William S. Orser
Senior Vice President

Detroit Edison

Fermi 2
6400 North Dixie Highway
Newport, Michigan 48166
(313) 586-5201

Nuclear Operations

July 5, 1990
NRC-90-0035

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

References: 1) Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

2) NRC Letter dated October 15, 1987,
(TAC No. 65164)

Subject: Quarry Operation in the Vicinity of Fermi 2

The Edw. C. Levy Co. has applied for a mining permit from Frenchtown Charter Township to operate a quarry on Toll Road in Monroe County. The proposed quarry site is located approximately 5600 feet SSW of the safety-related structures at Fermi 2 and approximately 1600 feet west of the Nuclear Operations Center (NOC) which houses the Emergency Operations Facility (EOF). Detroit Edison has obtained a copy of the application and also requested and received further information from Edw. C. Levy Co. to review and evaluate the possible impact of the proposed quarry operation on Fermi 2. A figure showing the relative locations is attached.

Previously the NRC has evaluated the potential hazard due to the operation of the Rockwood Quarry located 2 miles from the plant at the closest approach. The NRC issued the Safety Evaluation Report in Reference 2 concluding that the hazards are insignificant with respect to the Fermi 2 nuclear plant operation. Reference 2 required Detroit Edison to reevaluate the impact of the quarry operations on the safety of the plant if the distance from Rockwood Quarry to the plant safety related structures became less than two miles. Since the proposed Edw. C. Levy Co. quarry is located less than two miles from safety-related structures at Fermi 2, Detroit Edison has performed an evaluation of the possible impact of the proposed quarry operation on Fermi 2.

The evaluation considered the effect of quarry operation on safety-related structures primarily. The conclusion was that the proposed quarry will not affect safety-related structures at Fermi 2 or safe operation of the facility.

An assessment was also performed of the potential effects of the quarry on the EOF. The conclusion was that the EOF structure can

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withstand the forces due to the maximum amount of explosives expected to be stored at the quarry.

Submitted for NRC review is the Detroit Edison "Evaluation of the Proposed Toll Road Quarry," including Design Calculation 5117, Revision A, dated June 7, 1990, and information provided by Edw. C. Levy Co.

The conclusions reached are highly dependent on the information provided by Edw. C. Levy Co. (Appendix 1) regarding location of the quarry, maximum amount of explosives stored on site, type of explosives, transportation method including amount of explosives per vehicle, quarrying method, and truck routing. The calculation is especially sensitive to the truck routing which was described as I-75 North to Dixie Highway East to Toll Road, then south to quarry site. Use of Fermi Drive would be unacceptable. The sum of the amount of explosives on the truck or otherwise at the quarry site must not exceed 25,000 pounds. Additionally, the information provided stated that no dewatering would be performed at the quarry site. Therefore, the effects of such dewatering have not been evaluated.

Following NRC review, and if the quarry is constructed, relevant information will be incorporated into the Fermi 2 Updated Final Safety Analysis Report.

If there are any questions, please contact Ms. Lynne Goodman at (313) 586-4211.

Sincerely,

W. S. Orser
Senior Vice President

Enclosure

cc: A. B. Davis
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W. G. Rogers
J. F. Stang
Frenchtown Charter Township

bcc: A. Alchalabi
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P. Fessler
D. R. Gipson w/o enc.
L. S. Goodman
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A. Kowalczuk/R. Matthews w/o enc.
R. McKeon w/o enc.
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Enclosure to
NRC-90-0035

EVALUATION OF THE PROPOSED TOLL ROAD QUARRY

BACKGROUND

Detroit Edison has been notified regarding the proposal of a stone mining and processing quarry in Frenchtown Township. Edw. C. Levy Co. applied to Frenchtown Charter Township for a mining permit on June 19, 1989 for a quarry operation located on Toll Road, 3/8 mile S.E. of the intersection of Toll Road and Leroux Road. Detroit Edison has obtained a copy of this application and also requested and received further information from Edw. C. Levy Co. to review and evaluate the possible impact of the quarry operation on Fermi 2.

DESCRIPTION

The proposed Toll Road quarry is located approximately 5600 ft. SSW of the safety related structures at Fermi 2 and approximately 1600 ft. west of the Nuclear Operation Center (NOC). The quarry will extract dolomitic limestone using conventional techniques. The proposed quarry occupies 79 acres. The area to be used for mining is 52 acres. Over 35 years, 7.1 million tons of stone is projected to be excavated which will be used as concrete and asphalt aggregate or base for paving. The method of quarry operation will involve:

1. Overburden removal - pan scrapers
2. Drilling and blasting - ammonium nitrate emulsion
3. No pit dewatering
4. Dragline casting on bank
5. Endloader to truck to hopper and crusher
6. Conveyors to plant processing

Processing means employed on site are solely mechanical. No dewatering will be performed at the site. Besides explosives, the only other pontentially hazardous material is a maximum of 10,000 gallons of diesel fuel, stored mainly for earthmoving equipment.

The only potential concern for Fermi 2 is the explosives stored on site for blasting. The explosives will be transported to the quarry by truck. The maximum amount of explosives per truck is 20,000 lbs. The truck will travel I-75 north to Dixie Highway, east to Toll Road and south to the quarry site. The maximum amount of explosives on site will be 25,000 lbs. which will be contained in certified containers and equipment. Two types of explosives will be used at Toll Road quarry, both of which have a TNT equivalency of less than 1.0. High Prime (5%) with TNT equivalency of 0.96 and Pan 7000 (95%) with TNT equivalency of 0.72.

EVALUATION OF THE PROPOSED TOLL ROAD QUARRY

EVALUATION FOR SAFETY RELATED STRUCTURES

1. Potential Air Blast Effects

Detroit Edison has evaluated the potential effects of a hypothetical explosion of the explosives stored at the Toll Road quarry using NRC Regulatory Guide 1.91. The safe distance required per Reg. Guide 1.91 between proposed Toll Road quarry and Fermi 2 safety related structures is met to ensure that blast overpressure effects are insignificant. This safe distance is calculated for 25,000 lbs and 100,000 lbs. of explosives stored in the quarry. In addition, the safe distance is calculated for an accidental explosion during transit. Conservatively, the maximum single highway truck weight with 50,000 lbs. of TNT equivalent explosives is considered for the accidental detonation during transit. The actual distance between the quarry and Fermi 2 safety related structures (RHR-SW Corner), calculated by scaling site aerial photographs, is 5600 ft. The transit route is I-75 north to Dixie Highway, east to Toll Road and south to the quarry site.

All actual distances exceed the safe distances calculated per Reg. Guide 1.91 by at least a factor of approximately 3. On this basis Detroit Edison concludes that the accidental detonation of explosives associated with the proposed quarry operation will not pose any hazard to Fermi 2 due to overpressure effects.

Detroit Edison concurs with the judgement of the NRC Staff as stated in the Regulatory Guide 1.91 that for explosions of the magnitude considered here, the overpressure (air-blast) effects are controlling. However, Detroit Edison evaluated the ground motion and hydrostatic water pressure effects in addition to the governing overpressure effects as described below.

2. Ground Effects of Routine Blasting

Detroit Edison also considered the potential ground motion effects due to blasting. For this evaluation, U.S. Navy Design Manual 7.2 "Foundations and Earth Structures" has been used. The conservative calculations, assuming the blasting of 100,000 lbs. of TNT equivalent explosives, indicate that a particle velocity of 0.15 in/sec. will not be exceeded which falls well within the safe range of 2 in/sec.

3. Peak Hydrostatic Pressures

The ground acceleration due to the detonation of 100,000 lbs. of TNT equivalent explosives at a distance of 5600 ft. has been estimated conservatively. This ground acceleration has been compared with the safe shutdown earthquake (SSE) acceleration and the corresponding displacements were determined and converted into equivalent hydrostatic pressures. The increase in the hydrostatic pressures was then compared to the hydrostatic pressure due to the probable maximum flood at Fermi 2 and was found to be insignificant.

EVALUATION OF THE PROPOSED TOLL ROAD QUARRY

EVALUATION FOR SAFETY RELATED STRUCTURES (Cont'd.)

4. Effects on Ground Water

   The quarry will use well water as a source for product washing and dust suppression, in a closed loop system. No pit dewatering will be performed. Based on this information, Detroit Edison has concluded that the proposed Toll Road quarry activities will have an insignificant effect on the ground water flow at the Fermi 2 site.

EVALUATION FOR NOC

Detroit Edison has evaluated the potential effects of a hypothetical explosion of the explosives stored at the proposed Toll Road quarry using a similar approach as detailed for the evaluation of safety related structures. The potential air blast effects and ground effects of routine blasting will be acceptable for up to 25,000 lbs. of explosives. The blasting effects have been correlated to ground accelerations and compared with earthquake design accelerations.

NOC structure design utilizes bracing members in order to transfer lateral forces. Reinforced concrete walls around the perimeter of the building also help transmit these forces to the foundations. The EOF which occupies the SE corner of the first floor of the NOC structure is completely enclosed by 15" thick concrete shielding walls. Only a small portion of the NOC lateral forces are transferred thru EOF walls and the additional stresses caused by explosion forces are quite small considering the capacity of the EOF concrete enclosure. Based on our evaluation, the EOF structure will withstand the forces due to the explosion of 25,000 lbs. of TNT.

CONCLUSION

Detroit Edison's evaluation concludes that the proposed Toll Road Quarry will not affect safety related structures at Fermi 2, nor safe operation of the facility.

Detroit Edison will continue monitoring developments on the proposed Toll Road Quarry.

In addition, relevant information regarding the quarry operation will be incorporated into the Fermi 2 UFSAR as they become finalized.

