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RETURN TO REGULATORY CENTRAL FILES
ROOM 016

DRESDEN STATION SPECIAL REPORT NO. 28

Analyses & Procedures for Handling

General Electric IF-300 Spent Fuel Shipping Cask

ADDENDUM 2

Report of Discussions with AEC Staff

on July 27, 1973

AEC Dockets
50-237
50-249

RETURN TO REGULATORY CENTRAL FILES
ROOM 016

COMMONWEALTH EDISON COMPANY

August 9, 1973

2080.3

SPECIAL REPORT NO. 28
Addendum 2
Section 1

Response to Miscellaneous AEC Questions on Reactor Building Overhead Crane

I Brakes on Crane

The main hoist is equipped with two 6" General Electric IC9528-A 103 holding brakes with solenoid release, spring set (shoe brakes), which fail "set" upon loss of electricity to the solenoid. These brakes are similar to the "SR" solenoid brake shown in Figure 1. Each brake was factory adjusted to 150% (i.e. 730 ft.lb.) of the rated motor torque.

In addition to the two shoe brakes, a dynamic brake is included in the main hoist D.C. motor (i.e. GE 320 Maxspeed Control).

Note: A dynamic brake is neither a regenerative type brake nor an eddy-current brake, terms applicable to A.C. motors only.

The following definitions taken from Crane Manufacturers Association of America Specification #70 and ANSI B30.2.0, may be helpful in understanding dynamic brakes and eddy-current brakes:

2020.4

Dynamic Lowering: A method of control by which the hoist motor is so connected in the lowering direction, that when it is overhauled by the load, it acts as a generator and forces current either through the resistors or back into the line.

Eddy-Current Braking: A method of control by which the motor drives through an electric induction load brake.

Regenerative: Form of dynamic braking in which the electrical energy generated is fed back into the power system.

The shoe brakes are located at the inboard and outboard ends of the main hoist drive shaft as shown in simplified sketch, Figure 2. The dynamic brakes are an integral part of the motor and cannot be seen. Any one of the two shoe brakes is capable of stopping the hoist under full load. The dynamic brake is not capable of bringing the load to a "dead stop," it can only control the rate of descent.

2020.5

The three brakes used on the main hoist comply with the Electric Overhead Crane Institute Specification #61, Articles 31.B and 35, which was the code in effect at the time Dresden's crane was manufactured. Articles 31.B and 35 read as follows:

31.B

1. Each hoisting unit shall be provided with two means of braking. One brake shall be directly applied to the hoist motor shaft or other shaft in the hoist gear reduction and shall automatically set when current is cut off from the hoist motor. The other braking method may be either mechanical or electrical.

   a. A mechanical load brake, if furnished, shall automatically control the speed during lowering so as to prevent undue acceleration.

   b. Electrical dynamic lowering control or electrical braking control shall regulate the speed during lowering so as to prevent undue acceleration.

35

1. The hoist motor electric brake shall be applied automatically when power is interrupted.

2080.6

2. The rated torque of the brake shall be not less than the full load torque of the motor.

With the existing hoist braking system it can be demonstrated that there is redundancy if any single failure is considered as follows:

1. Consider a catastrophic shaft failure or coupling failure between the motor and rope drum. If such an accident occurred one shoe brake and the dynamic brake would be lost; however, the outboard solenoid brake is still capable of bringing the load to a "dead stop."

2. Consider a failure of the shaft between the rope drum and outboard brake. If such an accident occurred the outboard shoe brake would be lost; however, the inboard solenoid shoe brake and the dynamic brake are capable of bringing the load to a "dead stop."

3. Consider a loss of electrical power feed accident. If this accident occurred the solenoid shoe brakes would fail set bringing the load to a "dead stop." The dynamic brakes would be lost as power is required to create a field so the motor will act as a generator.

2080.7

II Hook on Crane

The hook was manufactured of rolled ASTM A-515-66 Grade 70 steel plate. Any inherent defects would be coplanar to the side surfaces of the hook and would not be depictable by X-ray. A copy of the physcial, chemical magnetic particle and ultrasonic test reports are attached (see Figures 3, 4, 5 and 6).

Stress calculations on the existing 6" I.D. hook show that the tensile stress is 10,250 psi with a safety factor of 6.83 based on minimum average tensile strength. Stress calculations were made on the basis of machining the hook to a 6 1/16" I.D. The resulting tensile stress is 10,280 psi and the safety factor is 6.81 (see Figure 7). Specification EOCI #61 states no minimum safety factor for a hook.

