}	1.4×10^{-5}
120-140	0.0078	0.039	3.4×10^{-6}	6.2×10^{-6}	1.7×10^{-5}	3.1×10^{-5}
140-160	0.014	0.070	1.0×10^{-6}	7.3×10^{-6}	5.3×10^{-6}	3.6×10^{-5}
160-180	0.019	0.098	2.3×10^{-7}	7.5×10^{-6}	1.2×10^{-6}	3.8×10^{-5}
180-200	0.024	0.12	4.7×10^{-8}	7.6×10^{-6}	2.4×10^{-7}	3.8×10^{-5}
200-220	0.029	0.15	9.0×10^{-9}	7.6×10^{-6}	4.6×10^{-8}	3.8×10^{-5}
220-240	0.034	0.17	1.5×10^{-9}	7.6×10^{-6}	7.8×10^{-9}	3.8×10^{-5}
240-260	0.039	0.20	2.9×10^{-10}	7.6×10^{-6}	1.5×10^{-9}	3.8×10^{-5}
260-280	0.043	0.22	5.5×10^{-11}	7.6×10^{-6}	2.8×10^{-10}	3.8×10^{-5}
280-300	0.064	0.32	1.2×10^{-11}	7.6×10^{-6}	6.2×10^{-11}	3.8×10^{-5}
300-320	0.099	0.50	3.2×10^{-12}	7.6×10^{-6}	1.6×10^{-11}	3.8×10^{-5}
320-340	0.13	0.67	6.8×10^{-13}	7.6×10^{-6}	3.4×10^{-12}	3.8×10^{-5}
340-360	0.16	0.83	1.4×10^{-13}	7.6×10^{-6}	6.8×10^{-13}	3.8×10^{-5}
360-380	0.19	0.98	2.6×10^{-14}	7.6×10^{-6}	1.3×10^{-13}	3.8×10^{-5}
380-395	0.22	1.1	3.8×10^{-15}	7.6×10^{-6}	1.9×10^{-14}	3.8×10^{-5}
>395	<0.23	<1.2	$<1.3 \times 10^{-15}$	7.6×10^{-6}	6.8×10^{-15}	3.8×10^{-5}

TABLE 5

Tornado — Doses and Dose Risks to Public

Maximum Wind Speed mph	Offsite Dose: Maximum Individual mrem/event	Offsite Dose: Population man-rem/event	Dose Risk: Maximum Individual mrem/year Incremental	Dose Risk: Maximum Individual mrem/year Cumulative	Dose Risk: Population man-rem/year Incremental	Dose Risk: Population man-rem/year Cumulative
<106	0	0	0	0	0	0
106-120	0	0	0	0	0	0
120-140	0	0	0	0	0	0
140-160	1.7	0.65	9.0×10^{-6}	9.0×10^{-6}	3.4×10^{-6}	3.4×10^{-6}
160-180	3.3	1.3	8.6×10^{-6}	1.8×10^{-5}	3.4×10^{-6}	6.8×10^{-6}
180-200	4.0	1.6	5.9×10^{-6}	2.3×10^{-5}	2.4×10^{-6}	9.1×10^{-6}
200-220	5.3	2.2	3.4×10^{-6}	2.7×10^{-5}	1.4×10^{-6}	1.1×10^{-5}
220-240	6.3	2.6	2.0×10^{-6}	2.9×10^{-5}	8.3×10^{-7}	1.1×10^{-5}
240-260	6.8	2.8	1.1×10^{-6}	3.0×10^{-5}	4.8×10^{-7}	1.2×10^{-5}
260-280	7.2	3.0	6.5×10^{-7}	3.1×10^{-5}	2.7×10^{-7}	1.2×10^{-5}
280-300	11	4.7	5.8×10^{-7}	3.1×10^{-5}	2.4×10^{-7}	1.2×10^{-5}
300-320	14	7.2	3.8×10^{-7}	3.2×10^{-5}	2.0×10^{-7}	1.3×10^{-5}
320-340	18	9.1	2.5×10^{-7}	3.2×10^{-5}	1.3×10^{-7}	1.3×10^{-5}
340-360	22	11	1.8×10^{-7}	3.2×10^{-5}	8.5×10^{-8}	1.3×10^{-5}
360-380	26	12	1.1×10^{-7}	3.2×10^{-5}	5.0×10^{-8}	1.3×10^{-5}
380-395	29	13	5.3×10^{-8}	3.2×10^{-5}	2.3×10^{-8}	1.3×10^{-5}
>395	<30	<14	$<9.2 \times 10^{-8}$	3.2×10^{-5}	$<4.1 \times 10^{-8}$	1.3×10^{-5}