DESIGN CALCULATION COVER SHEET

PART 1: DESIGN CALCULATION IDENTIFICATION

A) Design Calculation Number 5117

B) Volume Number I

C) Revision A

D) PIS Number A30-00

E) QA Level [X] Non-Q [ ] 1 [ ] 1M

F) ASME Code Classification [X]NA

G) Certification Required [ ] Yes [X] No

H) Lead Discipline ARCH/CIVIL

I) Incorporation Code W

J) Title

EFFECTS OF THE PROPOSED TOLL ROAD QUARRY ON FERMI 2 & NOC

K) Design Change Documents Incorporated (Number and Revision)

NONE

L) Design Calculations Superseded (Number and Revision)

NONE

M) Revision Summary

- New cover sheet and new pages 11 thru 15.
- Page 2 is revised.
- Revised title to add "NOC"

PART 2: PREPARATION AND APPROVAL

A) Prepared By H. Sahiner [signature] Date 6/7/90

B) Checked By A. Shahkarami [signature] Date 6-7-1990

C) Verified By A. Shahkarami [signature] Date 6-7-1990

D) Approved By [initials] 6-7-90

Sign [signature: Abdul Alchalabi] Date 6/7/90

NARMS - NUCLEAR SERVICES

DSN ______ Rev ______ Date ______

DTC File 1801 Recipient

Form FIP-CM1-11 Att1 P1/1 050190

DESIGN CALCULATION COVER SHEET

PART 1: DESIGN CALCULATION IDENTIFICATION

A) Design Calculation Number 5117	B) Volume Number I
C) Revision ϕ / D) PIS Number A30-00	E) QA Level NON-Q
F) ASME Code Classification [X] NA	G) Certification Required [ ] Yes [X] No
H) Lead Discipline CIVIL	I) Incorporation Code W

J) Title EFFECTS OF THE PROPOSED QUARRY TOLL RD ON FERMI 2.

K) Design Change Documents (Number and Revision) Incorporated

NONE

L) Design Calculations (Number and Revision) Superseded

NONE

M) Revision Summary

New calculation.

PART 2: PREPARATION AND APPROVAL

A) Prepared By

Sign H. SAHINER [signature] Date 1/19/90

B) Checked By A. SHANKARANAMI

Sign [signature] Date 1/29/90

C) Verified By A. SHANKARANAMI

Sign [signature] Date 1/29/90

D) Approved By

Sign [signature] 2/1/90 Abdul Alchalabi Date 2/1/90

ARMS - INFORMATION SERVICES

DSN DC-5117 Vol I Rev ϕ Date Feb 01, 1990

DTC TDPCAS File 1801 Recipient

Form FIP-CM1-11 Att1 P1/1 030289

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1/19/90

OBJECTIVE: TO EVALUATE THE EFFECTS OF ACCIDENTAL DETONATION OF EXPLOSIVES AT THE PROPOSED NEW E.C. LEVY CO. QUARRY LOCATED AT TOLL ROAD. TO EVALUATE THE IMPACT OF SUCH DETONATION ON FERMI 2 SAFETY RELATED STRUCTURES.

ASSUMPTIONS: THE INFORMATION PROVIDED BY EDW. C. LEVY CO. ON LETTER TO L. GOODMAN - Det. Edison - Dir. of Nucl. Licensing DATED SEPT. 27, 1989 (REF. 1) IS USED IN THIS CALC.

ALL OTHER ASSUMPTIONS ARE NOTED IN THE BODY OF THE DESIGN CALCULATION.

CONCLUSION: THE BLASTING ACTIVITIES AT THE PROPOSED LEVY QUARRY INCLUDING THE SHIPMENT AND STORAGE OF EXPLOSIVES AT THE QUARRY DO NOT ADVERSELY AFFECT SAFETY RELATED STRUCTURES AT FERMI 2.

 [signature] 1/19/90

REFERENCES

1. "EDW. C. LEVY CO." LETTER to Ms. Goodman - Det. Edison, dated Sept. 27, 89. Appendix 1.

2. REG. GUIDE 1.91 - U.S.N.R.C. Rev. 1, Feb. 78. App. 2

3. NAVFAC DM-7.2 - U.S. NAVY DESIGN MANUAL 7.2 - "FOUNDATIONS AND EARTH STRUCTURES." App. 3

4. D.C. 4510 - Vol. I, Rev. A. EFFECTS OF OFF SITE BLASTING ON FERMI 2. App. 4

5. AIR FORCE DESIGN MANUAL - PRINCIPLES AND PRACTICES FOR DESIGN OF HARDENED STRUCTURES, by N.M. Newmark, Illinois Univ., Urbana, Illinois, December 1962.

CALCULATION METHODS: THE FOLLOWING EFFECTS WERE CONSIDERED:

1 - BLAST INDUCED OVERPRESSURE: REG GUIDE 1.91 (REF. 2) IS USED TO CALCULATE THE EFFECTS OF BLAST INDUCED OVERPRESSURE.
2 - BLAST INDUCED GROUND MOTION: "NAVFAC DM-7.2 U.S. NAVY DESIGN MANUAL 7.2 - FOUNDATIONS AND EARTH STRUCTURES" WAS USED TO EVALUATE GROUND MOTION. (REF #3)
3 - PEAK HYDROSTATIC PRESSURES

THIS ANALYSIS ONLY EVALUATES SAFETY RELATED STRUCTURES. IT DOES NOT CONSIDER THE BLAST EFFECTS ON NON-SAFETY RELATED STRUCTURES SUCH AS OFFICE BUILDINGS AND SECURITY SYSTEMS.

SUMMARY OF EXPLOSIVE INFO. USED IN THIS CALCULATION (REF. 1)

- Max. amount of explosives on site @ quarry: 25,000 Lbs.
  5% (-) is "High Prime" with 0.96 TNT Equivalency
  95% (+) is "Pan 7000" with 0.72 TNT Equivalency.

- Peak Particle Velocity at quarry entrance: < 2" per second
- Peak Particle Velocity ½ mile away: < 0.1" per second

- Truck transporting explosives with max. amount of 20,000 Lbs.
- Truck route is I-75 N. to Dixie Hwy., E. to Toll Rd. and S. to the quarry.
- The distance between the proposed quarry and safety related structures at Fermi 2 is 5600 ft. This minimum distance is found by scaling the aerial photographs of the power plant and its vicinity.

EFFECTS OF QUARRY ON FERMI 2.

[signature] 1/19/90

1- **BLAST INDUCED OVERPRESSURE:**

From Reg. Guide 1.91, the safe distance $R = 45 W^{1/3}$

[R] = feet [W] = lbs k = 45 (coefficient)

Assume the explosive mix is conservatively 5% and 95%. The TNT equivalency of the mix will be:

$.05 \times .96 + .95 \times .72 = .732 \approx .74$

W = TNT equivalent = $.74 \times 25{,}000 = 18{,}500$ lbs

Safe distance: $R = 45 \cdot (18{,}500)^{1/3} = 1190$ ft.

Actual distance: 5600 ft.

As the actual distance is larger than the safe distance, no harm from blast induced overpressure will occur.

Additional safety margin: $\frac{5600'}{1190'} = 4.7$

From these results we can see that even if 100,000 lbs (50 tons) of TNT equiv. explosives are stored in the quarry, the safe distance will still be less than the actual distance.

Safe distance: $R = 45 \cdot (100{,}000)^{1/3} = 2010$ ft < 5600 ft (Actual distance)

EFFECTS OF QUARRY ON FERMI 2 [signature] 1/19/90

CONSIDER OVERPRESSURE FROM ACCIDENTAL DETONATION OF EXPLOSIVES IN TRANSIT.

Max. Inventory on truck: 20,000 lbs.

W = TNT equivalent = .74 × 20,000 = 14,800 lbs.

Safe distance: $R = 45 \times (14{,}800)^{1/3} = 1105$ ft.

Actual distance: 5600 ft. > 1105 ft

Additional Safety Factor: $\frac{5600}{1105} = 5.1$ ⇒ O.K.

CONSERVATIVE ANALYSIS: (FOR TRANSIT AND AT THE QUARRY)

Per Reg. Guide 1.91 assume the maximum probable hazardous solid cargo for a single highway truck 50,000 lbs is transported with a TNT equivalency of 1. The safe distance from an accidental explosion of such a cargo is $R = 45 W^{1/3}$.

$R = 45 \times 50{,}000^{1/3} = 1658$ ft. ⇒ safe distance

Actual distance: 5600 ft > 1658 ft

Additional safety factor: $\frac{5600}{1658} = 3.4$

These results indicate that the potential air blast effects of either an explosion in the quarry or an explosion of a shipment at its nearest point to the plant are not significant with respect to the safety related plant structures.

2 - GROUND MOTION EFFECTS

In order to estimate the maximum particle velocity NAVFAC DM-7.2 (Ref.3) has been used.

Fig.10 of (Ref.3) - Scaled Range = $R/W^{1/3}$ [$ft/lb^{1/3}$]

Where: R = Distance from Blast Point [ft]
W = Weight of explosive charge [lbs]
Actual W = 25,000 lbs, however use 100,000 lbs for conservatism.
Actual R = 5600 ft.

$$R/W^{1/3} = \frac{5600}{(100,000)^{1/3}} = 121\ ft/lb^{1/3}$$

From Fig.10, the maximum particle velocity (in/sec) corresponding to R=125 is ≈0.15 in/sec. (conservative)

Fig.11 of Ref.3 gives the guideline for assesing potential for damage induced by Blasting vibration. A particle velocity of 0.15 in/sec. falls well within the "safe" range which is 2 in/sec.

The review of above values indicates that the "accidental blast during transit" ground motion effects will also fall into the safe range.

Additional safety factor $= \frac{2}{0.15} = 13$

3. <u>PEAK HYDROSTATIC PRESSURES</u>:

To consider the effects of peak hydrostatic pressure a conservative analysis will be performed, neglecting the ground attenuation effects. In order to estimate the increase in hydrostatic pressure, a comparison is made between the ground displacements due to the detonation of explosives and the max. ground displacements due to an SSE.

Per UFSAR Fig. 2.5-67 Sheet 1, max. displacement is 15 in. at SSE acceleration of 0.15g.

From Ref. 5, Pages 4-58 and 61, the ground acceleration due to the detonation of 100,000 lbs of TNT equiv. explosives at a distance of 5600 ft. with an ave. velocity of compressive wave of 12,333 ft/sec (Fermi 2 UFSAR, Table 2.5-7) will be much smaller than 0.02g. However the value of 0.02g was used in Ref. 4 for the evaluation of the Rockwood Quarry. For conservatism we will use the same (0.02g) acceleration value in this calculation.

Normalized displacement $= \frac{0.02g}{0.15g}(15) = 2''$

Conservatively apply dynamic factor of 1.5 for a displacement of $1.5 \times 2 = 3''$

Equivalent pressure. $\frac{3''}{12''} \times 62.4 \times \frac{1}{144} = 0.11$ psi

Now we will compare this pressure (0.11 psi) with the increase in the hydrostatic pressure due to a probable maximum flood. (PMF)

From UFSAR Section 2.4.2.2 the PMF level is 586.9 Ft.