III Limit Switch for Crane

A new limit switch will be added to the main hoist to prevent hoisting the fuel cask 6" above the refueling floor. Delivery time on this switch has been quoted as 14 weeks by the manufacturer.

7080.8

In the interim, the existing limit switch will be readjusted so that the cask can not be lifted over 6" above the refueling floor. After the refueling operation has been performed, it can then be readjusted to its original high point limit.

The repeatability is approximately 2°. As this limit switch is attached to the drum, a 2° accuracy would be 1/8" travel.

IV Operator Qualification

The CECo. operators will be qualified to ANSI B30.2.0, Chapter 2-3.

2020 /

Operation and Maintenance Chart R-127

TYPE "SR" SOLENOID BRAKE

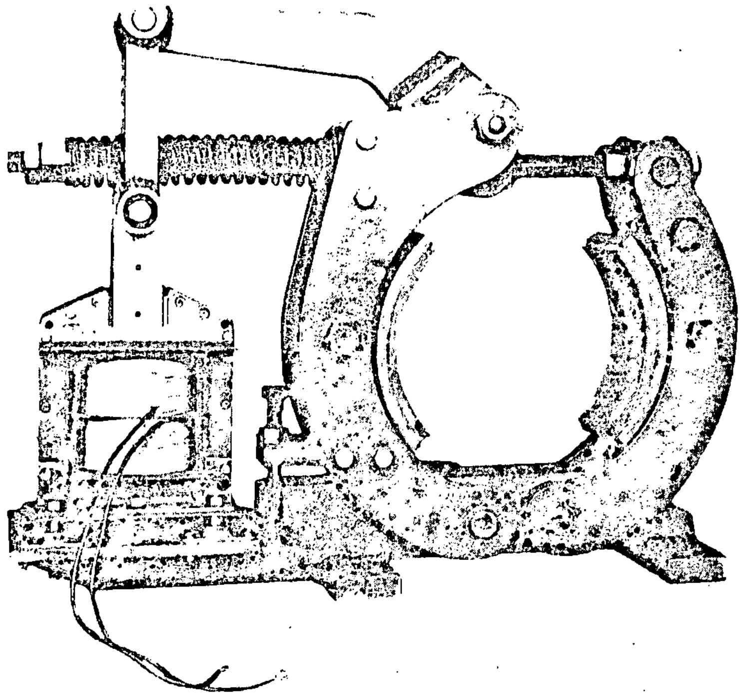


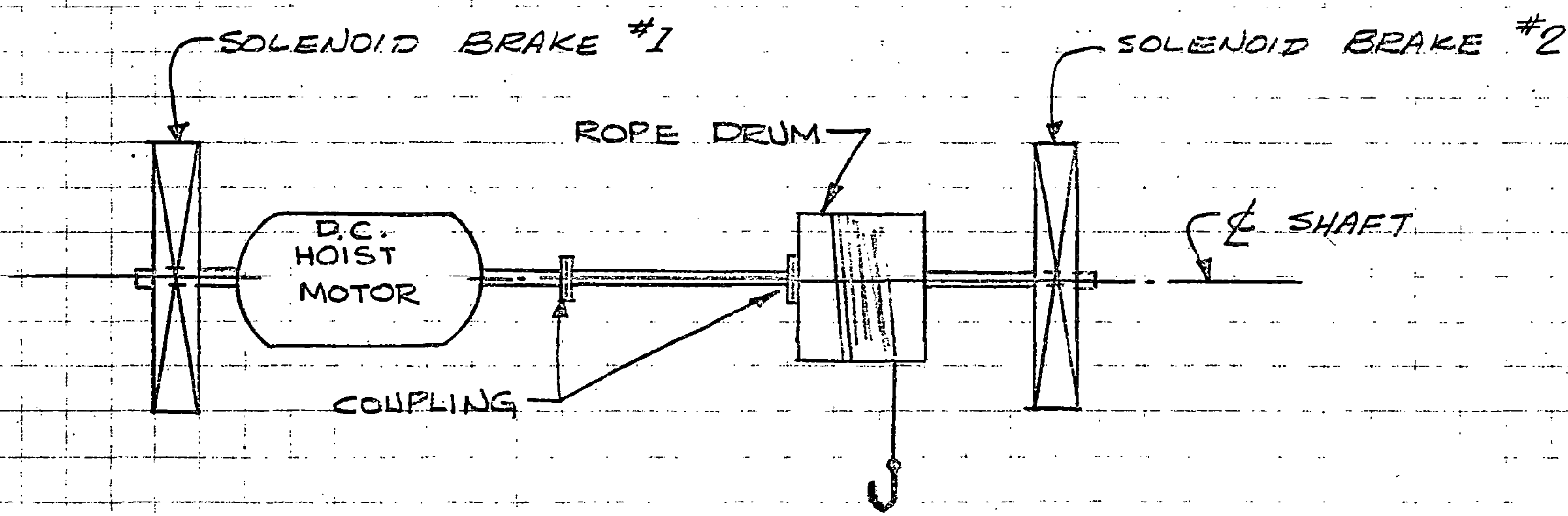
FIGURE 1

OPERATION

A powerful coil spring sets the brake shoes firmly against the wheel. To release the brake, the solenoid is energized, thereby attracting the plunger and pulling it downward. The motion of the plunger is transmitted to a connecting link which operates the release arm and moves the upper ends of the brake arms apart, thereby releasing the shoes from the wheel. The brake is applied by breaking the circuit to the solenoid, allowing the compression spring to extend and force the brake arms back to their original set position. Thus, the brake always maintains a safe condition by automatically setting and holding the load in case of power failure or accidental interruption of current.

Photo No. 4-623

2-020.10



NOTE : THE D.C. HOIST MOTOR HAS SELF-CONTAINED DYNAMIC BRAKE

FIGURE 2

INDUSTRIAL STAINLESS STEELS, INC.

