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SUBJECT:
RESPONSE TO NRC"S LTR DTD 08/18/77 & 11/22/77... FORWARDING ADDL INFO PERTAINING TO CASK DROP ANALYSIS... W/ATT DRAWINGS.

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January 31, 1978
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Director of Nuclear Reactor Regulation
Attn: R. W. Reid, Chief
Operating Reactors Branch No. 4
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

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U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

Dear Sir:

Three Mile Island Nuclear Station Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Cask Drop Analysis Additional Information

In response to your letter of August 18, 1977, and per our letter of November 22, 1977 (GQL 1622), enclosed please find the subject additional information.

Sincerely,

J. G. Herbein
Vice President-Generation

JGH:RJS:cjg

Enclosure

1584 142

A001/S
1/1
REDUCE DRWGS

THREE MILE ISLAND NUCLEAR STATION

UNIT 1

CASK DROP ANALYSIS

ADDITIONAL INFORMATION

1.0 The Cask Drop Evaluation for Three Mile Island Unit 1 (TMI-1), enclosed with your February 14, 1976 letter, states:

(1) "During transfer of the cask to and from the decontamination pit and raising and lowering of the cask within the pit, results of evaluations indicate that with the present system, cask drop accidents could possibly result in unacceptable damage to engineered safeguard circuits, spent fuel pool coolant pipes, and cooling water pipes to the spent fuel pool coolers. Met-Ed is currently evaluating possible plant modifications and changes to operating procedures to correct this situation," and

(2) "When the location for cask decontamination operations is selected, the specific plant modifications and changes to operating procedures and technical specifications that are required will be described to NRC. Until such time, the present cask decontamination pit will not be used."

The discussion supporting the proposed changes to the Technical Specifications transmitted by your letter of September 21, 1976 states that as a result of your studies, it is now proposed to relocate the cask decontamination area in the shaded area shown in Figure 3.11-3 of your September 21, 1976 submittal. Further, FSAR Figure 1-3 shows that the Unit 1 temporary new fuel storage area is located parallel to the transporter railroad tracks and could be in the path of the spent fuel cask as it travels to and from the Unit 1 decontamination area as well as the corresponding work stations in Unit 2.

It is expected that an incoming empty shipping cask will be moved from the transporter to the decontamination area for cleaning before being moved to the loading pit. For the Unit 1 loaded cask, it is possible that it will be moved from the cask storage and loading pit across the railroad tracks and again over the temporary new fuel storage area to the decontamination area for decontamination before being loaded on to the transporter.

To enable us to continue our review and evaluation of the safety implications of the Unit 1 proposed changes, once the shipping cask and transporter has entered the Unit 1 building for the offsite shipment of fuel from either Unit 1 or Unit 2, we will require the following additional information.

QUESTION

1.1 Provide one drawing showing the relative location of the following areas of Unit 1: (i) the new fuel storage areas; (ii) the spent fuel storage pool; (iii) the spent fuel cask storage and loading pit; and (iv) the specific location of the cask decontamination area.

1584 144

RESPONSE

The requested information is shown on Figure 1.

To further clarify these areas, the following figures have been revised:

Figure 1-3 TMI-1 FSAR

(1) "Temporary New Fuel Storage Rack" changed to "Receiving/ Shipping Area."

(2) "Spent Fuel Cask Storage Area" changed to "Spent Fuel Cask Storage & Loading Pit and Decontamination Area."

Figure 1-4 TMI-1 FSAR

(1) "Decontamination Pit" changed to "Decontamination Pit (Not Used)."

(2) "Spent Fuel Cask Storage" changed to "Spent Fuel Cask Storage & Loading Pit and Decontamination Area."

Figure 9-18 TMI-1 FSAR

(1) "Temporary New Fuel Storage Rack" changed to "Receiving/ Shipping Area."

(2) "Shipping Cask Area" changed to "Spent Fuel Cask Storage & Loading Pit and Decontamination Area."

(3) "Decontamination Pit Area" changed to "Decontamination Pit Area (Not Used)."

QUESTION

1.2 To adequately evaluate the potential for unsafe conditions occurring in Unit 1 following a cask drop accident at any point along its revised path of travel between the transporter, the newly located decontamination area, and the spent fuel cask loading pit, superimpose the travel paths of the shipping cask for Unit 1 and 2 within the Unit 1 building on the drawing requested above.

RESPONSE

The travel path of the shipping cask for Unit 1 and 2 within the Unit 1 building is shown on Figure 1.

QUESTION

1.3 Verify that the path of travel of the spent fuel cask from the transporter to the Unit 2 building has not changed due to these proposed changes or describe, discuss and demonstrate that no safety related consequences could result from these changes.

RESPONSE

1584 146

The path of travel of the spent fuel cask from the transporter to the Unit 2 building remains as shown in the TMI-2 FSAR, Volume 8, Section 9.1.4.2.2. See Figure 1.

Therefore, there are no changes to evaluate for safety related consequences.

QUESTION

1.4 Assuming the engineered safeguard circuit trays have been relocated as proposed in Figures IV-3 and IV-4 (February 14, 1976 submittal) and a cask drop accident occurs such as to disable one of the two separated engineered safeguard trays when the reactor is at power. Provide the following information:

(a) Describe, discuss, and demonstrate that the single event (cask drop), at any point along its path of travel, will not initiate another event that potentially could prevent a safe reactor shutdown or prevent adequate spent fuel cooling. Your analysis should assume a single failure in the systems associated with the remaining intact engineered safeguards tray or other essential systems but may include use of non-safety grade equipment. Where possible, reference the appropriate Figures in the FSAR which show the location of threatened equipment.

RESPONSE

1584 147

The engineered safeguard cable raceway system in the vicinity of the spent fuel cask handling path is separated and constructed so as to preclude damage to more than one redundant safeguard channel for any single failure. The raceways are separated and contained within two protected areas so that a postulated cask drop accident would not simultaneously damage redundant engineered safeguard channels. The simultaneous occurrence of an open or short circuit in the protected redundant engineered safeguard cable is highly improbable and not considered credible.

Additionally, we have analyzed the postulated cask drop and have concluded that this accident will not initiate another event that could preclude a safe reactor shut-down or prevent adequate spent fuel cooling. In addition, IEEE Trial-Use Standard Criteria for Safety Systems for Nuclear Power Generating Stations, August 15, 1977 IEEE Std. 603-1977 Paragraph 4.3 Single Failure Criterion, does not require an analysis that would "assume a single failure in the systems associated with the remaining intact engineered safeguards tray." A postulated cask drop is a design basis event and in itself is considered a single failure; therefore, the engineered safeguard system is not required to sustain a second single failure.