Assume normal lake level of 575.5 ft. The increase in the hydrostatic pressure due to a PMF = 586.9 - 575.5 = 11.4 ft.

$$11.4\ ft \times 62.4 \frac{in}{ft^3} \times \frac{ft^2}{144 in^2} = 4.94\ psi.$$

The hydrostatic pressure increase due to the explosion (0.11 psi) is much smaller than the increase due to a PMF. (4.94 psi)

Per Ref. 1, no dewatering will be performed at the quarry site.

The rock properties at Fermi 2 are assummed to be the same as those evaluated per Ref. 4, Sht. 9 & 10.

 H. Saturier [signature] 4/20/90

OBJECTIVE: The Nuclear Operations Center (NOC) is located approx 1600ft. from the proposed E.C. Levy Co. quarry. NOC Building is not a Safety Related Structure, however Emergency Operations Facility (EOF) activities are directed from NOC. For this purpose, DC 5117 is revised to include the evaluation and impact of the proposed Quarry on the NOC.

Assumptions: All assumptions used for Rev. Ø of this D.C., for the evaluation of the Safety Related structures remain valid. If other assumptions are used, they will be noted in the body of the design calculation.

CONCLUSION: NOC will still meet the guidelines as stated in NUREG 1.91, provided that explosives transported and stored in the quarry do not exceed 25,000 lbs.

REFERENCES:

- Fermi 2 UFSAR - 7.8.4.2
- Dwgs. 6C721AA-2014 thru 2018

[signature] 4/20/90

1 - **Blast Induced Overpressure:**

Safe distance - $R = 45 W^{1/3}$ Ref. Reg. Guide 1.91 (2)

$R = 45 \times (18,500)^{1/3} = 1190$ ft

Actual distance : 1600 ft

If only 25,000 lbs of explosive mix is stored on site per Ref. #1, App. 1, no harm will occur from blast induced overpressure.

Additional safety margin $\frac{1600}{1190} = 1.3$

Calculate the max. allowable - TNT equivalent - explosives stored in the quarry:

Safe distance: $R = 1600 = 45 (W')^{1/3} \rightarrow W'$ = max. allow. explosive (TNT equiv.)

$W' = 44949$ lbs ≈ 22 tons.

OVERPRESSURE FROM ACCIDENTAL DETONATION IN TRANSIT:

By inspection of Pg. 7 of this D.C. safe distance (1105 ft.) is less than Actual distance (1600 ft.) for 20000 lbs of inventory on truck.

Now calculate for the max. cargo allowed for a single highway truck per Reg. guide 1.91. R - Safe distance was found to be 1658 ft.

[signature] 4/20/90

The actual distance (1600 ft) is less than the safe distance. There is no additional safety margin. However due to the closeness of these distances it may be ruled as acceptable provided that no other route is used to the quarry. Fermi Drive is not an acceptable route. This calculation is not valid if Ref. #1, App. 1, Item #7 truck route is not followed.

2 - GROUND MOTION EFFECTS:

Scaled Range: $R/W^{1/3} = \frac{1600}{(100{,}000)^{1/3}} = 34{,}5\ ft/lb^{1/3}$

From Fig. 10 of Ref. #3, the max. particle velocity (in/sec) is $\approx$ 1.5 in/sec

This value of [1.5 in/sec] is less than 2 in/sec which is the safe range per Ref. #3, Fig. 11.

3. EVALUATION OF ACCELERATIONS AND DISPLACEMENTS

Let us calculate the ground accelerations due to the detonation of explosives at a distance of 1600 ft. From Ref.#5 Formula 4-35 is used.

$$a_r \cdot W^{1/3} = (1.0 \times 10^4)\, g \left(\frac{R}{W^{1/3}}\right)^{-3.5} \left(\frac{c}{1000\,fps}\right)^2$$

R = distance in ft. (1600 ft)
W = Weight of explosive in lbs.
c = 13,000 fps - ave. velocity of compressive wave.

If 1) W = 100,000 lbs ⇒ $a_r = 0.15g$ displ. = 15 in
2) W = 50,000 lbs ⇒ $a_r = 0.08g$ " = 8 in
3) W = 25,000 lbs ⇒ $a_r = 0.048g$ " = 5 in

For $a_r = 0.15g$ which is equal to SSE acceleration, max. ground displacement is 15 in. (UFSAR Fig. 2.5-67 Sht. 1)
Considering that the NOC building is built per BOCA and using seismic loading values given for this type of building we find that it is designed for $a = 0.025g$.

$V = Z.K.C.W$ [C = 0.1, K = 1, Z = 0.25]

$V = 0.025W$

$V = m.a \longrightarrow a = \frac{V}{m} = \frac{V}{W/g} = 0.025g < a_r = 0.048g$ for W = 25,000 lbs

Effects of Quarry on NOC [signature] 5/23/90

The NOC building has been designed with additional concrete shielding walls around the Emergency Operations Facility. (EOF) The lateral forces -wind/earthquake- are transferred with diagonal bracing. Explosion forces which will cause ground accelerations will be resisted by the same diagonal bracing. The EOF walls are 15" thick reinforced concrete and independent from the diagonal bracing except for SE corner of the building.

Even though the lateral forces, due to 25,000 lbs of explosive accidental detonation, may be larger than wind or earthquake forces, their impact on the EOF structure will not be significant and concrete walls can support the additional loading by engineering judgement. Approx. wt. of Building: 6400k
Total Shear Force @ base: 6400×0.048g = 307 k

Assume 1/4 of shear force: $\frac{306}{4} \approx 77$ k. on EOF corner.

Assume 100' × 1.25' Concrete wall: 125 sqft resisting the shear.

Shear stress: $77000/125 \times 144 = 4.28$ psi

Concrete ult. shear stress: $V_c = 2\sqrt{f'_c} = 2\sqrt{3000} = 109.5$ psi

Conc. Shear stress due to explosion is very insignificant

$1.7 \times 4.28 \ll 0.85 \times 109.5$

7.3 psi $\ll 93.1$ psi   o.k.

APPENDIX I

REF. #1
APPENDIX 1

EDW. C. LEVY CO. ... AVE. DETROIT, MICHIGAN 48209 313-843-7200

RECEIVED ON SEP 29 1989 LICENSING

September 27, 1989

Ms. Lynne Goodman, Director of Nuclear Licensing
Fermi 2
6400 North Dixie Highway
Newport, Michigan 48166

Dear Ms. Goodman:

After consulting with the blasting company that has been working on the project with us, we have developed the following information for you based on your questions of 8/16/89.

1. Maximum amount of fuel oil stored on site? 10,000 gallons of diesel fuel.

2. Maximum amount of explosives on site and type? 25,000 lbs. which will be contained in certified containers and equipment. None will be stored on site over night. The amounts of each type of explosive used per blast will be addressed in question #3.

3. The combination of explosives to be used and its TNT equivalence? We expect to use 5% or less "High Prime" and 95%+ of a product called "Pan 7000".

Product	TNT Equivalent
High Prime	0.96
Pan 7000	0.72

4. Peak Particle Velocity at quarry entrance and 1/2 mile away? By law we will not be able to exceed a Peak Particle Velocity in excess of 2" per second at the quarry entrance. Therefore, based on available information the PPV 1/2 mile away will be less than approximately 0.1" per second.

5. Transportation type? Truck

6. Maximum amount per vehicle? 20,000 lbs.

7. Truck route? I-75 North to Dixie Hwy. East to Toll Road and South to the plant site.

8. Processing means? Solely mechanical.

9. Any hazardous chemicals? None

It is correct that no dewatering will be performed at the site. I hope that this information along with the information we will generate at a future date once testing can be done on the actual site, will be sufficient in allowing you to continue your documentation of our project.

If you have any questions concerning this information or any other that I can help you with, please call.

Sincerely,

EDW. C. LEVY CO.

Jim Weber

Jim Weber
Corporate Development

JW:sg

APPENDIX 2

APPENDIX 9

REF. #2

Revision 1
February 1978

U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 1.91
EVALUATIONS OF EXPLOSIONS POSTULATED TO OCCUR ON TRANSPORTATION ROUTES NEAR NUCLEAR POWER PLANTS

A. INTRODUCTION

General Design Criterion 4, "Environmental and Missile Design Basis," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that nuclear power plant structures, systems, and components important to safety be appropriately protected against dynamic effects resulting from equipment failures that may occur within the nuclear power plant as well as events and conditions that may occur outside the nuclear power plant. These latter events include the effects of explosion of hazardous materials that may be carried on nearby transportation routes. This guide describes methods acceptable to the NRC staff for determining whether the risk of damage due to an explosion on a nearby transportation route is sufficiently high to warrant a detailed investigation. Acceptable methods for evaluating structural adequacy when an investigation is warranted are also described. This guide is limited to solid explosives and hydrocarbons liquified under pressure and is not applicable to cryogenically liquified hydrocarbons, e.g., LNG. It considers the effects of airblasts on highway, rail, and water routes but excludes pipelines and fixed facilities.

B. DISCUSSION

In order to meet General Design Criterion 2, "Design Basis for Protection Against Natural Phenomena," of Appendix A to 10 CFR Part 50 with respect to tornadoes, the structures, systems, and components important to safety of a nuclear power plant must be designed to withstand the effects of a design basis tornado, including wind, pressure drop, and the effects of missiles, without causing an accident and without damage that would prevent a safe and orderly shutdown. In addition, those structures, systems, and components must be designed to accommodate the vibratory ground motion associated with the Safe Shutdown Earthquake.

The effects of explosives that are of concern in analyzing structural response to blast are incident or reflected pressure (overpressure), dynamic (drag) pressure, blast-induced ground motion, and blast-generated missiles. It is the judgment of the NRC staff that, for explosions of the magnitude considered in this guide and the structures, systems, and components that must be protected, overpressure effects are controlling. Drag pressure effects will be much smaller than those due to the wind loading assumed for the design basis tornado. The effects of blast-generated missiles will be less than those associated with the blast overpressure levels considered in this guide. If the overpressure criteria of this guide are exceeded, the effects of missiles must be considered. The effects of blast-induced ground motion at the overpressure levels considered in this guide will be less than those of the vibratory ground motion associated with the Safe Shutdown Earthquake.

This regulatory guide describes a method for determining distances from critical plant structures to a railway, highway, or navigable waterway beyond which any explosion that might occur on these transportation routes is not likely to have an adverse effect on plant operation or to prevent a safe shutdown. Under these conditions, a detailed review of the transport of explosives on these transportation routes would not be required.