EASTERN STAINLESS STEEL SERVICE CENTER

Stainless Steel Specialists Since 1924 255 BENT STREET, CAMBRIDGE, MASS. 02141

INVOICE NO. A 8737

RECEIVED MAR 22 1967

SOLD TO: WHITING CORP. 157TH & LATHROP AVE. HARVEY, ILLINOIS 60426

SHIP TO: 5 Ton Hook

D01026

A78065-6M-1

CUSTOMER'S ORDER NO.	CUSTOMER'S REQ. NO.	DATE	SALESMAN	ACCOUNT NO.	SHIPPED VIA	PPD.	COL.	DATE SHIPPED
839		3/21/67	93 M	89084	R.E. to Chicago	✓		4/7/67

QUANTITY

A-240

NO.	AISI GRADE	C.	MN.	P.	S.	SI.	CR.	NI.	MO.	CU.	CB.	TI.	CO.
55167	304	.042	1.48	.023	.012	.53	18.00	9.63	.36	.19			.05

OTHER ELEMENTS

SIZE	TENSILE	YIELD	ELONG	R. A.
2-1/4" THK x 12" x 26"	78,800	40,000	57%	63%

HRAP

HARDNESS	HARDENABILITY
BHN 188	

INDUSTRIAL STAINLESS STEELS, INC.

1 pc.
235 #

"ULTRASONIC TESTED SATISFACTORILY TO MIL STD 271 B BY PROCEDURE ISS 2 WITH 1" DIA. X 2.25 MC LONGITUDINAL CRYSTAL."

COMMONWEALTH OF MASSACHUSETTS — MIDDLESEX COUNTY
SUBSCRIBED AND SWORN TO BEFORE ME
THIS 11th DAY OF April, 1967
BY Catherine M. O'Brien
NOTARY PUBLIC

MY COMMISSION EXPIRES MARCH 15, 1974

INDUSTRIAL STAINLESS STEELS, INC. CERTIFIES THAT THIS IS A TRUE COPY OF ORIGINAL TEST REPORT NOW ON FILE AND THAT THE MATERIAL SHIPPED MEETS THE REQUIREMENTS OF THE ORDER.

BY Carl Eisenwinter
ASSISTANT METALLURGIST

CERTIFIED TEST REPORT

FIGURE 3

FIGURE 4

WHITING CORPORATION

Manufacturers of HEAVY INDUSTRIAL EQUIPMENT

AREA CODE 312
INTEROCEAN 8-9400 (CHICAGO LINE)
EDISON 1-4000 (HARVEY LINE)

HARVEY, ILLINOIS, 60426 U.S.A.
(CHICAGO SUBURB)

MAGNAFLUX REPORT

Customer GENERAL ELECTRIC COMPANY

Pur. Order No. 3447114 Whiting Req'n. No. 78065 - 15-1

Description 125 TON SISTER HOOK

Drawing No. S29693-3-E Piece No.