TABLE 6

Earthquake — Doses and Dose Risks to Public

Intensity* (g)	Offsite Dose: Maximum Individual mrem/event	Offsite Dose: Population man-rem/event	Dose Risk: Maximum Individual mrem/year Incremental	Dose Risk: Maximum Individual mrem/year Cumulative	Dose Risk: Population man-rem/year Incremental	Dose Risk: Population man-rem/year Cumulative
<0.045	0	0	0	0	0	0
0.045-0.096	0.61	0.30	6.8×10^{-3}	6.8×10^{-3}	3.3×10^{-3}	3.3×10^{-3}
0.096-0.15	1.8	0.91	2.3×10^{-3}	9.1×10^{-3}	1.1×10^{-3}	4.5×10^{-3}
0.15-0.20	6.0	3.0	1.8×10^{-3}	1.1×10^{-2}	8.9×10^{-4}	5.4×10^{-3}
0.20-0.25	13	6.4	1.4×10^{-3}	1.2×10^{-2}	7.1×10^{-4}	6.1×10^{-3}
0.25-0.31	21	10	1.4×10^{-3}	1.4×10^{-2}	6.8×10^{-4}	6.7×10^{-3}
0.31-0.41	32	16	1.4×10^{-3}	1.5×10^{-2}	7.0×10^{-4}	7.4×10^{-3}
0.41-0.54	48	24	9.9×10^{-4}	1.6×10^{-2}	4.9×10^{-4}	7.9×10^{-3}
0.54-0.63	63	31	4.1×10^{-4}	1.6×10^{-2}	2.0×10^{-4}	8.1×10^{-3}
0.63-0.76	76	37	3.8×10^{-4}	1.7×10^{-2}	1.9×10^{-4}	8.3×10^{-3}
>0.76	85	42	6.8×10^{-4}	1.8×10^{-2}	3.3×10^{-4}	8.6×10^{-3}

* Peak ground acceleration

TABLE 7

Comparison of Offsite Doses Calculated for Natural Phenomena-Related Releases From the Proposed PM Facility with Exposure Guidelines

Maximum Dose to Offsite Individual,[1] mrem/event			Established Limit/Guide Value
High Velocity Straight Wind	Tornado	Earthquake	
0.23	30	85[2]	7300 mrem/event[3] 30 mrem/yr[4]

1. Lung exposure.
2. Assuming average meteorological conditions; under more conservative "accident" conditions, the calculated dose is increased to about 1400 mrem.
3. Calculated from maximum permissible lung burden under accident conditions given in DOE 6430 (Ch. XXIII, "Unirradiated Enriched Uranium Storage Facilities"). If the lung burden is assumed to remain constant (no biological removal), the dose commitment increases to 15 rem.
4. SRP Technical Standard, DPSTS-RH-W-0.1.

TABLE 8

Offsite Dose Risk Summary

Event	Integrated Dose Risk: Maximum Individual mrem/yr	Population man-rem/yr
Straight wind	7.6×10^{-6}	3.8×10^{-5}
Tornado	3.2×10^{-5}	1.3×10^{-5}
Earthquake	1.8×10^{-2}	8.6×10^{-3}
Overall Risk	1.8×10^{-2}	8.7×10^{-3}

APPENDIX A

STRUCTURAL DAMAGE FROM NATURAL EVENTS

A. Building Construction

The proposed powder metallurgy (PM) facility will be housed in a new single story building about 60 x 120 feet in size located immediately north of existing Building 321-M. The PM building will be constructed to high resistance specifications (see footnote to p. 2). In addition to processing areas, service areas, and office space, the building will contain a storage vault for uranium oxide containers. The storage vault will meet requirements of DOE 6430 and be of sturdier construction than the PM building.