Per the Cask Drop Evaluation, February 14, 1976 item 4 page IV-9 it is concluded that the "changes described" will provide reasonable assurance that cask drop accidents during transfer of the cask to and from the cask loading pit and raising and lowering of the cask within the pit will not result in the cask falling into the "B" spent fuel pool. This means that there can be no damage to the mechanical equipment of the spent fuel pool cooling system. The only mechanical portion of the spent fuel pool cooling system that could be damaged is that portion of the 4" line (for filling and partially emptying the spent fuel cask storage and loading pit) that penetrates the liner of the west wall of the pit. Since the only function of this pipe is to fill and partially empty the spent fuel cask storage and loading pit, no damage whatsoever is incurred to the spent fuel cooling system.

QUESTION 1584 148

1.4(b) In reference to the criteria that will be followed in making the modifications, the following statement is made "Damage to multicolored circuits along with damage to circuits associated with one of those colors is acceptable since the multicolored circuits are protected interconnections between two redundant channels." Provide further clarification which demonstrates that the protected interconnections between two redundant channels will provide adequate protection in the event of: (a) any open circuit, (b) any short circuit and (c) any short circuit between any two conductors that could develop as a result of a cask drop accident, and thereby provide assurance that no more than one channel of redundant engineered safeguards system, or reactor protection system could be degraded or disabled.

RESPONSE

There is only one multi-colored circuit in the vicinity of the cask travel area. This circuit provides an interlock to the reactor building emergency cooling unit fan. This circuit is run in conduit through the area of a postulated cask drop accident. The loss of this circuit through an open circuit could cause the loss of the Reactor Building cooling fan; a short circuit would definitely cause the loss of the fan control circuit and therefore the fan would be inoperable until minor modifications could be made. The consequences of the fan loss are minor (the requirements for this fan are described in Section 6.3 of the FSAR) since this is the third redundant back-up to the Reactor Building Emergency Cooling System.

STATEMENT

1584 149

2.0 It is stated in your submittal that:

(1) the cask will be handled above and adjacent to engineered safeguard equipment;

(2) the floor slabs are not designed to withstand the impact of a dropped cask;

(3) cask sizes considered in the evaluation included small truck casks weighing approximately 25 tons up to the large rail casks weighing up to the rated capacity of the fuel handling crane of 110 tons.

QUESTION

2.1 Based on the most adverse combination of cask drop conditions, at all points along its revised path of travel within the Unit 1 building, demonstrate by analysis that sufficient design margin exists to enable the staff to conclude that, for the specific shipping casks considered, the resulting damage will not preclude the facility's essential equipment (such as pumps, piping, valves, and electrical trays) from attaining and maintaining a controlled, cold safe reactor shutdown. Where structures are found to withstand the impact of the cask drop, present the input parameters assumed in the analysis including: cask weight, cask impact area, drop height, drop location, and the assumptions regarding credit taken in the analysis for the action of impact limiters.

RESPONSE

The results of an evaluation of the effects of postulated spent fuel cask drop accidents at Three Mile Island Unit 1 are contained in the February 14, 1976, submittal (Met-Ed letter GQL 0215 to NRC dated February 14, 1976). Proposed technical specification changes to plant operating procedures during cask handling are contained in the September 21, 1976, submittal (Met-Ed letter GQL 1244 to NRC dated September 21, 1976).

The evaluation included cask drop accidents during transfer of the cask between the railcar and the top of the "B" spent fuel pool, transfer of the cask to and from the cask loading pit and raising and lowering of the cask within the pit, and transfer of the cask to and from the decontamination pit and raising and lowering of the cask within the pit. Thus, cask drop accidents were considered at all points along the revised transfer path. Cask sizes considered in the evaluation included small truck casks weighing approximately 30 tons up to large rail casks weighing up to the rated capacity of the fuel handling crane of 110 tons. Considerations were given to integrity of the spent fuel storage pool and spent fuel assemblies stored in the pool, and integrity of safety systems and equipment located below the cask transfer path. Results of the evaluation are summarized below.

During transfer of the cask between the railcar and the top of the "B" spent fuel pool, results of evaluations indicated that cask drop accidents at certain locations could possibly result in unacceptable damage to engineered safeguard circuits located in cable trays below the cask transfer path. Accordingly, Met-Ed has relocated one engineered safeguard circuit tray (containing two engineered safeguard circuits) and revised the cask transfer path to take advantage of the physical separation that now exists between other trays so that single cask drop accidents will not result in unacceptable damage to engineered safeguard circuits located below the cask transfer path. The specific details are discussed in Section IV.A of the

February 14, 1976, submittal and the September 21, 1976, submittal.

During transfer of the cask to and from the cask loading pit, results of evaluations indicated a cask drop on the edge of the pool wall could result in the cask being deflected into the "B" spent fuel pool. Accordingly, Met-Ed has revised the cask transfer path to the cask loading pit so that the cask will be tipped in a direction away from the "B" spent fuel pool in the event of a cask drop on the edge of the pool wall. The revised cask transfer path to the cask loading pit is discussed in Section IV.B of the February 14, 1976, submittal and the September 21, 1976, submittal.

During transfer of the cask to and from the decontamination pit and raising and lowering of the cask within the pit, results of evaluations indicated that cask drop accidents could possibly result in unacceptable damage to engineered safeguard circuits, spent fuel pool cooling pipes, and cooling water pipes to the spent fuel pool coolers. Accordingly, Met-Ed has decided not to use the present cask decontamination pit. The cask will be decontaminated in the cask loading pit and transferred to the receiving/shipping area.

Results of additional evaluations indicate that during transfer of the cask over the receiving/shipping area on the 305'-1" elevation, south of the railcar slab, cask drop accidents could possibly damage green engineered safeguard circuits located in the air intake tunnel. To do this, the cask would have to penetrate two floor slabs at elevations 305'-1" and 293'-0" as shown in Figure IV-2 of the February 14, 1976, submittal. Since the resulting damage would be limited to one redundant system, the possible damage is considered acceptable in accordance with the criteria established in Section IV-A of the February 14, 1976, submittal.

The railcar slab at elevation 301'-6" and the operating floor slab at elevation 305'-1" (refer to Figures IV-3 and IV-4 of the February 14, 1976, submittal) located below the revised cask transfer path are not designed to withstand the impact of a dropped cask. Therefore, in the cask drop evaluation, the engineered safeguard circuits located in trays below these floor slabs are assumed to be damaged in the event of cask drop accidents over these floor slabs. The specific circuits that could be damaged are identified in Section IV-A of the February 14, 1976, submittal. As discussed in the February 14, 1976, submittal, the revised cask transfer path and the plant modification to relocate one entire engineered safeguard circuit tray provide reasonable assurance that single cask drop accidents over the floor slabs at elevations 301'-6" and 305'-1" will not result in damage to more than one redundant channel of engineered safeguard circuits. This will assure that the resulting damage will not preclude the facilities' essential equipment from attaining and maintaining a controlled, cold, safe reactor shutdown.

The bottom of the cask loading pit is constructed of reinforced concrete to bedrock and thus is designed to withstand the impact of a dropped cask. Maximum drop height is approximately 44 feet. Likewise, the 5-foot wide walls of the "B" spent fuel pool are constructed of reinforced concrete to bedrock and are also designed to withstand the impact of a dropped cask. Maximum drop height is approximately 1 foot (FSAR Section 9.7.1.1.). The 1.5-foot wide east wall of the cask loading pit is also constructed of reinforced concrete to bedrock.