Type of material FSC

Method: Coil X Prod X Dry X Wet

Amperes 800 & 500 AC DC X

Remarks 800 AMP 6" PROD SPACING WAS USED

500 AMP 4" PROD SPACING WAS USED

500 AMP USED ON COIL

NO REPORTABLE INDICATION DETECTED

Accepted [signature] Date NOV. 28, 1967

Inspector D. McCULLOCH

All test results set forth herein represent our best judgement of conditions in the material tested.

WHITING CORPORATION

[signature]

Mgr., Quality Control Department

2020,13

FORM #081 R. 9/62

LUKENS STEEL COMPANY

INSPECTION DEPARTMENT

NON-DESTRUCTIVE TESTING REPORT

CUSTOMER	MILL ORDER NO. 8647-60243-1	TYPE TEST REFLECTOSCOPE	DATE 4-7-67
	QUALITY H.T. SIL. KILLED FBX 70,000	SPECIFICATION MIL-S-271B 3% NOTCH	
	CUSTOMER NO. UC 8329	EQUIPMENT USED SPERRY UM721 REFLECTOSCOPE	
CONSIGNED TO	SEARCH UNIT 2 1/4 MEG. 1 1/8 DIA. S.B. SPACING 2 1/4 MEG. 1"X1" 45° A.B.	AMPLITUDE AMPERAGE	COUPLANT METHOD SOAP + WATER
	TRANSDUCER TYPE OF PRODS SPERRY	GRID REF. 100% STRAIGHT +200% ANGLE BEAM	TYPE OF SURFACE BLASTED
	INSPECTORS NAME & QUALIFICATIONS MASKULA + BROWN	SIZE 1 - 62 1/2 X 36 3/4 X 8	
	WITNESSED BY	MELT & SLAB C2692-4B	MARK

78065-5M-1

I HEREBY CERTIFY THAT THE ABOVE IS CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

UT OK PER SPEC

B. 7 [illegible]

INSPECTION [illegible]

FIGURE 5

LUKENS STEEL COMPANY

COATESVILLE, PA.

TEST CERTIFICATE

PURCHASER:

3 Whiting Corp.
157th & Lathrop Ave.
Harvey, Ill.

DATE: 4-8-67 FILE NO. 8647

CONSIGNEE:

MILL ORDER NO.	CUSTOMER P.O.	
60243-1	UC 8329	GR 4667 NT

SPECIFICATIONS: A-515-66 Gr.70 Fbx. 70000

BEND TEST O.K. HOMOGENITY TEST O.K.

CHEMICAL ANALYSIS

MELT NO.	C	MN	P	S	CU	SI	NI	CR.	MO	V	TI	AL	B		
C2692	24	76	006	023		26									V.IDR.Steel

PHYSICAL PROPERTIES

MELT NO.	SLAB NO.	YIELD PSI X100	TENSILE PSI X100	% ELONG. IN 2"	% R.A.	BHN	IMPACTS			DWG#	DESCRIPTION
C2692	4B	441	704 720	30						U-51215-1 DET.D	1-Sketch x 8" A 78065-5M-1 125 Ton
Sketch and	tests	norm.									

FIGURE 6

We hereby certify the above figures are correct as contained in the records of the company.

SUPERVISOR-TESTING H. H. Kline

SARGENT & LUNDY FOR COMMONWEALTH EDISON CO,
MAIN HOOK ON CRANE NO. 9492 (REQN. 78065)
125 TON CAPACITY SISTER HOOK — 6" EYE

WHITING CORP.
61997
By RAM
Date 7-13-73
PG. 1 OF 2

DRG. S-29693-E

MAT'L. - ASTM A-515 GRADE 70
70,000 PSI MIN. ULT. TENSILE
52,500 PSI MIN. ULT. SHEAR
38,000 PSI MIN. Y.P.