B. High Winds and Tornadoes

In this analysis, the approach followed in References 1 and 2 was used to estimate structural damage from high velocity winds. The description of damage that was developed for each Fujita scale category in Reference 3 was used to establish the family of curves shown in Figure A-1. The relationship between the word description for each tornado category and the extent of damage was arbitrarily established between no damage and total destruction. The wind force in Figure A-1 is the product of the vertical surface area of the structure being considered and the (spatially averaged) wind speed impinging on the structure, i.e., for tornadoes, the radial variation in wind speed is considered.

The proposed PM building will be designed to withstand a wind loading of 30 psf. From this point on the abscissa in Figure A-1, a line was drawn parallel to the "steel framed warehouse" curve to represent the relationship between wind force and wind damage for the PM building. Total destruction of the PM building is assumed to occur at a wind loading of 200 psf or from wind speeds of 280 mph or greater.*

As indicated in Section A the storage vault will be of sturdier construction than the PM building. The vault is assumed to have the same resistance to winds as do reinforced concrete warehouses shown in Figure A-1. Using this curve and the wind force-wind speed relationship, damage to the vault is expected to begin at wind speeds of about 280 mph and total damage is expected at a wind speed of about 400 mph.

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* The following equation (for calculating stagnation pressure) allows conversion from wind speed to wind force:

$$F = 0.00256\ V^2$$

where F = wind force, psf
V = wind speed, mph

Following the approach in Reference 1, activity releases from the PM facility processing area and the vault are assumed to be proportional to the extent of damage to building and vault, respectively. Projected releases of activity from each during straight winds and tornadoes are given in Tables 1 and 2 in the text.

C. Earthquakes

The family of curves developed in Reference 1 that represent earthquake damage for different structures was used in this analysis to estimate the resistance of the PM building and vault to such damage (see Figure A-2). The proposed PM building is assumed to be represented by the curve "moderately designed-constructed buildings" in the figure. The storage vault is assumed to have the same resistance as a reinforced concrete warehouse (curve for "well designed-constructed buildings" in Figure A-2). With these assumptions and the further assumption of proportionality between extent of damage and activity release, the releases of activity from the process area and the vault were projected as given in Table 3 (text).

REFERENCES FOR APPENDIX A

1. W. L. Marter and W. L. Poe. **Dose and Dose Risk Caused by Natural Phenomena — Proposed Process Control Laboratory.** DPST-82-341, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC (February 1982).

2. W. L. Poe. **Risk of Tornado Damage to Waste Solidification Facilities.** DPST-76-249, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC (March 1976).

3. T. T. Fujita. **Proposed Characterization of Tornadoes and Hurricanes by Area and Intensity.** SMRP (Satellite and Mesometeorology Research Project) Research Paper 91 (February 1971).