Additional calculations have been performed to determine the structural adequacy of the east wall of the cask loading pit as a result of postulated cask drop accidents. As indicated in Section IV-B of the February 14, 1976, submittal, a cask drop on the east wall of the cask loading pit will result in local crushing of the wall of less than 0.50-inch at the top. The gross strength of the east wall is not affected by this amount of local crushing. The east wall has been analyzed for stability or buckling due to the cask impact load and the vertical and horizontal reaction loads due to a cask tipping accident on the edge of the wall. Results of these calculations indicate the wall is structurally adequate for the maximum applied impac⁺ ‿nd reaction loads.

Input parameters for the above analyses are summarized below.

Cask Considered	Assumed Weight tons	Impact Area (1) in2	Drop Height in	Drop Location
NFS-4	30	660 - Balsa 77 - Steel	6	Center of 5'-0" wide south wall of "B" spent fuel pool and center of 1'-6" wide east wall of cask loading pit.
NL! 1/2	30	855 (2)	6	
IF 300	75	814 (3)	6	
IF 400 (Proposed)	110	1134 (3)	6	
NL! 10/24	110	3959 (2)	6	

(1) Total impact area of the bottom of the cask. The impact area on the 1'-6" east wall is

$$\text{Total Impact Area} \times \frac{\text{Dia of Cask} \times \text{Width of East Wall}}{\text{Projected Area of Cask Bottom}}$$

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(2) Impact area of cask bottom plate without impact limiters.

(3) Impact area of the impact fins.

For the NLI 1/2 and NLI 10/24 casks, the impact limiters were assumed to be removed from the cask, i.e., no credit was taken in the analysis for the impact limiters. For the IF 300 and IF 400 (proposed) casks, no credit was taken for the energy absorption characteristics of the impact limiters. The actual impact area of the impact fins located on the cask bottom plate was used in the analysis. For the NFS-4 casks, credit was taken for the balsa wood impact limiter which is an integral part of the cask bottom plate.

Two additional areas of the structure found to withstand the impact of the cask drop within the Unit 1 building are discussed in Section IV.A.3 of the February 4, 1976 submittal (Points B and C). For these areas the input parameters assumed in the analysis are:

a. Cask Weight	110 Tons
b. Cask Impact Area	Point Impact
c. Drop Height	44'-0"
d. Drop Location	Direct hit on to the North and South wall of the rail-car slab, at Elevation 305'-1".
e. Credit for Cask Impact Limiters	None

QUESTION

2.2 Demonstrate that following a cask drop accident the cask will not tip, roll, or impact on Unit 1 temporarily stored new fuel in a manner which would lead to a criticality accident. In particular, state a maximum credible value for the multiplication factor (K_{eff}) following such a cask drop accident considering the effects of any possible reduction in fuel spacing, with the introduction of neutron moderating material (aqueous foam, water from ruptured pipes or fire-fighting apparatus, etc.). This maximum credible value should include reflective effects from structural concrete and any other moderating materials near the fuel mass. Provide the assumptions made in the analyses and the resulting safety margins which support your conclusions.

RESPONSE

As shown on Figure 1, the area south of the railroad track is no longer designated as a temporary storage area for new fuel. New fuel will be receipt inspected in this area and then will be transferred to the new fuel storage racks shown in Figure 1 or to the spent fuel pools. No new fuel will be permitted in the receiving/shipping area during cask handling operations. Therefore the questioned impact of an accident on Unit 1 temporarily stored new fuel cannot occur.

QUESTION

3.0 For each of the spent fuel shipping casks that will be handled, demonstrate that the crane hoist will not subject the various cask trunnions and handling yokes, considered in your evaluation, to excessive deceleration loads under the following assumptions: (1) the cask is near its upper limit of travel; (2) the cask is being lowered at its maximum speed as defined by the hoist controls; and (3) the crane experiences a loss of power thereby causing the hoist mechanical load brake and the solenoid brake to automatically set.

Accordingly, in tabular form for each cask, provide the following information:

(a) the static factors of safety of the cask handling yoke, the cask trunnions and the weight of cask;

(b) the maximum lowering speed as defined by the hoist controls; and

(c) the results of dynamic analyses which demonstrate that the cask trunnions and handling yoke have sufficient design margin to preclude their failure due to the deceleration loads created by the hoist breaks.

RESPONSE

The considered casks are in conformance with 10 CFR § 71.3(c). The static factor of safety of the cask handling yoke and the cask trunnions is 3.0 based on the yield strength of the material. The maximum lowering speed as defined by the hoist concrols is 5 feet per minute.

Dynamic analyses have been performed considering that the deceleration load hypothesized in Items 3.0 (1), (2) and (3), is absorbed by the crane hoist reeving between the take-up drum/upper block and the main block in its highest position. The results of these analyses are:

Cask Weight (Tons)	Dynamic Load	Factor of Safety On Yield
110	1.1	3 ÷ 1.1 = 2.7
75	1.1	3 ÷ 1.1 = 2.7
25	1.2	3 ÷ 1.2 = 2.5

These results are conservative as no credit is taken for the mechanical portion of the crane acting as an energy absorber.

The results demonstrate that the cask trunnions and handling yoke have sufficient design margin to preclude their failure due to the deceleration loads created by the hoist brakes.

QUESTION

4.0 It has been noted that the bases provided in your September 21, 1976 submittal for Item 3.11.2 of the revised Technical Specifications has omitted reference to FSAR Figure 9-18A entitled "Fuel Handling Building Crane Key Interlock System Limits". Provide a revised Figure 9-18A showing the new key interlocked limits of travel of the crane.

Further, the basis for the present Technical Specification states that in the "unlikely event of a load drop accident, there would be no possibility of this resulting in any damage.....". The proposed corresponding statement in the revised Technical Specification basis states there "would be less possibility." Describe, discuss and clarify the purpose of this revision and the potential equipment and structures involved.

1584 158

RESPONSE

FSAR Figure 9-18A will be revised showing the new key interlock limits of travel of the crane. This will be accomplished by substituting Figure 1 for 9-18A. Additional details are also shown in Figures IV-4 and IV-6 of the February 14, 1976, submittal.

The substitution of the phrase "would be less possibility" for "would be no possibility" in the revised Technical Specification was editorial in nature and was not to be construed as a revision in itself potentially affecting equipment and structures. The appropriate phraseology shall be "would be no possibility" as was previously stated in the original Technical Specification.

QUESTION

5.0 Since the keyed interlock limits of crane travel only applies when the load being handled exceeds 15 tons, provide the following information regarding the system acceptability when there is a load of 14 tons on the crane hook, and it is over the stored spent fuel when "two blocking" occurs (i.e., the upper limit switch fails and the lower hoist block contacts the lower block). Demonstrate that either (a) the resulting radiological release will remain within acceptable limits should the lower load block and hook drop and impact on the stored spent fuel; or (b) the lower load block and hook will not drop should "two blocking" occur. (In the latter case, the analysis should take into account the peak stall torque of the hoist motor plus the kinetic energy of the hoist motor plus the kinetic energy of the hoist power train and motor when the hook is being raised at its maximum rated speed as allowed by the control system).