SECTION A-B

ITEM	AREA	ARM	MOM. OF AREA	d	Ad^2	I_o
1	22	6.16	135.5	6	792	22.1
2	13.1	8.625	116	3.3	143	3.36
3	31.9	17.625	563	5.46	953	47.87
	67.0		814.5		1888	73.33

$\frac{814.5}{67} = 12.17''$ $I = 1888 + 73 = 1961$

$Z_T = \frac{1961}{8.17} = 240$ $Z_C = \frac{1961}{7.58} = 259$

MAX. BENDING MOMENT
$144{,}000 \times 11 = 1{,}590{,}000$ IN-LB

MAX. BENDING STRESS
$\frac{1{,}590{,}000}{240} = 6{,}620$ PSI - TENSION

$\frac{1{,}590{,}000}{259} = 6{,}140$ PSI - COMPRESSION

TENSION STRESS
$\frac{120{,}000}{67} = 1{,}790$ PSI - DIRECT

SHEAR STRESS
$\frac{88{,}000}{67} = 1{,}310$ PSI - DIRECT

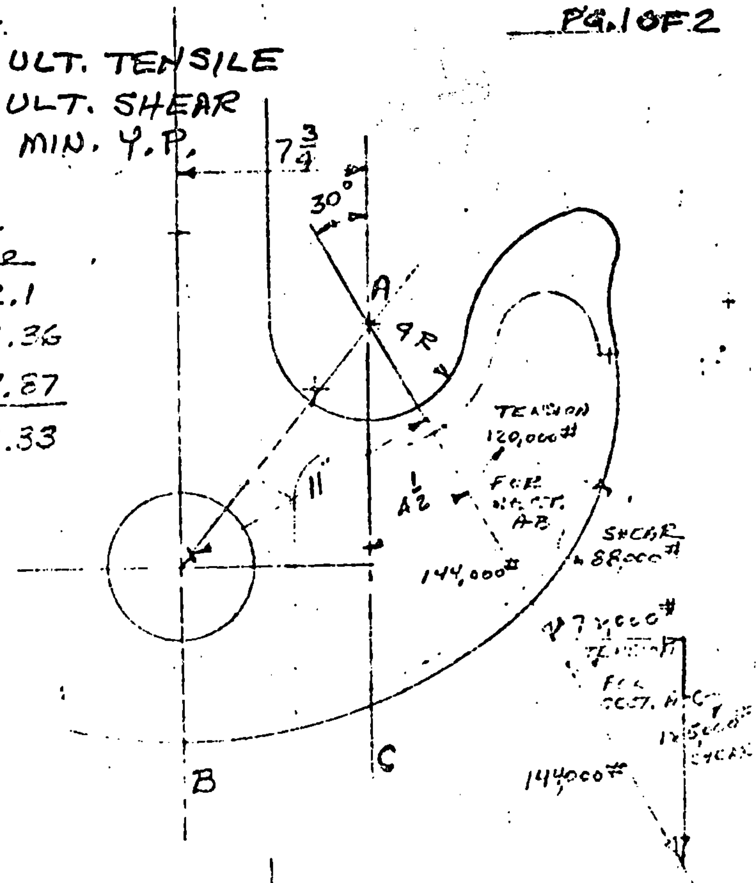
MAX. TENSION STRESS
$6620 + 1790 = 8{,}410$ PSI

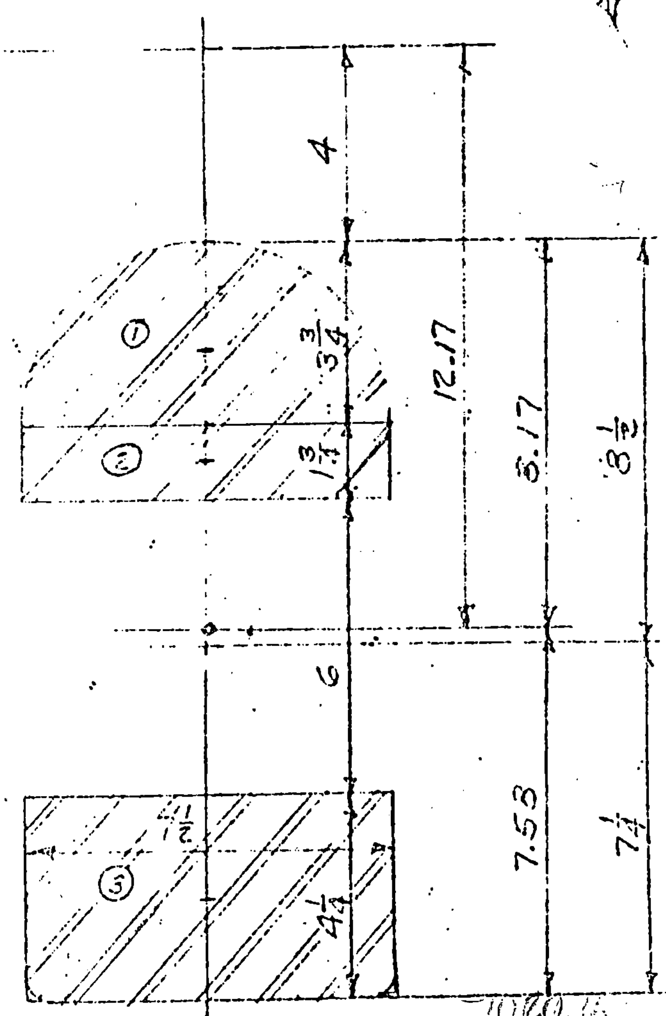
MAX. COMPRESSION STRESS
$6140 - 1790 = 4{,}350$ PSI