A method for establishing the distances referred to above can be based on a level of peak positive incident overpressure (designated as P_{so} in Ref. 1) below which no significant damage would be expected. It is

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the judgment of the NRC staff that, for the structures, systems, and components of concern, this level can be conservatively chosen at 1 psi (approximately 7 kPa). Based on experimental data on hemispherical charges of TNT cited in Reference 1, a safe distance can then be conservatively defined by the relationship

$$R \geq kW^{1/3} \qquad (1)$$

where R is the distance in feet from an exploding charge of W pounds of TNT. When R is in feet and W in pounds, k = 45. When R is in meters and W in kilograms, k = 18.

The concept of TNT equivalence, i.e., finding the mass of substance in question that will produce the same blast effect as a unit mass of TNT, has long been used in establishing safe separation distances for solid explosives. A test program is required to establish that equivalence (Ref. 2). For solid substances more efficient in producing blast effects than TNT, equivalents are known by the manufacturers. For solid substances not intended for use as explosives but subject to accidental detonation, it is conservative to use a TNT equivalence of one in establishing safe standoff distances, i.e., use the cargo mass in Equation (1).

Application of the TNT equivalence concept to possible detonations of vapor clouds formed after an accidental release of hydrocarbons is not as well documented. However, investigations of accidents that resulted in blast damage have used this concept in attempts to estimate, based on blast damage, the effective yield of the explosion (Ref. 3). Most assessments of this type have led to estimates that less than one percent of the calorific energy of the substance was released in blast effects. Since the ratios of heat of combustion of hydrocarbons to that of TNT are typically about 10, this corresponds to an equivalence on a mass basis of 10 percent. However, there have been accidents in which estimates of the calorific energy released were as high as 10 percent. The blast energy realized depends, in great measure, on phenomena that are accident specific, i.e., the rate of release of the substance and the way in which the cloud is ignited. A reasonable upper bound to the blast energy potentially available based on experimental detonations of confined vapor clouds is a mass equivalence of 240 percent (Ref. 4). A detailed analysis of possible accident scenarios for particular sites, including consideration of the actual cargo, site topography, and prevailing meteorological conditions may justify a lower effective yield. But, when establishing safe stand-off distances independent of site conditions, use of an upper bound is prudent.

Determination of the maximum probable quantity of hazardous cargo is dependent on both the transportation mode and the vehicles utilized. The maximum probable hazardous solid cargo for a single highway truck is 50,000 pounds (23,000 kg). Similarly, the maximum explosive cargo in a single railroad box car is approximately 132,000 pounds (60,000 kg). The largest probable quantity of explosive material transported by ship is approximately 10,000,000 pounds (4,500,000 kg). For illustrative purposes, the safe distances, as defined by inequality (1), are shown in Figure 1 for these quantities of TNT. When shipments are made in connected vehicles such as railroad cars or barge trains, an investigation of the possibility of explosion of the contents of more than one vehicle is necessary.

In cases where the distances from the transportation route to the structures, systems, and components that must be protected are not sufficiently great to allow a conclusion (based on conservative assumptions) that the peak positive incident overpressure would be less than 1 psi (approximately 7 kPa), an analysis of the frequency of hazardous cargo shipment may show that the attendant risk is sufficiently low. It is the judgment of the NRC staff that, if the exposure rate, r, defined in Equation (2) can be shown to be less than 10^{-7} per year, the risk of damage due to explosions is sufficiently low.

$$r = nfs \qquad (2)$$

where
- r = exposure rate,
- n = explosion rate for the substance and transportation mode in question in explosions per mile,
- f = frequency of shipment for the substance in question in shipments per year, and
- s = exposure distance in miles (see Figure 2).

If the substance in question is shipped on more than one transportation mode near the plant, exposure rates calculated for the modes should be summed.

If an adequate data base for estimating the explosion rate for a substance is lacking, an estimate can be made by utilizing nationwide statistics for the particular transportation mode, i.e.,

$$n = n_1 n_2 \qquad (3)$$

where
- n_1 = accidents per mile for the transportation mode, and
- n_2 = cargo explosions per accident for the transportation mode.

Because of the low frequency of occurrence of the events under consideration, estimates based on aver-

age frequency may have wide confidence bands, and conservative estimates may be preferred. If estimates of explosion rate, frequency of shipment, and exposure distance are made on a realistic or best estimate basis, an exposure rate less than 10^{-7} per year is sufficiently low. If conservative estimates are used, an exposure rate less than 10^{-6} per year is sufficiently low.

If it cannot be shown that the distance to the transportation route is great enough or that the exposure rate is low enough to render sufficiently low the risk of damage to a structure housing a system or component that must be protected, an analysis of the blast load effects may be made. The loading combination to be considered may be limited to:

$$C = D + L + T_o + R_o + B \quad (4)$$

where
- C = combined load effect,
- D = dead load effect,
- L = live load effect (not including wind or snow loads),
- T_o = thermal load effect during normal operating or shutdown conditions,
- R_o = pipe reaction effect during normal operating or shutdown conditions, and
- B = blast load effect, with the explosion source positioned to maximize the load combination for the structural element under consideration. Only the incident (or, if appropriate, reflected) pressure loading need be considered.

Either a static analysis using twice the appropriate pressure loading or an elastic analysis using dynamic load factors (Ref. 5) is acceptable for computing blast load effects. The blast pressure should be considered to act both inward and outward in order to account for dynamic stress reversal. Overturning and sliding stability as well as the ability of supporting structures to carry loads transmitted from the directly loaded exterior surfaces must be assessed.

C. REGULATORY POSITION

In the design of nuclear power plants, the ability to withstand the possible effects of explosions occurring on nearby transportation routes should be considered. The following methods are acceptable to the NRC staff for ensuring that the risk of damage due to an explosion on a nearby transportation route is sufficiently low.

1. When carriers that transport explosives can approach vital structures of a nuclear facility no closer than the distances computed using Figure 1, no further consideration need be given to the effects of blast in plant design. In calculating TNT equivalents, assumptions of 100 percent TNT (mass) equivalence for solid energetic materials and 240 percent TNT (mass) equivalence for substances subject to vapor phase explosions are acceptable upper bounds when effective yields generated from test data do not exist. Lower effective yields may be justified by analyses accounting for reaction kinetics, site topography, and prevailing meteorological conditions when the hazardous cargos can be identified.

2. If transportation routes are closer to structures and systems important to safety than the distances computed using Figure 1, the applicant may show that the risk is acceptably low on the basis of low probability of explosions. A demonstration that the rate of exposure to a peak positive incident overpressure in excess of 1 psi (7 kPa) is less than 10^{-6} per year, when based on conservative assumptions, or 10^{-7} per year, when based on realistic assumptions, is acceptable. Due consideration should be given to the comparability of conditions on the route to those of the accident data base.

3. If transportation routes are closer to structures and systems important to safety than the distances computed using Figure 1, the applicant may show that the risk to the public is acceptably low on the basis of capability of the safety-related structures to withstand blast and missile effects associated with detonation of the hazardous cargo. In assessing the capacity of structures to resist blast loads, a simplified quasi-static analysis of blast effects using the load combination of Equation (4) is acceptable. Effective yields based on analyses accounting for reaction kinetics, site topography, and prevailing meteorological conditions can be used when justified.

D. IMPLEMENTATION

The purpose of this section is to provide guidance to applicants and licensees regarding the NRC staff's plans for utilizing this regulatory guide.

Except in those cases in which the applicant proposes an alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used in the evaluation of construction permit applications docketed on or after February 24, 1978.

If an applicant wishes to use this regulatory guide in developing submittals for applications docketed on or before February 24, 1978, the pertinent portions of the application will be evaluated on the basis of this guide.

REFERENCES

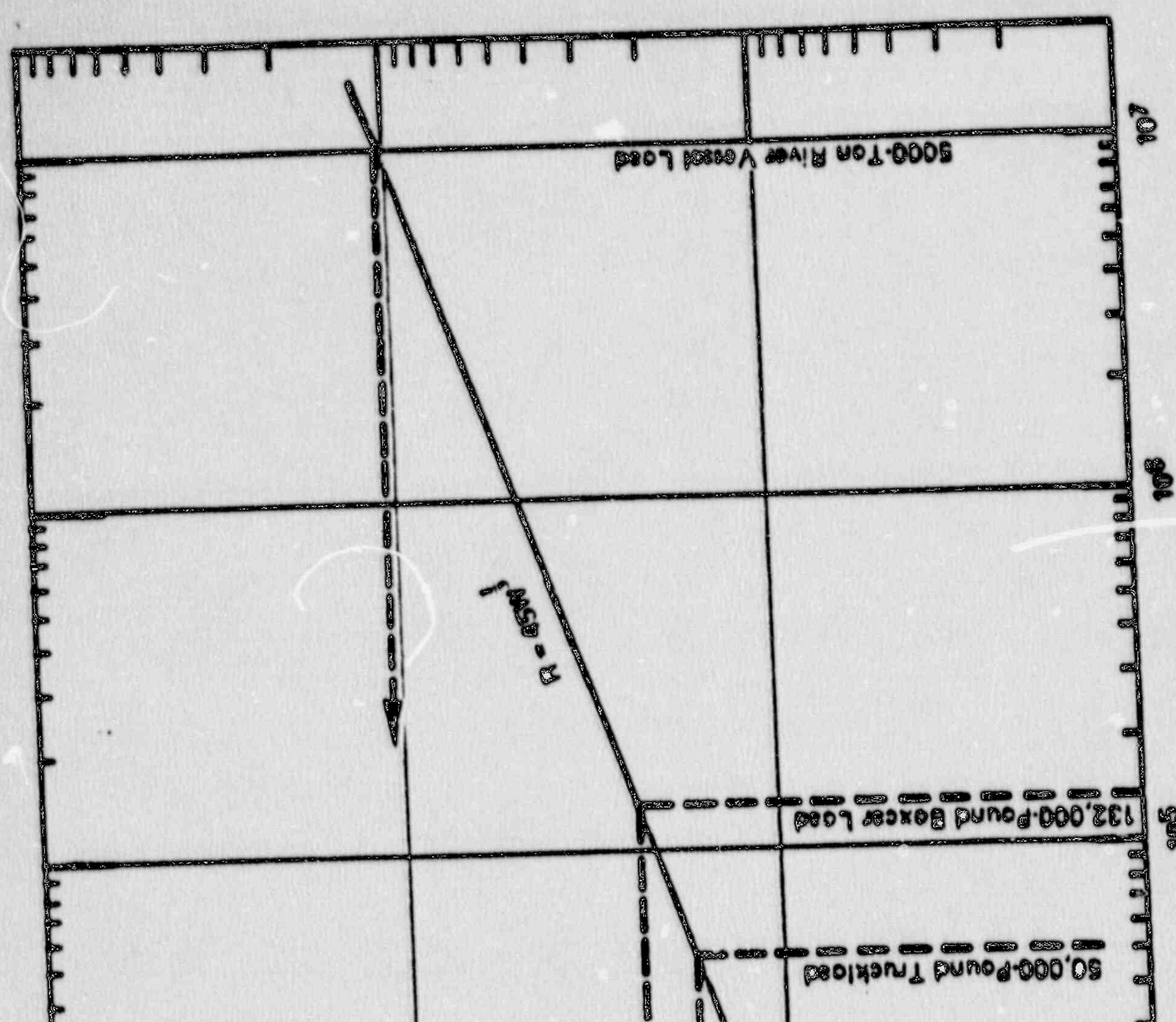
1. Department of the Army Technical Manual TM 5-1300, "Structures to Resist the Effects of Accidental Explosions," June 1969.