RESPONSE

Loads of 14 tons and less will be handled on the auxiliary crane trolley/block. "Two blocking" will be prevented by the addition of a second limit switch. This limit switch will provide a redundant means of stopping the crane block from exceeding its upper travel limit.

QUESTION

6.0 In regard to the shipping cask crane which is shared by Units 1 and 2, it has been noted that the staff's Safety Evaluation Report for Unit 2, dated September 1976, contains the following statement "We find the fuel handling system to be acceptable for a cask not exceeding 70 tons in weight, and will condition the operating license accordingly until and unless the applicant justifies use of a larger cask." Section 3.11.4 of the Unit 1 Technical Specifications would permit the crane to handle loads up to 110 tons since it states "Loads in excess of hook capacity shall not be lifted, except for load testing."

Describe and discuss any differences which exist between Units 1 and 2 as it relates to cask drop accidents. Further, the depth of detail provided should enable the reviewer to concur in the acceptability of 110 ton loads for the crane when they are being handled in the Unit 1 facility.

RESPONSE

The Unit 2 FSAR indicates that a cask tipping analysis has been performed for the proposed IF400 shipping cask which represents the maximum size and weight (~100 ton) of any cask under consideration. It also states that any cask drop over the fuel handling bridge operating floor or the cask pool will not result in damage to the spent fuel pool or other safety related components. The cask pool dimensions and design were based on the characteristics of the 70 ton General Electric cask, IF300. However, a recent reanalysis has revealed that the Unit 2 fuel handling building is able to withstand a cask drop accident of weight equal to the capacity of the crane from a height of six inches.

Unit 1 was analyzed in all respects for the larger size cask and is, as a result, requesting licensing for the rated capacity of the crane.

Therefore, no difference exists between Units 1 and 2, with respect to cask drop accidents.

QUESTION

7.0 Figure IV-3, (February 14, 1976 submittal) showing the modified cask transfer path and new location for engineered safeguards tray, indicates that the railcar is located partially outside the building during those times when the cask is being lifted from and lowered onto the railcar. Describe and discuss what means will be provided to prevent the railcar position from being adversely altered during a cask handling accident, such that it spans both the red and green cable trays during a cask drop accident and thereby being in a position to potentially cause damage to both redundant portions of the engineered safeguards cable trays.

1584 161

RESPONSE

The detail cask handling procedures will require that the brakes on the cask carrier, i.e., either the railcar or truck bed, be set and wheel chocks positioned prior to unloading or loading the spent fuel cask to prevent the carrier position from being adversely altered during a postulated cask drop accident. The procedures will also prohibit the cask carrier from being moved further into the building until the cask is removed from above the carrier.

QUESTION

8.0 Since the rail car will be partially outside the building during cask handling operations, describe, discuss and demonstrate that there are no significant adverse safety consequences resulting from having the heavy rolling door, shown in FSAR Figure 1-8, Section E1 - E1, open during such operations involving the offsite shipment of spent fuel from either Units 1 or 2 should a cask handling accident occur. Should the open doors result in a potential hazard to public health and safety, describe your proposed corrective measures.

RESPONSE

An analysis was performed to determine the radiological consequences at the TMI site boundary for a gross release of activity from a fully loaded fuel cask. The analysis is based on the following:

a. The accident is assumed to occur after the assemblies have cooled for 120 days.

b. All of the rods in twenty assemblies are assumed to rupture as a result of the accident.

c. The damaged assemblies are all assumed to be the highest powered assemblies. The inventory per assembly is determined by applying a radial peaking factor of 1.7 to the inventory of an average assembly. The inventory of an average assembly is determined by dividing the core inventories of Table 15A-2 of the Unit 2 FSAR by the number of assemblies in the core.

d. All of the activity in the clad gap in the damaged rods is released instantaneously to the environment. The gap activity is based on Regulatory Guide 1.25 assumptions, i.e. 10 percent of the total noble gases other than Kr-85, 30 percent of the Kr-85, and 10 percent of the total radioactive iodine in the rods at the time of the accident.

e. Atmospheric diffusion is calculated using a 0-2 hour dispersion factor at the exclusion boundary of 6.1×10^{-4} sec/m^3. This value is based on Table 6.2-9c submitted in Amendment 48 to the FSAR for Unit 2.

Isotopic releases to the atmosphere using these assumptions are summarized below:

Isotope	Activity Released (curies)
Kr-85	5.02+4
Xe-131m	9.78+0
Xe-133	3.76-1
I-131	4.32+1

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The resulting thyroid and whole body doses at the exclusion boundary are 13.5 and 0.016 Rem, respectively. These exposures are well within the guidelines of 10CFR100. Since the calculations are extremely conservative and were performed without taking credit for isolation of the cask loading area, no changes to facility equipment or Technical Specifications have been considered.

QUESTION

9.0 On Page IV-4, of your February 14, 1976 submittal, you state "Administrative procedures will be used to limit the height the cask lower surface is raised above the top of the "B" spent fuel pool to 6 inches maximum". Proposed Technical Specification 3.11.3 also makes a related reference to administrative control of load elevation.

Clarify what will be the carrying height of the cask bottom surface, with respect to fixed structures, at all points along the path of travel of the spent fuel shipping cask while it is within the building. What are the measures, in addition to administrative controls, which could be incorporated to preclude cask drop heights exceeding the above carrying heights.

RESPONSE

Maximum height over spent fuel pool walls will be six inches. Maximum height over 305'-1" floor will be 43'-5".

Presently there are structures that interfere with this travel scheme. These obstructions (a six inch curb, a few handrail posts and a fuel handling bridge stop) will be removed during cask handling operations.

QUESTION

10.0 Provide proposed Technical Specifications for crane rope inspection and replacement and for assuring operability of the limit switches which restrict crane travel. Use the appropriate corresponding parts of chapter 2-2 of the American National Standards Institute ANSI B30.2 for guidance in preparing your response.

RESPONSE

Procedure 3010 outlines the frequent and periodic inspection of cranes at TMI and is in accordance with ANSI B30.2 This procedure implements our legal requirements of Federal Register Par. II, Subpart N, Sec. 1910.179 of the Occupational Safety and Health Act and fulfills our commitment made in Amendment 50 of the TMI-1 FSAR. Based on the above and since the NRC Standard Tech. Spec's do not require the above details, we feel that no technical specification is necessary.

QUESTION

11.0 The FSAR states "A Whiting automatic paddle-type limit switch is installed for upper hoist limit to prevent "two-blocking" situations." Describe the design features or procedures that will be used to provide assurance that a single failure will not defeat this protection against 'two-blocking".