MAX. SHEAR STRESS
$\left(\left(\frac{8410}{2}\right)^2 + 1310^2\right)^{.5} = 6{,}050$ PSI

MAX. NORMAL TENSILE STRESS
$\frac{8410}{2} + 6050 = 10{,}250$ PSI

SAFETY FACTOR $= \frac{70000}{10250} = 6.83$





SECTION A-B

N-2704-R

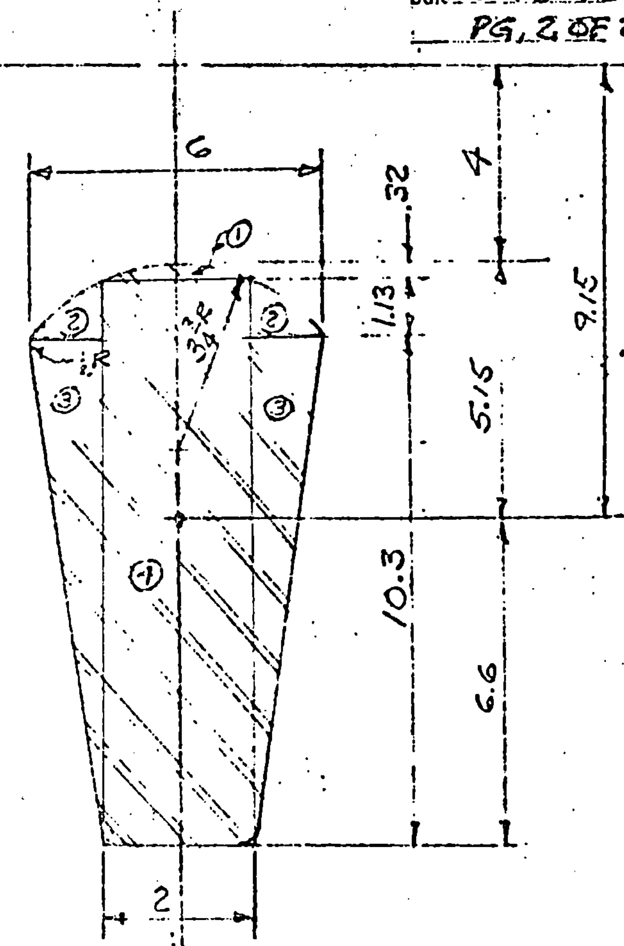
125 TON SISTER HOOK (CONT'D.)

SECTION A-C

ITEM	AREA	ARM	MOMENT OF AREA	d	Ad^2	I_o
1	.75	4.25	3.19	4.9	18	—
2	1.7	4.8	8.15	4.35	32.4	—
3	15.6	8.65	135	.45	3.16	91.7
4	34.5	10	345	.85	24.8	370
	52.55		491.34		78.36	461.7