2. Napadensky, H. S., and L. Jablansky, "TNT Equivalency Investigations," Proceedings of the 16th Annual Explosives Safety Seminar, Department of Defense Explosives Safety Board, Washington, D.C., Septemb : 1974.

3. Strehlow, R. A., and W. E. Baker, "The Characterization and Evaluation of Accidental Explosions," NASA CR-134779, June 1975.

4. Eichler, T. V., and H. S. Napadensky, "Accidental Vapor Phase Explosions on Transportation Routes near Nuclear Power Plants," Final Report J 6405, IIT Research Institute, Chicago, Illinois, April 1977.

5. Biggs, J. M., "Introduction to Structural Dynamics," McGraw-Hill, New York, 1964.



DISTANCE FROM EXPLOSION IN FEET

TNT EQUIVALENT IN POUNDS

Figure 1. Radius to Peak Incident Pressure of 1 PSI.

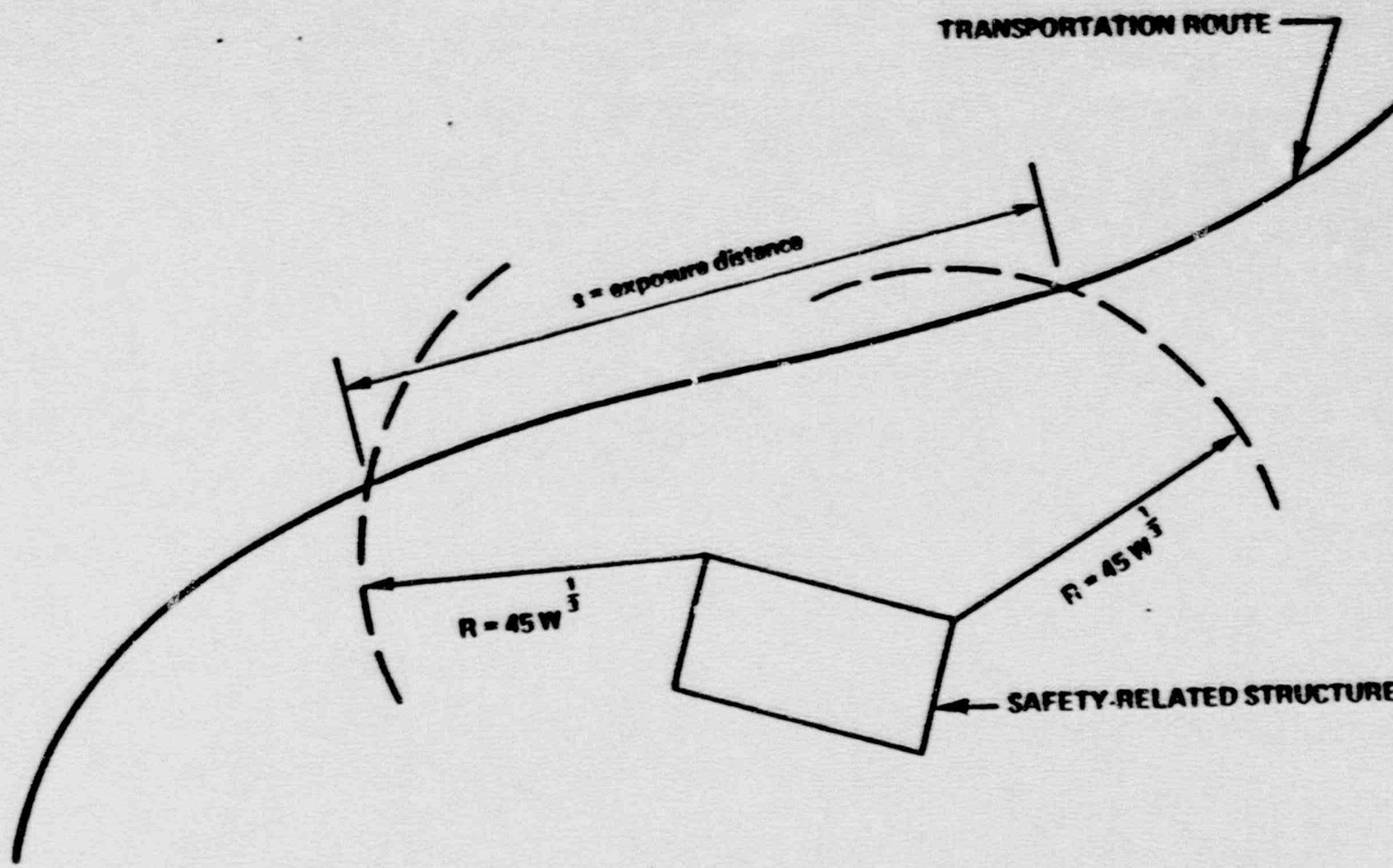


Figure 2. Exposure Distance Calculation

APPENDIX 3

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~~APPENDIX X~~

NAVFAC DM-7.2
MAY 1982

APPROVED FOR PUBLIC RELEASE

REF. #3
APPENDIX 3

FOUNDATIONS AND EARTH STRUCTURES

DESIGN MANUAL 7.2

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
200 STOVALL STREET
ALEXANDRIA, VA. 22332

TOTAL P.09

3. RIPPABILITY. Excavation ease or rippability can be assessed approximately from field observation in similar materials or by using seismic velocity, fracture spacing, or point load strength index. Figure 8 (from Reference 10, Handbook of Ripping, by Caterpillar Tractor Co.) shows an example of charts for heavy duty ripper performance (ripper mounted on tracked bulldozer) as related to seismic wave velocity. Charts similar to Figure 8 are available from various equipment manufacturers. Figure 8 is for guidance and restricted in applicability to large tractors heavier than 50 tons with engine horsepower greater than 350 Hp. Ripper performance is also related to configuration of ripper teeth, equipment condition and size, and fracture orientation.

Another technique of relating physical properties of rock to excavation ease is shown on Figure 9 (from Reference 11, Logging the Mechanical Character of Rock, by Franklin, et al.) where fracture frequency (or spacing) is plotted against the point load strength index corrected to a reference diameter of 50 mm. (See Reference 12, The Point-Load Strength Test, by Broch and Franklin.)

A third and useful technique is exploration trenching in which the depth of unrippable rock can be established by digging test trenches in rock using rippers (or other excavation equipment) anticipated to be used for the project. The size and shape of the area to be excavated is a significant factor in determining the need for blasting, or the equipment needed to remove the rock.

4. BLASTING. Of major concern is the influence of the blasting on adjacent structures. The maximum particle velocity (the longitudinal velocity of a particle in the direction of the wave that is generated by the blast) is accepted as a criterion for evaluating the potential for structural damage induced by blasting vibration. The critical level of the particle velocity depends on the frequency characteristics of the structure, frequency of ground and rock motion, nature of the overburden, and capability of the structure to withstand dynamic stress. Figure 10 can be used for estimating the maximum particle velocity, which can then be used in Figure 11 (from Reference 13, Blasting Vibrations and Their Effects on Structures, by Bureau of Mines) to estimate potential damage to residential structures. Guidance for human response to blasting vibrations is given in Figure 12 (from Reference 14, Engineering of Rock Blasting on Civil Projects, by Hendron).

Once it has been determined that blasting is required, a pre-blasting survey should be performed. As a minimum, this should include: (a) examination of the site; (b) detailed examination and perhaps photographic records of adjacent structures; and (c) establishment of horizontal and vertical survey control points. In addition, the possibility of vibration monitoring should be considered, and monitoring stations and schedules should be established. During construction, detailed records should be kept of: (a) charge weight, (b) location of blast point and distance from existing structures, (c) delays, and (d) response as indicated by vibration monitoring. For safety, small charges should be used initially to establish a site specific relationship between charge weight, distance, and response.