RESPONSE

1584 165

"Two-blocking" is prevented on the fuel handling crane main hook by a paddle-type limit switch, and by Adminsistrtive control. A screw-type switch on the main hook is presently utilized as a lower limit switch. This switch will be modified to also function as an upper limit switch. Therefore, a single failure in the system would still have redundant means of preventing "two-blocking."

QUESTION

12.0 Provide a summary of the cask stability analysis when the cask is dropped on the south wall of the "B" spent fuel pool for both eccentric and straight drop conditions."

RESPONSE

Results of the cask stability analysis when the cask is dropped onto the 5-foot wide south wall of the "B" spent fuel pool are presented below for the eccentric drop condition. Results for the straight drop are less severe than the eccentric drop condition and therefore are not controlling.

The main elements of the cask stability analysis are summarized below.

1. The cask bottom surface is assumed to be raised 6 inches above the top of the spent fuel pool wall and the cask center of gravity is assumed to be located 3 inches from the center of the 6-inch wide transfer path as shown in Figure 2a.

2. The lifting trunnion or lifting yoke arm on one side of the cask is assumed to fail. This lets the cask drop straight down 3 to 5 inches (depending on the cask involved) until the resulting slack in the system is removed, i.e.,

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a straight line of action is established between the unfailed cask trunnion, the center of the lifting yoke and the cable drum as shown in Figure 2b. At this point, the cable becomes tight.

3. As the cask continues to drop the load in the cable increases in direct proportion to the stretch of the cable. The eccentrically applied load reduces the casks vertical velocity and imparts angular and lateral velocity to the cask as shown in Figure 2c.

4. Eccentric drop analyses indicate that the maximum force produced in the cable is about 4 times the weight of the cask. At this load, the up until now unfailed cask trunnion or yoke arm is expected to fail. The cask then free falls with constant angular and lateral velocity as shown in Figure 2d until it impacts the top of the south wall of the "B" spent fuel pool.

5. The angular and lateral kinetic energy of the cask at impact are determined from the above model. Assuming all of this energy goes into increasing the potential energy of the cask, the amount the cask center of gravity is raised due to tipping is calculated as shown in Figure 2e. The cask is considered stable and will not tip over if the cask center of gravity is on the stable side of the pivot point, i.e., to the right of the pivot point shown in Figure 5.

Analyses were performed for three cask weights; 30-ton (NFS-4 and NLI 1/2), 75-ton (IF 300), and 110-ton (IF 400 - proposed, and NLI 10/24). Results are summarized below and show that all of the casks would be stable due to eccentric drops from 6 inches or less.

Cask Weight tons	Cask Position at Impact		Cask Velocity at Impact		Increase in Cask Center of Gravity	Increase in Cask Center of Gravity at which Cask becomes Unstable
	Δx, in	$\Delta\theta$, Deg	$\dot{x}$, in/sec(1)	$\dot{\theta}$ Rad/sec	Δh, in	Δh_{max}, in
30	1.88	.776	10.68	.077	0.50	3.05
75	2.08	1.85	11.80	.183	1.10	2.92
110	2.22	2.58	12.6	.256	1.60	2.86

(1) Includes maximum bridge travel speed = 50 fpm (10 in/sec).

QUESTION

13.0 Show that the liner plate will not tear if the east wall of the loading pit deflects 1" as postulated in Section IV-B-3. Also discuss the effects on the fuel racks which are in contact with the east wall due to the 1" deflection.

RESPONSE

No credit is taken for the 3/16-inch liner plate in the analysis to determine the structural adequacy of the east wall of the cask loading pit for impact loads due to a postulated eccentric drop accident. Therefore, the conclusions stated in the February 14, 1976, submittal stating that the deflection of the east wall is less than 1 inch and that gross failure of the east wall will not occur are valid even if the liner plate locally tears. It is also noted that the 1-inch wall deflection is calculated to cause a maximum strain in the liner plate of about 1.6 percent. This is well below the minimum elongation of the stainless steel liner plate of 40 percent.

The 1-inch deflection reported in the February 14, 1976, submittal to the NRC is for a case where the cask impacts the 1'-6" wide east wall of the cask loading pit following a postulated eccentric drop accident while raising or lowering the cask within the pit. The maximum calculated deflection of 1-inch occurs when the cask impacts the east wall at the top of the cask loading pit where the wall is considered as a cantilever since no credit is taken for support at the north end from the fuel transfer gate. At the elevation of the spent fuel storage racks, the east wall of the cask loading pit is much stiffer because it is supported at the north end, i.e., at this elevation the wall is no longer considered a cantilever since the opening for the fuel transfer gate stops about 2.5 feet above the spent fuel storage racks. Hence, the deflection of the east wall of the cask loading pit at the elevation of the spent fuel storage racks due to cask impact loads is expected to be significantly less than 1 inch.

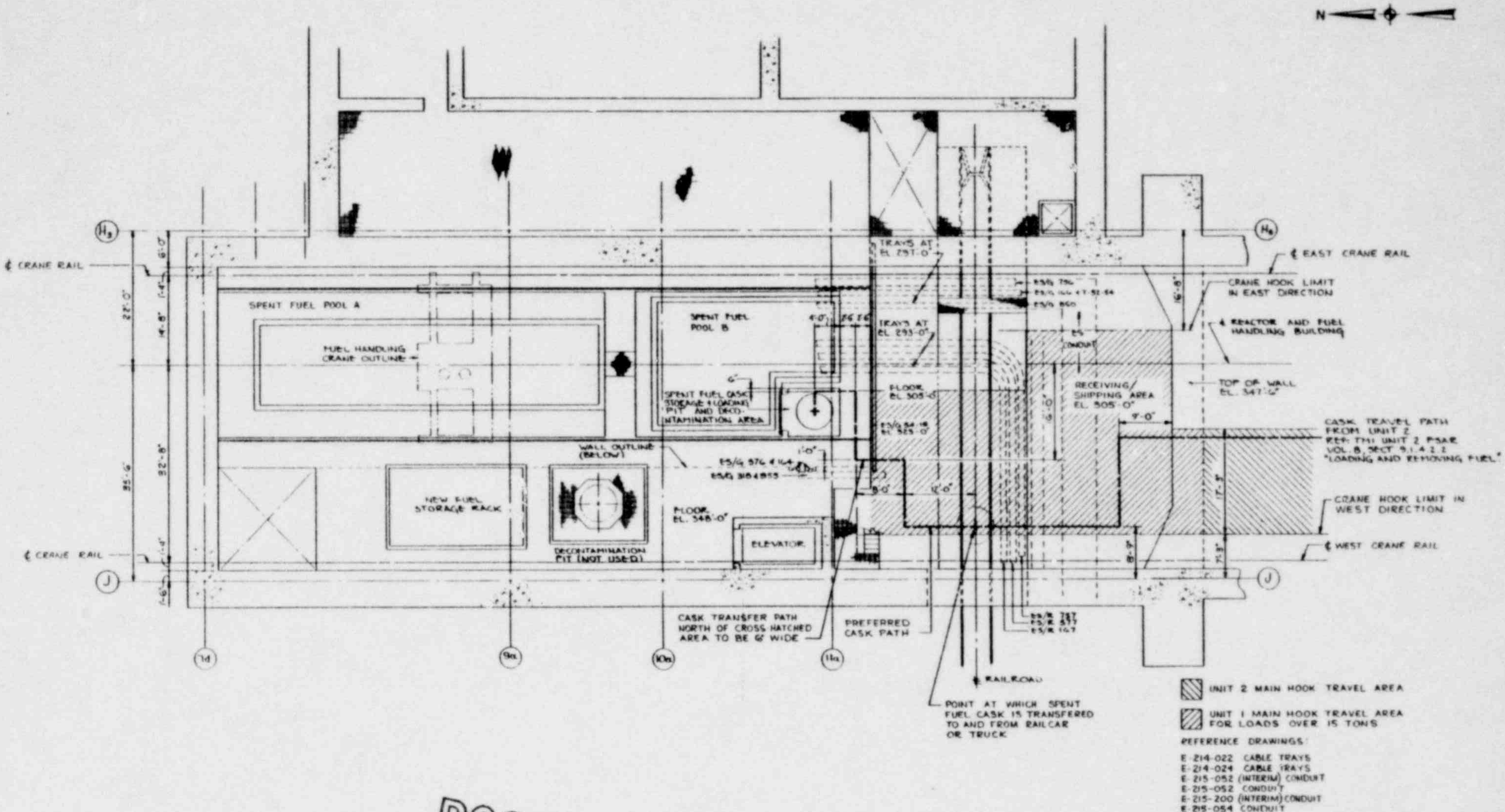
Additional analyses have been performed to (1) determine the deflection of the east wall of the cask loading pit at the elevation of the spent fuel storage racks due to cask impact loads on the side of the wall following a postulated eccentric drop accident, and (2) evaluate the effect of the deflection of the wall on the spent fuel storage racks that are in contact with the wall. Results of these analyses are summarized below.