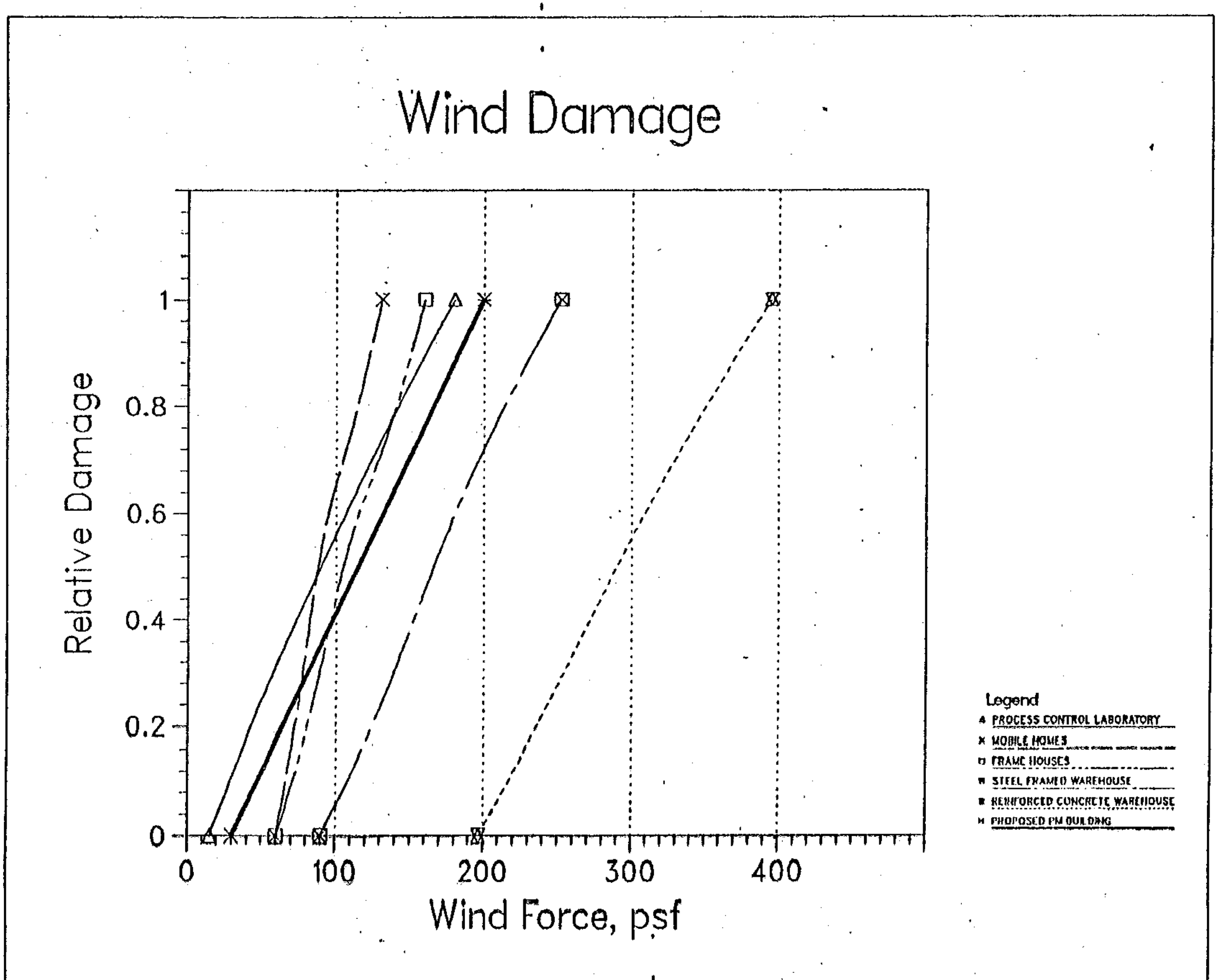

Figure A-1 Effect of Wind Force on Relative Damage to Different Structures

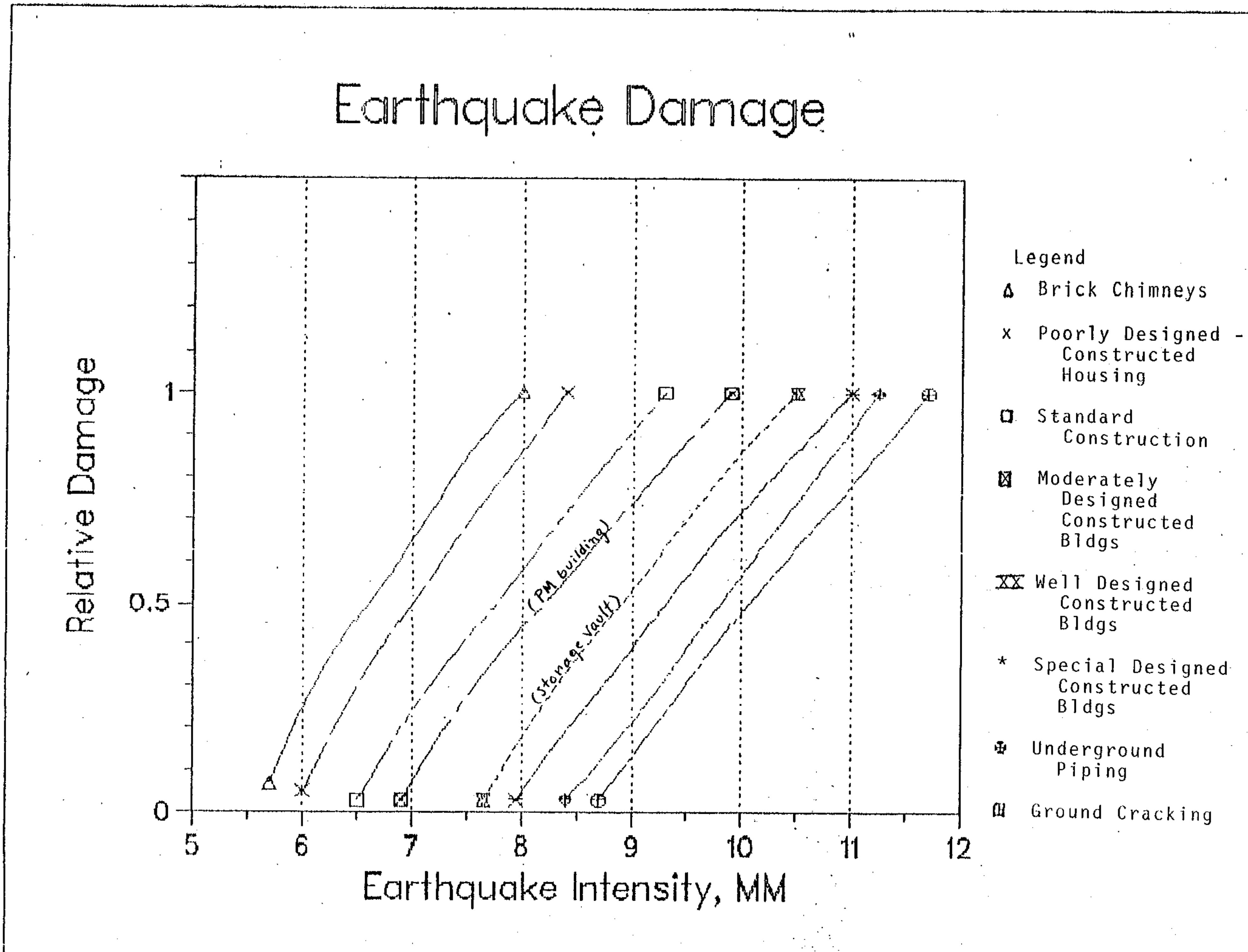

Figure A-2 Effect of Earthquake Intensity on Relative Damage to Different Structures

APPENDIX B

EXPECTED FREQUENCIES OF SEVERE NATURAL PHENOMENA AT SRP

A. High Winds and Tornadoes

McDonald[1] recently completed an analysis of high winds and tornadoes at SRP. High wind probabilities were based on measurements at the weather station in Augusta, GA for the years 1950 to 1978. Tornado probabilities were determined based on an analysis of tornado frequencies for the area around SRP for the years 1950 to 1978. The expected frequencies, determined from this study, of intense winds and tornadoes striking a point at SRP are shown in Figure B-1.

B. Earthquakes

A probabilistic analysis of expected earthquake frequencies at SRP was recently completed by URS/John A. Blume and Associates.[2] This analysis evaluated historic seismicity in three seismic source regions: the Atlantic Coastal Plain tectonic province, the Appalachian Mountains tectonic province, and the Charleston seismic zone. The probabilistic analysis determined the expected (long-term average) rate of equaling or exceeding any given level of peak ground acceleration (PGA) at SRP from earthquakes of all possible sizes and locations. The expected exceedance rate of peak ground accelerations at SRP from earthquakes, developed in this study, are shown in Figure B-2. In this figure, the range of PGA's evaluated in the Blume Study has been extended to higher accelerations based on information given in Reference 3. The abscissa in Figure B-2 also shows earthquake intensity as measured by the modified Mercalli Scale (MMI); PGA and MMI were correlated by the method of Murphy and O'Brien.[4]

REFERENCES FOR APPENDIX B

1. J. R. McDonald. **Assessment of Tornado and Straight Wind Risks at the Savannah River Plant Site, Aiken, South Carolina.** McDonald, Mehta, and Minor, Lubbock, TX (October 1982).

2. **Update of Seismic Criteria for the Savannah River Plant.** DPE 3699, Vol. 2, E. I. du Pont de Nemours & Co., Engineering Department, Wilmington, Delaware (September 1982).