$\frac{491.34}{52.55} = 9.15''$ $I = 78.3 + 461.7 = 540$

$Z_T = \frac{540}{5.15} = 105$ $Z_C = \frac{540}{6.6} = 82$



SECTION A-C

MAX. BENDING MOMENT
144,000 × 4.5 = 648,000 IN-LB

MAX. BENDING STRESS

$\frac{648\,000}{105} = 6,170$ PSI – TENSION

$\frac{648,000}{82} = 7,900.$ PSI – COMPRESSION

TENSION STRESS = $\frac{72,000}{52.55} = 1,370$ PSI – DIRECT

SHEAR STRESS = $\frac{125,000}{52.55} = 2,380$ PSI – DIRECT

MAX. TENSION STRESS = 6,170 + 1,370 = 7,540 PSI

MAX. COMPRESSION STRESS = 7,900 – 1,370 = 6,530 PSI

MAX. SHEAR STRESS = $\left(\frac{7540}{2}^2 + 2380^2\right)^{.5} = 5840$ PSI

MAX. NORMAL TENSILE STRESS = $\frac{7540}{2} + 5840 = 9610$ PSI

TENSION STRESS IN STEM = $\frac{250,000}{3^2 \pi} = 8,840$ PSI

Reply to Sixteen AEC Questions on Reactor Building Overhead Crane

Q1. State the maximum allowable crane velocities to be maintained for bridge travel, trolley travel, hoisting and lowering when handling the spent fuel cask. What is the maximum velocity provided by the manufacturer of the crane for hoisting, lowering, trolley and bridge travel with rated load? What positive means will be provided to maintain the allowable handling velocities during spent fuel cask handling?

A1. The manufacturer (Whiting Corporation) has given the maximum velocities of bridge, trolley and hoists as follows:

	Speeds (Ft./min.)	
	Full Load	No Load
Main Hoist	5.6	16.8
Aux. Hoist	20	64
Trolley Traverse	10	20
Bridge Travel	50	100

The "allowable handling velocities" during spent fuel cask handling will be the maximum velocities cited above. Lesser velocities will be maintained at the discretion of the operator, given the particular circumstances. It should be noted that our structural analyses were based on the maximum velocities citied and allowed no credit for discretionary reductions in velocities.

2020.18

Q2. What are the positive overtravel restrictions that will be provided to maintain the route selected for hoisting, lowering, trolley and bridge travel?

A2. The "overtravel restrictions" that will be provided to maintain the selected route are all administrative, except for the limit switches provided for hoisting overtravel. These administrative restrictions are described in Dresden Special Report No. 28.

Q3. What are the positive controls to be provided to maintain only one directional movement, at a time, that is hoisting, lowering, trolley or bridge travel separately?

A3. There are no positive controls provided to maintain one-directional movement other than the mechanical limitations of the overhead crane and the administrative procedures spelled out in Dresden Special Report No. 28.

Q4. What will be provided to prevent "two-blocking" and overtravel during hoisting?

A4. Dresden Station has modified the geared limit switch on the main drum to limit travel of the IF-300 cask to no more than 6" above the fuel handling floor. The positive-hook block limit switch (designed to locate the position of the hook independently) has also been relocated to limit travel of the IF-300 cask to no more than 6" above the fuel handling floor.

-3020117

Q5. State in percent of rated hoist driving motor HP the maximum stalling torque that will be developed by main hoist drive should the cask "hang-up" during hoisting.

A5. Stalling torque is 200% of rated HP.

Q6. What is the maximum lead line rope stress to main hoist drum during hoisting of the rated load? What is the ultimate strength of rope that will be used? State mechanical efficiency of hoisting system, and individually for drive, gear reduction, drum and reeving? (Sheaves are to be included with the reeving.)

A6. The lead line rope force on the main drum is 11.868 tons.

The Rope is an 1 1/8" diameter IPS-IWC steel center rope, 12 cable, 7 strand, 37 wire with a breaking strength of 53.8 tons.

The mechanical efficiencies are as follows:

A. Hoisting System	0.82
B. Drive	0.95
C. Gear Reduction	0.95
D. Drum and Reeving	0.909

2080,20

Q7. State the effects on the handling system and the attached load should malfunction or failure occur in the control brake, gear reduction, drum, rope, hook, and other hoisting components or yoke becoming disconnected from one trunnion.

A7. With the existing hoist braking system it can be demonstrated that there is redundancy if any single failure is considered as follows:

A. Consider a catastrophic failure of the control brake (dynamic lowering brake). If such an accident occurred, two shoe brakes are capable of bringing the load to a "dead stop."

B. Consider a catastrophic failure of one shoe brake. If such an accident occurred the dynamic brake is [redacted]able to slow the descent of the load and the second shoe brake is [redacted]able to bring the load to a "dead stop."