> The maximum calculated deflection of the east wall of the cask loading pit at the elevation of the upper spent fuel storage rack supports is about 0.5 inch.

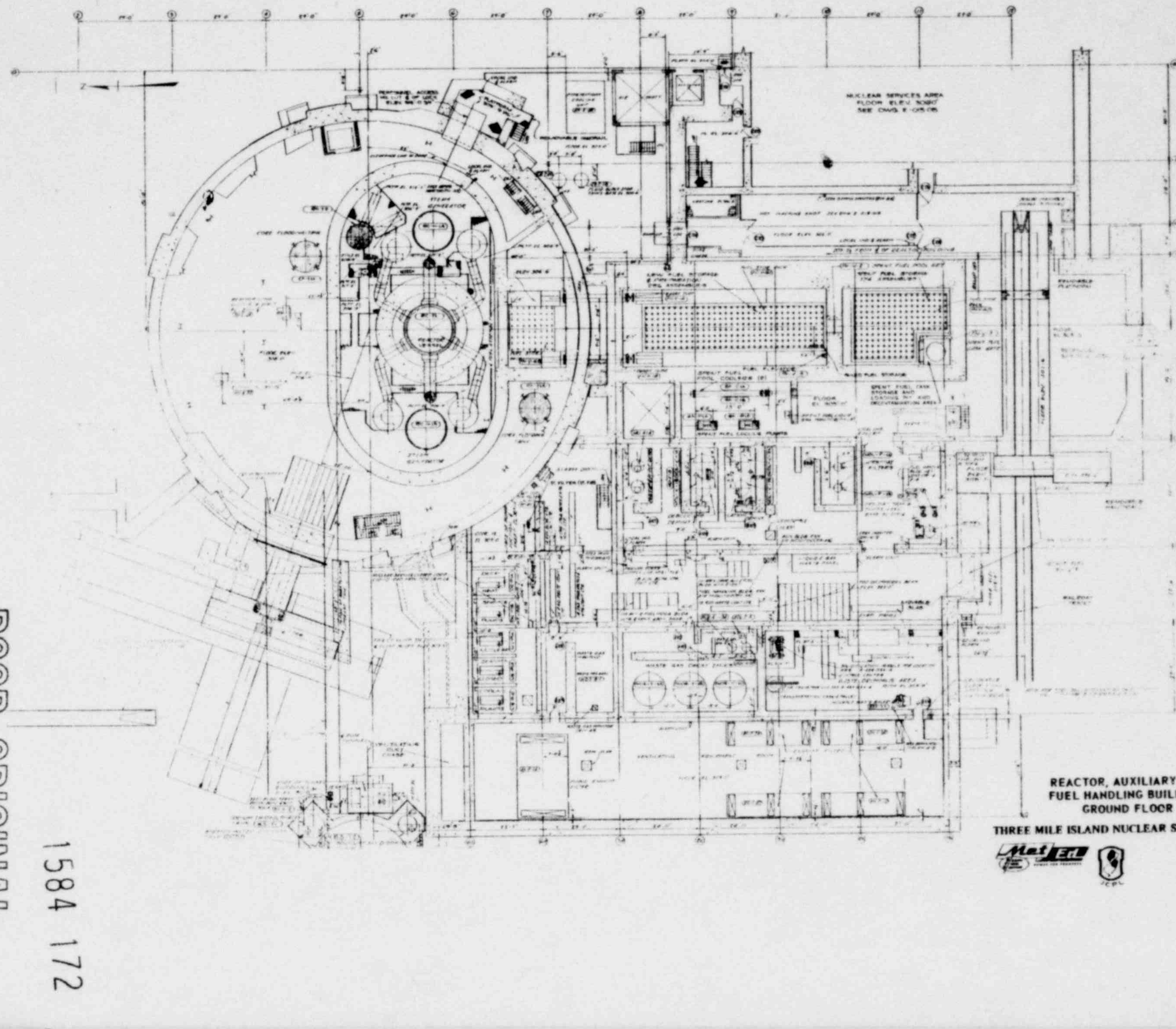
The maximum calculated impact load transmitted into the spent fuel storage rack supports is about 320 kips. Assuming this impact load is carried by the three middle supports (out of a total of seven), the maximum load per support is about 107 kips.

Thus, as a worst case, the effect of the 0.5 inch deflection of the east wall of the cask loading pit could be to reduce the center-to-center spacing between fuel assemblies of two adjacent rows from 13.625 inch to 13.125 inch. It should be noted that the above reduction in center-to-center spacing applies only in the east-west direction of the spent fuel pool. The center-to-center spacing of fuel assemblies of adjacent racks in the north-south direction and center-to-center spacing of fuel assemblies within the individual racks is not changed.

Based on extrapolation of sensitivity studies performed in Metropolitan Edison Company Three Mile Island Nuclear Station Unit 1 "Spent Fuel Pool Modification Description and Safety Analysis", the calculated multiplication factor is less than 0.95 and therefore acceptable. It should be noted as with all previous analysis, no credit is taken for any boric acid concentration in the spent fuel pool water.