3. W. L. Marter and W. L. Poe. **Dose and Dose Risk Caused by Natural Phenomena — Proposed Process Control Laboratory.** DPST-82-341, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC (February 1982).

4. J. R. Murphy and L. J. O'Brien. **The Correlation of Peak Ground Acceleration Amplitude with Seismic Intensity and Other Physical Parameters:** Bulletin of the Seismological Society of America, v. 67, No. 3, p9. 877-915 (1977).

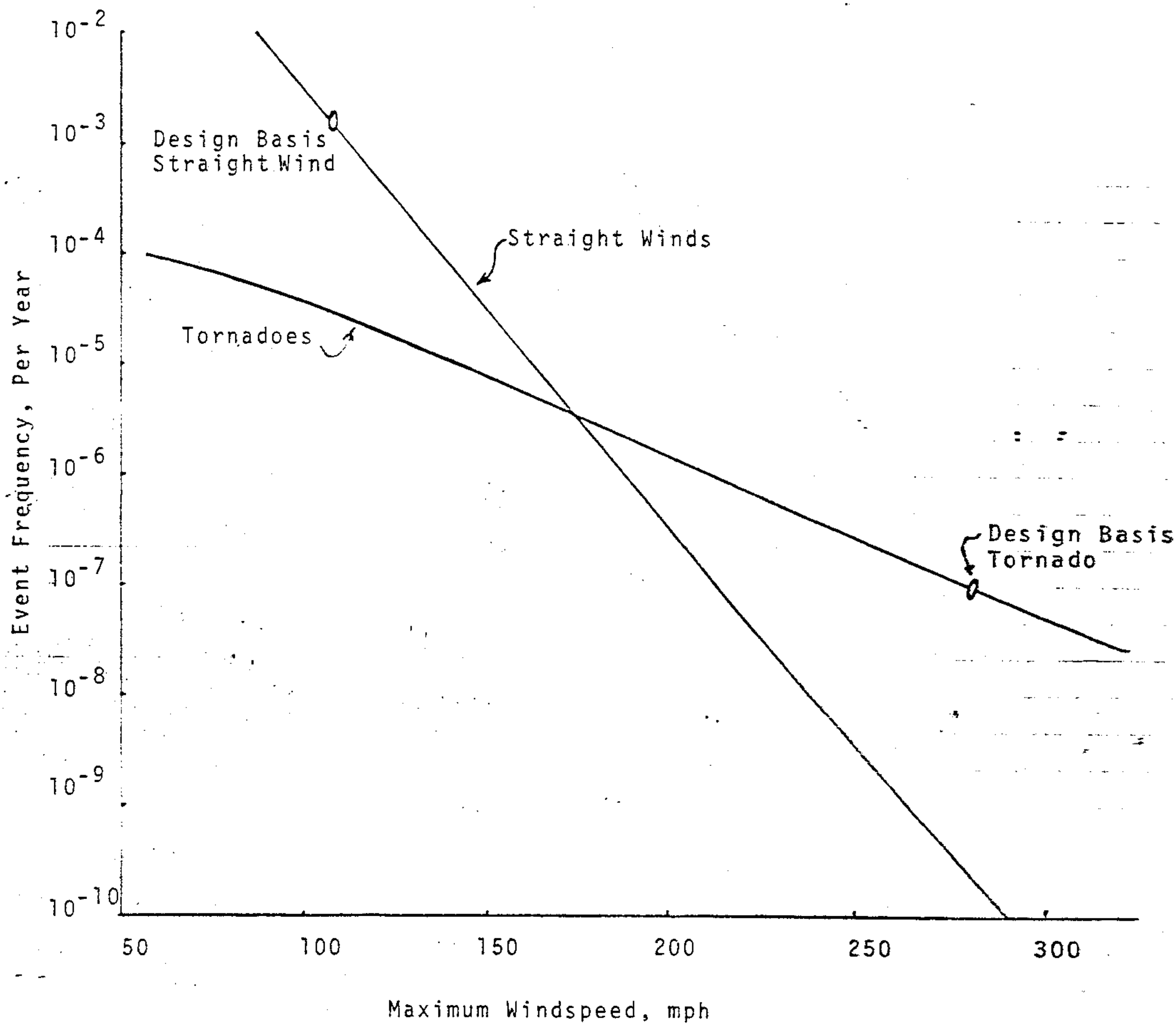

Figure B-1 Expected Frequencies of Intense Winds and Tornadoes in the Vicinity of SRP (McDonald, 1982)