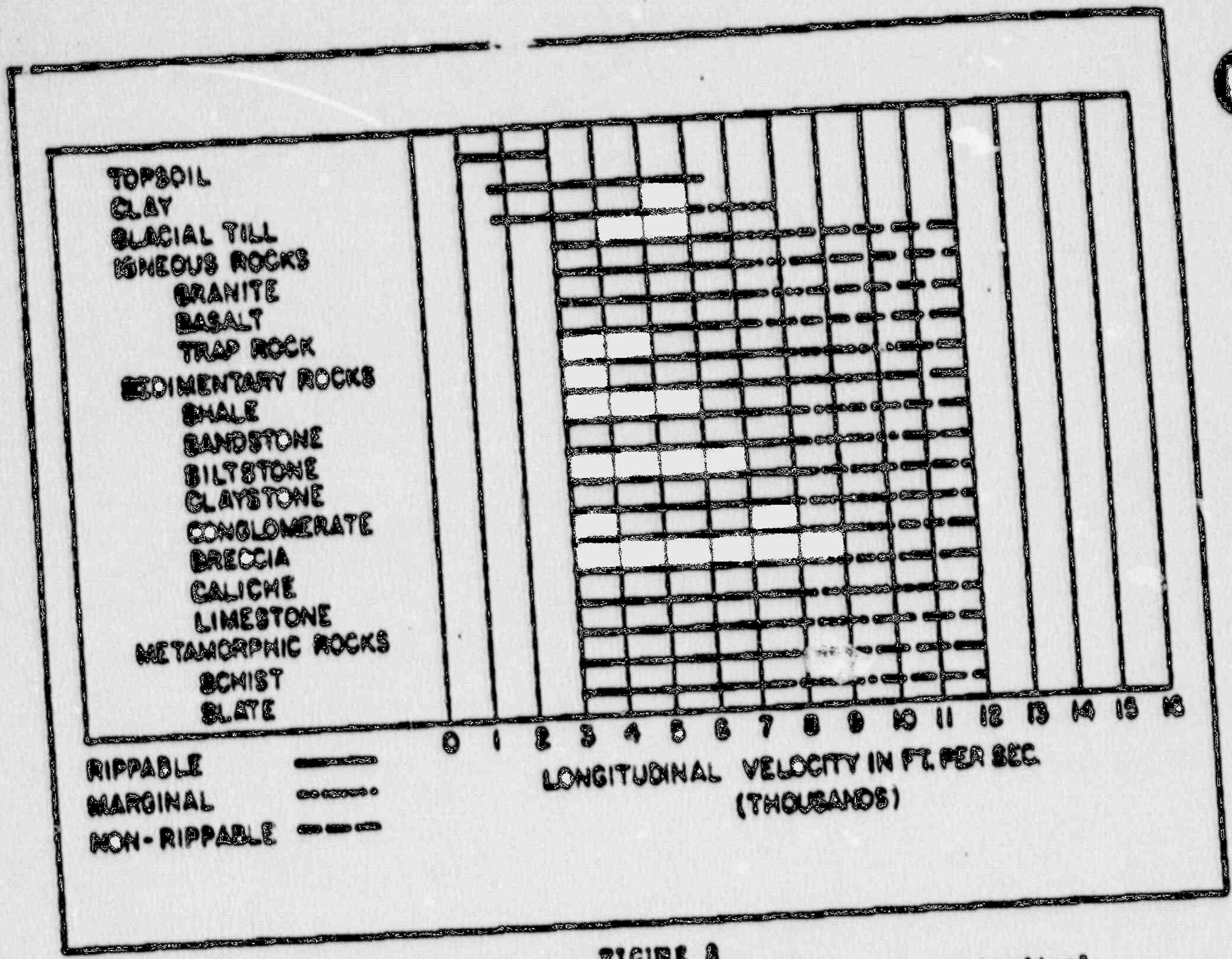


FIGURE 8
Rippability of Subsurface Materials Related to Longitudinal Seismic Velocity for a Heavy Duty Ripper (Tractor-Mounted)

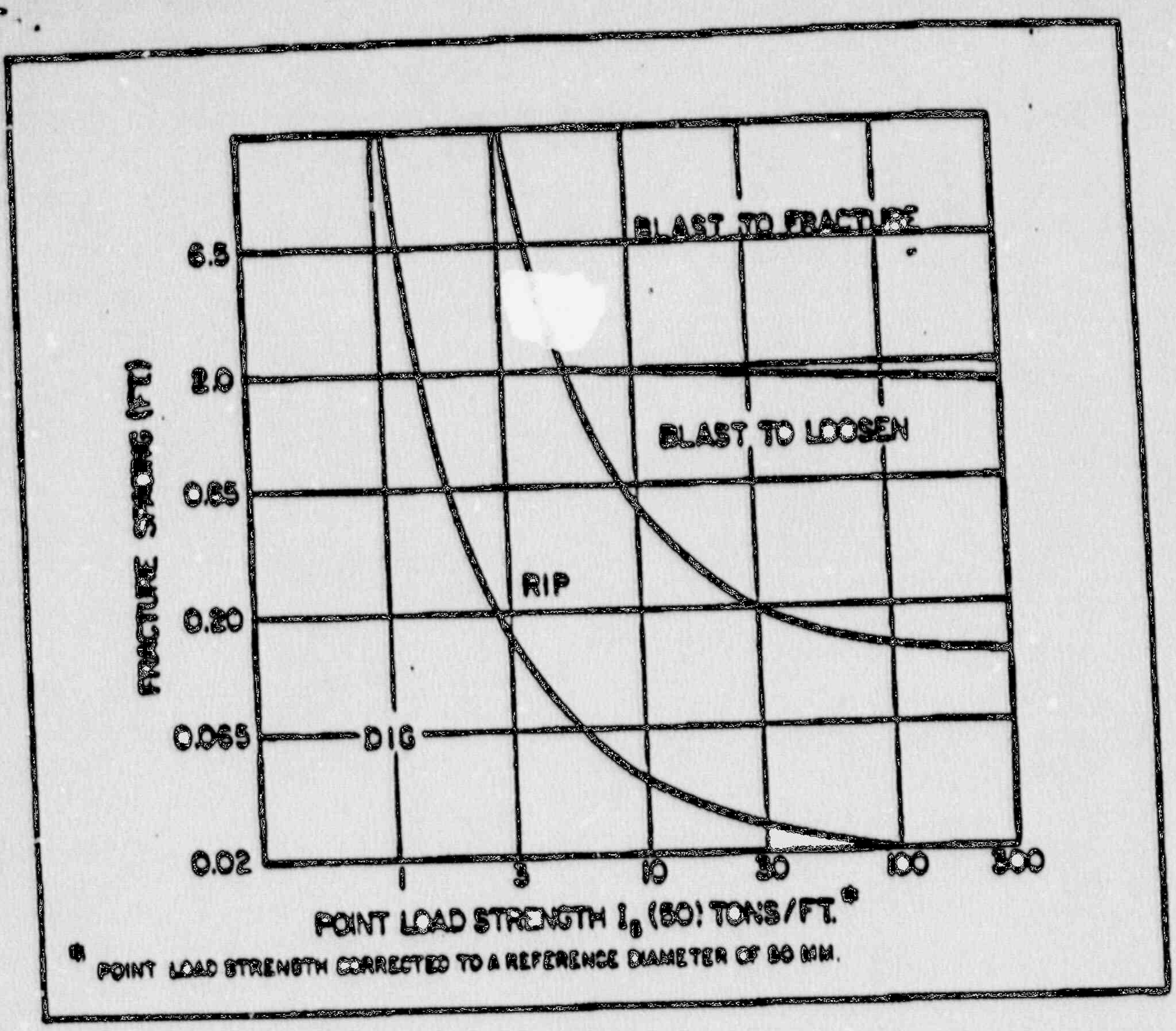
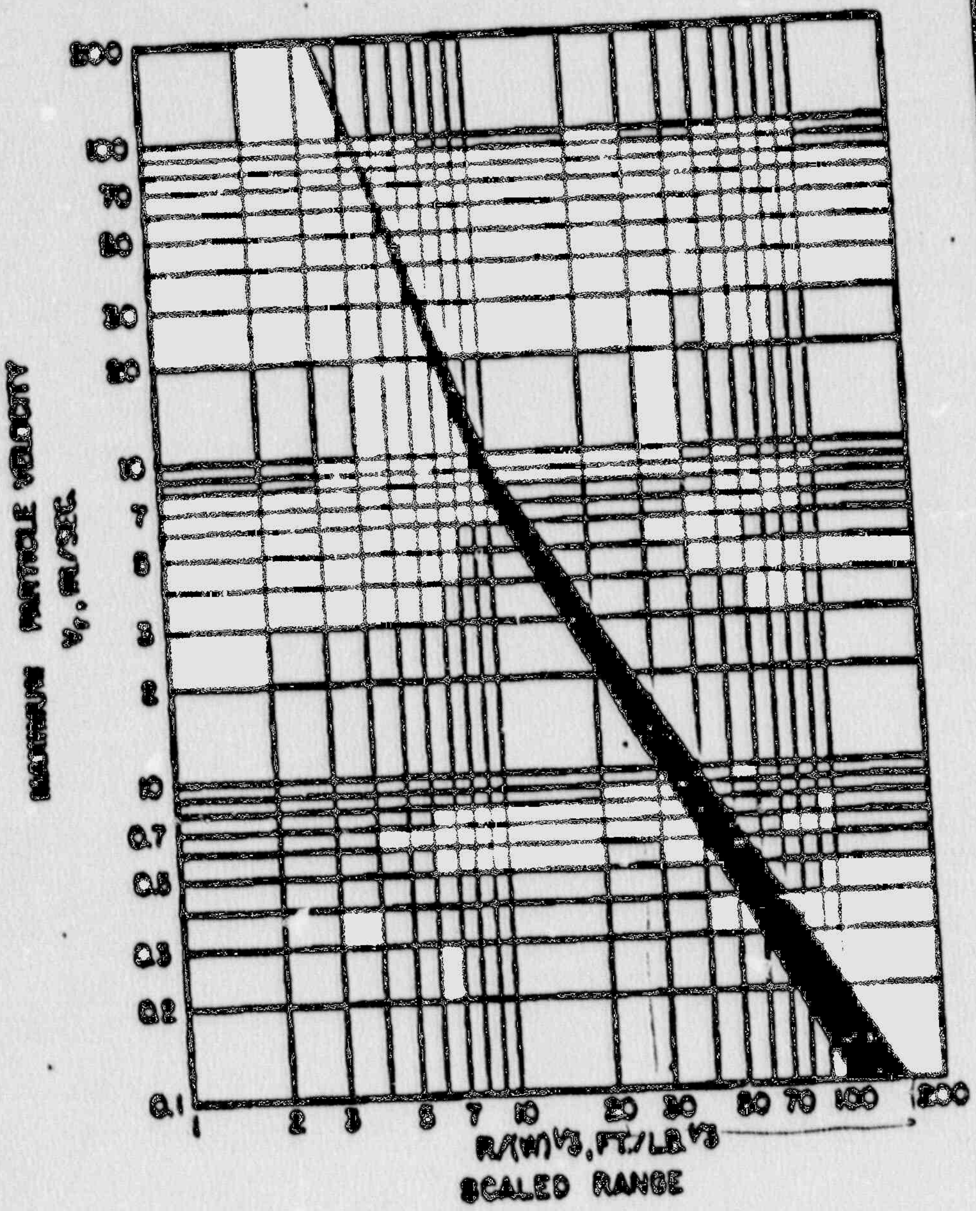


FIGURE 9
Suggested Guide for Ease of Excavation



EXAMPLE:

Weight of Explosive Charge = 8 lbs. = W

Distance from Blast Point = 100 ft. = R

$R/(W)^{1/3} = 50$

Peak V_r = 0.9 in/sec from chart

FIGURE 10
Cube Root Scaling Versus Maximum Particle Velocity

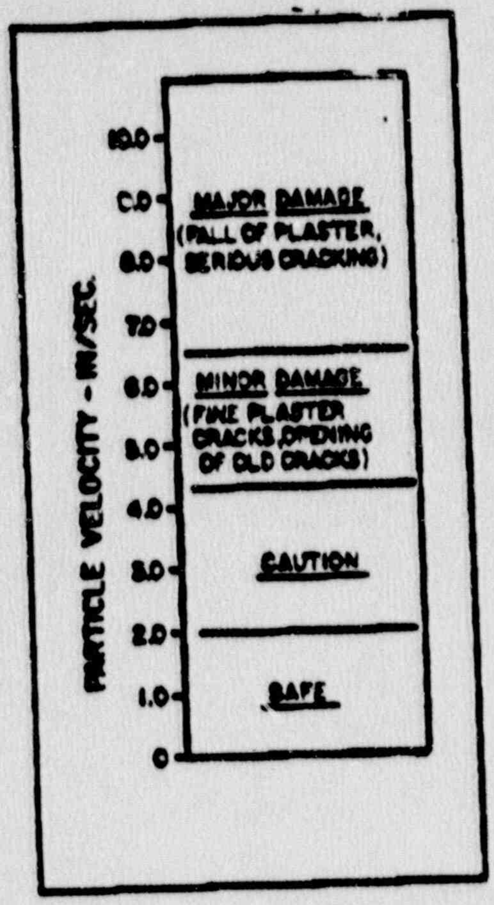


FIGURE 11
Guideline for Assessing Potential for Damage Induced by Blasting Vibration to Residential Structure Founded on Dense Soil or Rock

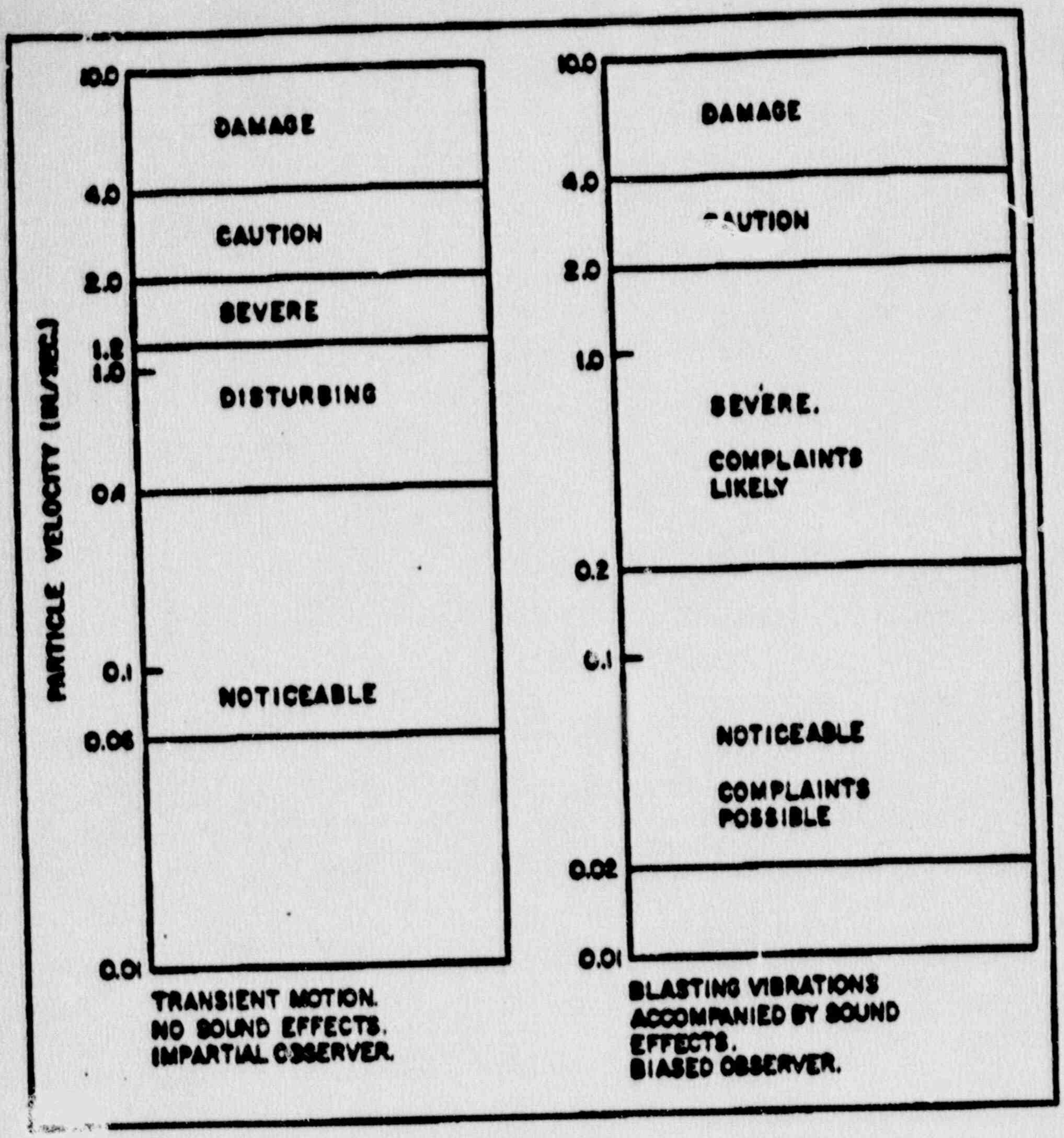


FIGURE 12
Guide for Predicting Human Response to Vibrations and Blasting Effects

APPENDIX 4

DESIGN CALCULATION APPROVAL SHEET
ENRICO FERMI UNIT 2

DC No. 4510
Volume I
Revision A
PIS No. A 80-00
No. of Pages 10

Title EFFECTS OF OFFSITE BLASTING ON FERMI 2

Description of Revision ADDED PAGES 9 & 10 TO JUSTIFY THE USE AN ACCELERATION OF .02g

Lead Discipline: CIVIL

	Signature	Date
Prepared by:	RA Bayer	7/17/87
Verified by:	H. SAHINER [signature]	7/21/87
Project Engineer (Support Organization Only)	NA	7/21/87
Supervisor Electrical/I&C - P&PE	NA	7/21/87
Supervisor Mechanical/Civil - P&PE	[signature]	7/21/87
Supervisor Systems Engineering	RAB 7/21/87 JW Hoffman for JR Green	7-23-87

ARMS - INFORMATION SYSTEMS

DTC TDPCAS DSN DC-4510 VOL I Rev A Date 7-23-87
PIS A8000 PIS File Recipient

DESIGN CALCULATION APPROVAL SHEET
ENRICO FERMI UNIT 2

DC No. 4510
Volume 1
Revision 0
PIS No. A30.00
No. of Pages ______

Title EFFECTS OF OFFSITE BLASTING ON FERMI 2

Description of Revision ______

Lead Discipline: CIVIL

	Signature	Date
Prepared by:	RA Bayer	3/23/87
Verified by:	A. E. Calandra	3/24/87
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Supervisor Mechanical/Civil - P&PE	AK 3/24/87 Abdul Alchalabi	3/24/87
Supervisor Systems Engineering	J. L. Green	3/24/87

ARMS - INFORMATION SYSTEMS

DTC TDPCAS DSN DC-4510 VOL I Rev 0 Date 3-24-87
PIS A30.00 PIS ______ File ______ Recipient ______

DC 4510

3/20/87

SHEET 1 OF 80

FERMI 2

EFFECTS OF OFFSITE BLASTING ON FERMI 2

[signature] 3/24/87

OBJECTIVE: TO EVALUATE THE EFFECTS OF ACCEDIENTAL DETONATION OF EXPLOSIVES AT ROCKWOOD STONE INC. (RSI) ROBERTS ROAD QUARRY ON FERMI 2 SAFETY RELATED STRUCTURES.

THIS EVALUATION CONSIDERS THE FOLLOWING:

- OVER PRESSURE
- BLAST INDUCED GROUND MOTION
- PEAK HYDOSTATIC PRESSURES

CONCLUSION: THE BLASTING ACTIVITIES AT RSI INCLUDING THE SHIPMENT AND STORAGE OF EXPLOSIVES AT RSI DO NOT ADVERSELY AFFECT SAFETY RELATED STRUCTURES AT FERMI 2.

FERMI 2
EFFECTS OF OFFSITE BLASTING ON FERMI 2

R.A. Bryer

J. Colandrea 9/20/89

CALCULATION METHODS.

REGULATORY GUIDE 1.91 (REFERENCE 3) IS USED TO EVALUATE THE EFFECTS OF BLAST INDUCED OVER PRESSURE

REFERENCE 4 IS USED TO EVALUATE GROUND MOTION

BOUNDARY CONDITIONS:
THIS ANALYSIS ONLY EVALUATES NUCLEAR SAFETY RELATED STRUCTURES. IT DOES NOT CONSIDER THE BLAST EFFECTS ON NON-SAFETY RELATED STRUCTURES SUCH AS OFFICE BUILDINGS AND SECURITY SYSTEMS

ASSUMPTIONS:
THE TYPE AND QUANTITY OF EXPLOSIVES DESCRIBED IN REFERENCE 2 ARE ASSUMED TO BE CORRECT

DEFINITIONS OF TERMS AND UNITS ARE NOTED IN THIS DESIGN CALCUATION

LOADING CONDITIONS ARE NOTED IN THIS DESIGN CALCULATION

COMPUTER CODES NONE

FORMULAS ARE NOTED IN THIS DESIGN CALCULATION

FERMI 2
EFFECTS OF OFF SITE BLASTING ON FERMI 2
RA Buyer
J. Colandrea 8/24/87

EXPLOSIVES USED AT RSI ARE AMMONIUM NITRATE FUEL OIL (ANFO)

ANFO HAS A TNT EQUIVALENCE OF 1.08

ANFO IS DELIVERED TO RSI IN TRUCK TRAILERS CONTAINING 40,000 POUNDS OF ANFO

THE MAXIMUM INVENTORY OF ANFO AT RSI IS 2 TRAILERS OR 80,000 POUNDS

THE ANFO IS STORED IN THE TRAILERS AT GROUND LEVEL (NOT IN THE QUARRY EXCAVATION)

THE DISTANCE FROM RSI TO FERMI 2 SAFETY RELATED STRUCTURES IS ABOUT 3 MILES

THE SHORTEST DISTANCE BETWEEN FERMI 2 SAFETY RELATED STRUCTURES AND THE EXPLOSIVE TRANSIT ROUTE IS 2 MILES.