PLAN–FUEL HANDLING BUILDING
ELEVS. 348'-0" AND 305'-0"
FIGURE 1



REACTOR, AUXILIARY AND
FUEL HANDLING BUILDINGS
GROUND FLOOR

THREE MILE ISLAND NUCLEAR STATION UNIT 1

FIGURE 1–3

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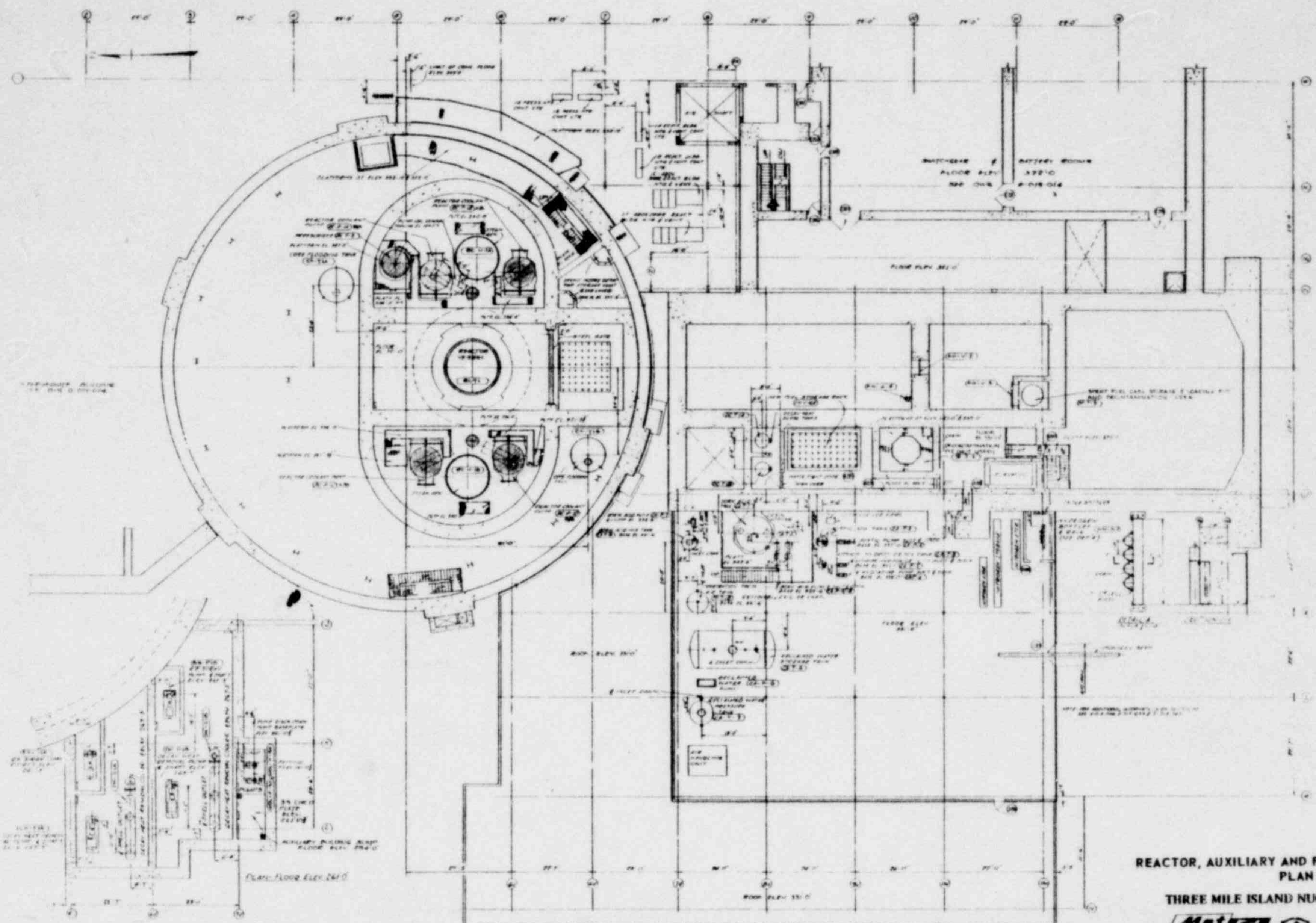
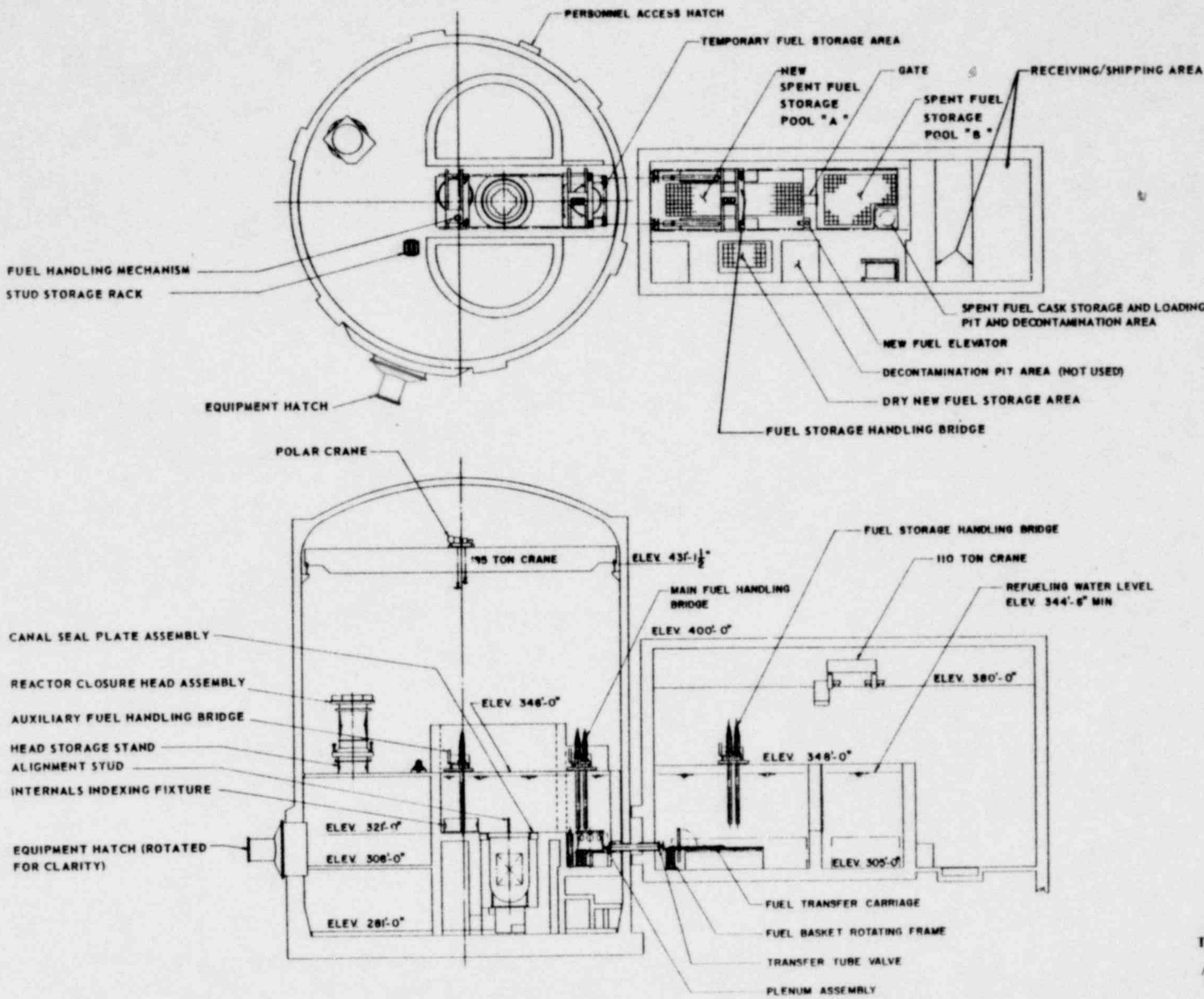