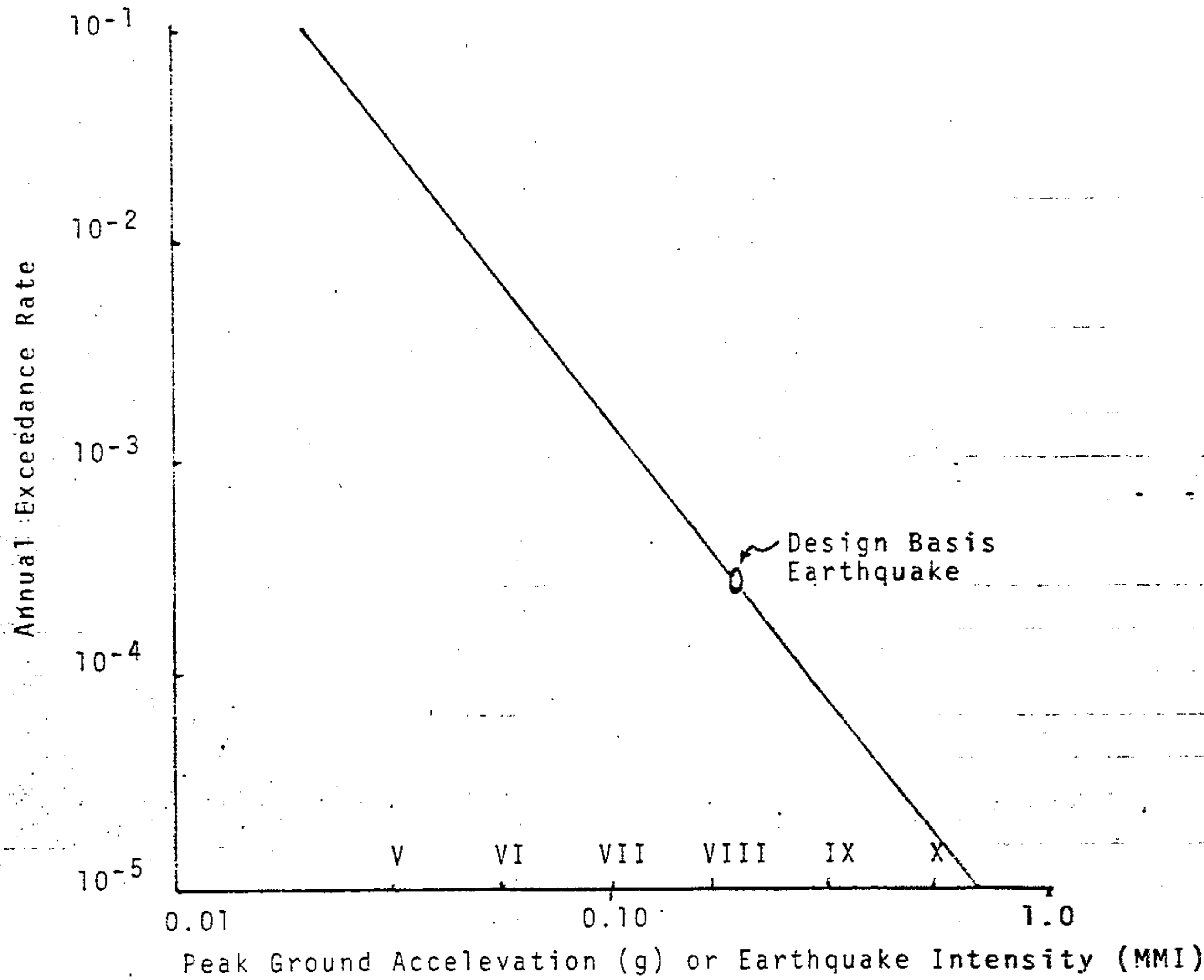

Figure B-2 Earthquake Intensity vs Annual Exceedance Rate at SRP.