CONSIDER OVERPRESSURE

AT RSI QUARRY, INVENTORY OF ANFO = 80,000
DISTANCE TO EF2 = 3 MILES = 15,840

FROM REGULATORY GUIDE 1.91, THE SAFE DISTANCE $R = 45W^{1/3}$

W = TNT EQUIVALENT = 1.08 x 80,000 = 86,400

SAFE DIST. $R = 45(86,400)^{1/3} = 1989$ ft
ACTUAL DISTANCE = 15,840'
SAFETY FACTOR = $\frac{15,840}{1989}$ = 7.96

FERMI 2
EFFECTS OF OFF SITE BLASTING ON FERMI 2
R.A. Bryan G Chandler 3/28/77

CONSIDER OVERPRESSURE FROM ACCIDENTAL DETONATION OF EXPLOSIVES IN TRANSIT.

INVENTORY OF ANFO = 40,000#
DISTANCE FROM TRANSIT ROUTE TO EF2 = 2 MILES
= 10,560 ft

W: TNT EQUIVALENT = 1.08(40,000) = 43,200#

SAFE DISTANCE $R = 45 W^{1/3}$
$= 45 (43,200)^{1/3}$
$R = 1579$ ft

ACTUAL DISTANCE = 10,560 ft

SAFETY FACTOR = $\frac{10,560}{1579}$ = 6.69

CONCLUSION: OVERPRESSURE DUE TO ACCIDENTAL DETONATION OF 80,000 POUNDS OF ANFO AT RSI QUARRY OR 40,000 POUNDS OF ANFO IN TRANSIT DOES <u>NOT</u> PRESENT A HAZARD TO FERMI 2

CONSIDER GROUND MOTION EFFECTS

USING FIGURE 10 OF REFERENCE 4

SCALED RANGE = $\frac{R}{(W)^{1/3}}$

AT RSI QUARRY, R = DISTANCE = 15,840'
W = 1.08 × 80,000 = 86,400#

SCALED RANGE = $\frac{15,840}{(86,400)^{1/3}}$ = 358

FERMI 2
EFFECTS OF OFF SITE BLASTING ON FERMI 2
RA Bryan J. Colandrea 8/24/87

FROM FIGURE 10, MAX VELOCITY < 0.1 IN/SEC.

FROM FIGURE 11, VELOCITIES LESS THAN 2 IN/SEC ARE SAFE.

$$\text{SAFETY FACTOR} = \frac{2}{0.1} = 20$$

FOR 40,000 POUNDS OF ANFO IN TRANSIT

$$\text{SCALED RANGE} = \frac{10,560}{(1.05 \times 40000)^{1/3}} = 301$$

FROM FIGURE 10, MAX VELOCITY < 0.1 IN/SEC

CONCLUSION: THE GROUND MOTION VELOCITY DUE TO ACCIDENTAL DETONATION OF 80,000 POUNDS OF ANFO AT RSI, OR 40,000 POUNDS OF ANFO IN TRANSIT IS LESS THAN 0.1 INCH PER SECOND. THIS IS 20 TIMES LESS THAN THE UPPER BOUND OF SAFE PARTICLE VELOCITIES.

CONSIDER THE EFFECTS OF PEAK HYDROSTATIC PRESSURE.

WILL PERFORM A CONSERVATIVE ANALYSIS BY NEGLECTING THE EFFECTS OF GROUND ATTENUATION.

WILL ESTIMATE THE INCREASE IN HYDROSTATIC PRESSURE AS FOLLOWS.

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FERMI 2 — SHEET 6 OF 80

EFFECTS OF OFF SITE BLASTING ON FERMI 2

R.A. Bryer — G. Columbra 4/4/87

DETERMINE MAXIMUM GROUND DISPLACEMENT DUE TO A SSE. FROM FSAR FIGURE 2.5-71 SHEET 1, MAX DISPLACEMENT = 15 INCHES AT ACCELERATION OF .15g

WILL NOW NORMALIZE THIS DISPLACEMENT TO THE DISPLACEMENT EXPECTED AT AN ACCELERATION OF .02g. NOTE, PER REFERENCE 1, .02g IS THE THE PEAK ACCELERATION DUE TO THE DETONATION OF 82,000 POUNDS OF EXPLOSIVES AT 8700 FEET. SINCE THE DISTANCE BETWEEN FERMI 2 AND RSI IS 15,840 FEET, THIS IS A CONSERVATIVE VALUE

$$\text{NORMALIZED DISPLACEMENT} = \frac{.02g}{.15g}(15) = 2''$$

APPLY MULTIMODAL FACTOR OF 1.5 FOR A DISPLACEMENT OF 1.5(2) = 3"

$$\text{EQUIVALENT PRESSURE} = \frac{3''}{12''/ft} \times \frac{62.4\#}{ft^3} \times \frac{ft^2}{144\,in^2} = .11\,psi$$

WILL COMPARE THIS EQUIVALENT PRESSURE WITH THE INCREASE IN HYDROSTATIC PRESSURE DUE TO A PROBABLE MAXIMUM FLOOD. (PMF)

FROM FSAR SECTION 2.4.2.2, THE PMF LEVEL IS ELEVATION 586.9 FEET

ASSUME NORMAL LAKE LEVEL OF 575.5 FEET

THE INCREASE IN HYDROSTATIC PRESSURE DUE TO A PMF = 586.9 - 575.5 = 11.4 FEET

$$= 11.4\,ft \times 62.4\frac{\#}{ft^3} \times \frac{ft^2}{144\,in^2} = 4.94\,psi$$

DC 4510 8/28/87

SHEET 7 OF 8

FERMI

EFFECTS OF OFF SITE BLASTING OF FERMI 2

RA Bryan

J. Colandrea

CONCLUSION

THE INCREASE IN HYDROSTATIC PRESSURE DUE TO THE ACCIDENTAL DETONATION OF 80,000 POUNDS OF ANFO IS 0.11 PSI WHICH IS ENVELOPED BY THE INCREASE IN HYDROSTATIC PRESSURE DUE TO A PMF.

$$SAFETY\ FACTOR = \frac{4.94}{.11} = 44.9$$

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SHEET 8 OF 11

FERMI 2
EFFECTS OF OFF SITE BLASTING ON FERMI 2
RA Bryer

G Colandrea 3/20/87

REFERENCES

1. LETTER FROM NRC (J. J. STEFANO) TO EDISON (B. R. SLYVIA) DATED 2/27/87. (APPENDIX 1)

2. EDISON LETTER VP-86-0100 DATED 7/24/86 TO NRC. (APPENDIX 2)

3. NRC REGULATORY GUIDE 1.91, EVALUATIONS OF EXPLOSIONS POSTULATED TO OCCURE ON TRANSPORTATION ROUTES NEAR NUCLEAR POWER PLANTS. (APPENDIX 3)

4. NAVFAC DM-7.2 U.S. NAVY DESIGN MANUAL 7.2 FOUNDATIONS AND EARTH STRUCTURES (APPENDIX 4)

FERMI 2
EFFECTS OF OFFSITE BLASTING ON FERMI 2
RA Bryer

PAGE 6 OF THIS CALCULATION USES AN ACCELERATION OF .02g WHICH WAS PROVIDED BY REFERENCE 1. THE FOLLOWING DISCUSSION PROVIDES THE BASIS FOR USING THIS ACCELERATION.

REFERENCE 1 REFERS TO A PREVIOUS NRC REVIEW OF A NUCLEAR POWER PLANT, IN WHICH THE NRC STAFF ANALYZED THE DETONATION OF 82,000 POUNDS OF EXPLOSIVES AT A DISTANCE OF 5700 FEET.

THE PLANT REFERRED TO IN REFERENCE 1 IS THE ZIMMER NUCLEAR PLANT LOCATED 25 MILES SOUTHEAST OF CINCINATTI, OHIO.

THIS EVALUATION WILL COMPARE THE ROCK PROPERTIES OF THE ZIMMER SITE WITH THE FERMI 2 SITE. ALL DATA IS TAKEN FROM THE ZIMMER FSAR AND THE FERMI 2 UFSAR.

ROCK PROPERTY	FERMI 2	ZIMMER
1. ROCK TYPE UPPER LAYER	DOLOMITE (UFSAR Fig. 2.5-58	LIMESTONE & SHALE (FSAR 2.5.1)
2. AVERAGE SPECIFIC GRAVITY	2.44 (UFSAR TABLE 2.5-5)	2.66 (FSAR TABLE 2.5-R)
3. AVERAGE VELOCITY OF COMPRESSIVE WAVE	12,333 ft/sec (UFSAR TABLE 2.5-7)	14,140 ft/sec (FSAR TABLE 2.5-16)
4. AVERAGE ULTIMATE COMPRESSIVE STRENGTH	1.36×10^6 PSF (UFSAR TABLE 2.5-5)	1.99×10^6 PSF (FSAR TABLE 2.5-9)

FERMI 2
EFFECTS OF OFFSITE BLASTING ON FERMI 2
Bill Boyer

THE NRC EVALUATION OF ZIMMER RESULTED IN A ACCELERATION OF LESS THAN .02g FOR THE DETONATION OF 82,000 POUNDS OF EXPLOSIVES AT A DISTANCE OF 8700 FEET. THIS OCCURED IN ROCK WHICH HAS A AVERAGE COMPRESSIVE WAVE VELOCITY OF 14,140 ft/SEC.

THE FERMI 2 SITUATION CONSIDERS A DETONATION OF 80,000 POUNDS OF EXPLOSIVES AT A DISTANCE OF 10,500 FEET. THE AVERAGE COMPRESSIVE WAVE VELOCITY OF THE FERMI 2 ROCK IS 12,333 ft/SEC.

SINCE THE WAVE VELOCITY AT FERMI 2 IS ONLY 87% OF WAVE VELOCITY AT ZIMMER, THE ACCELERATION DUE TO BLASTING NEAR FERMI 2 WOULD BE LESS THAN THE ACCELERATION DUE TO BLASTING NEAR ZIMMER.

THE VOLUME OF EXPLOSIVES CONSIDERED FOR FERMI 2 IS LESS THAN THE VOLUME OF EXPLOSIVES CONSIDERED AT ZIMMER. THE DISTANCE BETWEEN FERMI 2 AND THE POSTULATED EXPLOSION IS 21% GREATER THAN THE DISTANCE BETWEEN ZIMMER AND THE POSTULATED EXPLOSION.

BECAUSE OF THE LOWER WAVE VELOCITY AT FERMI 2 AND THE SMALLER VOLUME OF EXPLOSIVES AT FERMI 2 AND THE GREATER DISTANCE AT FERMI 2, IT IS CONSERVATIVE TO USE AN ACCELERATION OF .02g FOR THE FERMI 2 EVALUATION.