REACTOR, AUXILIARY AND FUEL HANDLING BUILDINGS
PLAN VIEW

THREE MILE ISLAND NUCLEAR STATION UNIT 1

FIGURE 1-4



POOR ORIGINAL

FUEL HANDLING SYSTEM
THREE MILE ISLAND NUCLEAR STATION UNIT 1

FIGURE 9-18

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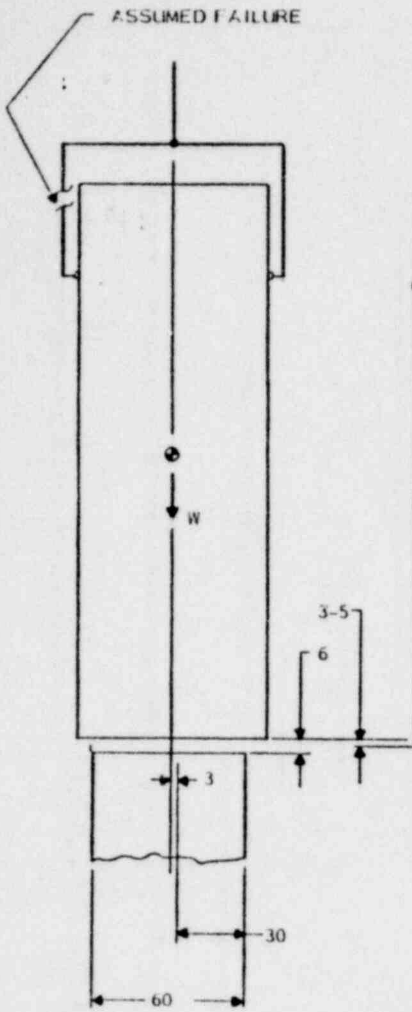

FIGURE 2-A

INITIAL POSITION OF CASK AT THE TIME OF ASSUMED ECCENTRIC DROP

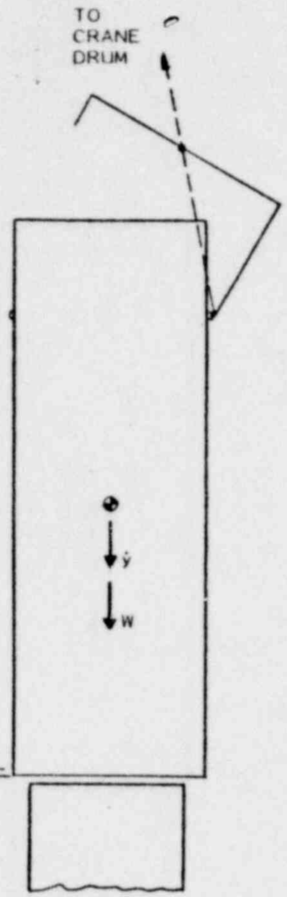

FIGURE 2-B

STRAIGHT DROP UNTIL CABLE BECOMES TIGHT

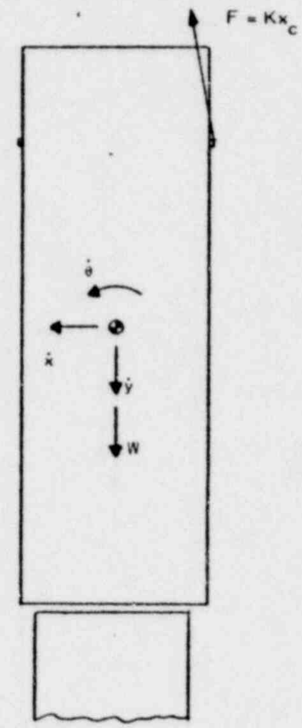

FIGURE 2-C

CABLE FORCE APPLIED - IMPARTS ANGULAR AND LATERAL VELOCITY

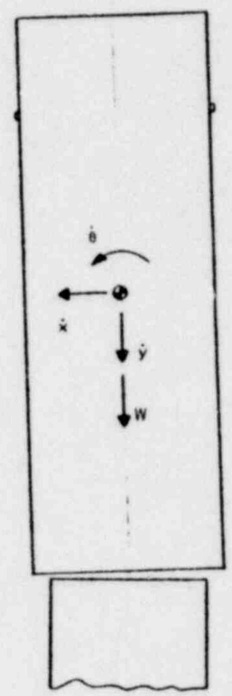

FIGURE 2-D

CASK DROP WITH CONSTANT ANGULAR AND LATERAL VELOCITY

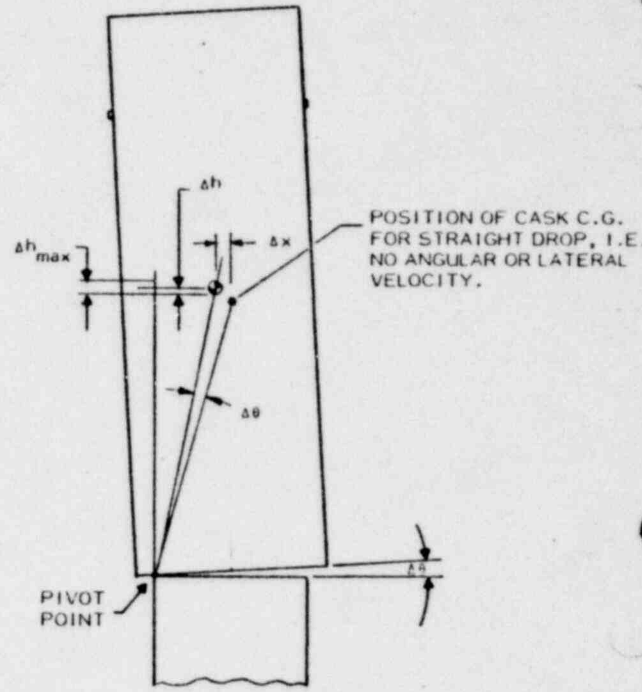

FIGURE 2-E

CASK IMPACT WITH SPENT FUEL POOL WALL

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