C. If the gear reduction failed and the load started to free fall, one solenoid brake is [redacted]able to bring the load to a "dead stop."

D. If the drum disconnected from one end of the shaft, there is a solenoid brake available to stop the load on the other end of the shaft.

2020.21

E. It is highly unlikely that 1 1/8" diameter rope will break. A break would mean dropping of the load.

F. The hook is designed, constructed and NDE tested to preclude a failure. Failure would mean dropping of the load.

G. If the yoke becomes disconnected from one trunnion, the load (assuming no resting support) would be sufficient to break the other yoke arm. This would mean dropping of the load.

Q8. Provide an evaluation which demonstrates the safe handling of hoisting from attachment to the spent fuel cask through to the emergency holding brake of the hoisting machinery. This to include the lifting yoke, modifications to existing hook, the hook, load block, rope reeving system, drums, gear reduction and the control braking system. State what safety items and devices were taken into account and are provided in this evaluation.

A8. The bulk of this evaluation is presented in Dresden Special Report No. 28. Machining of the hook has already been described herein. The control braking system has already been described herein. Crane system details are available in the equipment manuals located on-site.

7-080, 22

Q9. State the impact considerations that were included in the crane design for all handling modes for the rated load. Express these in percent of the allowable stresses provided in the calculations presented in Special Report No. 28. Indicate the effect of impact through all modes of the proposed spent fuel cask handling on mechanical and structural elements.

A9. Whiting does not use impact calculations in their design work, since they always work with a safety factor of 5.0.

Q10. Describe the effects of inadvertent operation over the selected route. Should a cask drop accident occur at any point over the selected route starting with removal of cask from the R/R shipping car during hoisting through hatchway and horizontal travel to the fuel pool, describe the effects on safe reactor operation and/or shutdown. The discussion should include a cask drop free from the yoke and a cask drop in which the rope fails and load block, hook and yoke remain with the cask for any position of travel over the operating floor. What will be the effects on the spent fuel pool floor, walls and the fuel stored in the pool?

Present a "free fall" diagram with dimensions of the cask and attached components with your answer to these probable accidents.

Q11. What is the amximum height attainable above the operating floor and the floor of pool should the load block meet the head block (two-blocking)? State the effects of a cask drop from this maximum height in respect to the floor of the pool and the operating floor should the rope fail at the point of two-blocking and the cask drop with load block hook and lifting devices attached.

2020121

Note: "two blocking" is not considered possible (See Q.4 and A.4 above). Maximum height above fuel floor = 6".

Answer:

Drop in the hatchway

As was mentioned in Special Report No. 28, the worst-case accident would be the loss of the suppression chamber (torus). If minimum water volume cannot be maintained at 112,000 ft^3, an orderly shutdown shall be initiated and the reactor shall be in a cold shutdown condition within 24 hours.

Drop on the refueling floor

The maximum drop heights for perfect vertical drop are presented in Table II, Page A-15 of Special Report No. 28. Calculations for the decon pit are found on Page A-12 thereof. Depths of penetrations are tabulated in the additional structural information presented above. The additional weight of the load block, hook and yoke amounts to approximately 7 kip. This does not significantly modify the conclusions of Special Report No. 28.

2000, 25

Q12. Provide information on NDE (non-destructive examination) and quality assurance conducted by the crane manufacturer at his plant or component manufacturer's plant. What were the materials used in the cut hook fabrication? State ASTM specification number, the ultimate and yield strengths and the allowable design stress. Was hook tested to 150% of rated load? Was hook measured before testing and after testing? What were the NDE criteria used to verify hook integrity.

A12. The hook was manufactured of rolled ASTM A-515-66, Grade 70, steel plate. Any inherent defects would be coplanar to the side surfaces of the hook and would not be depictable by X-ray. A copy of the physical, chemical magnetic particle and ultrasonic test reports are attached. Stress calculations on the existing 6" I.D. hook show that the tensile stress is 10,250 psi with a safety factor of 6.83 based on minimum average tensile strength. Stress calculations were made on the basis of machining the hook to a 6 1/16" I.D. The resulting tensile stress is 10,280 psi and the safety factor is 6.81. The calculations are attached.

The hook was not tested to 150% of rated load, therefore measurements were not called for. Original NDE records are attached.

2020.26

Q13. Provide documented information on the 125% rated load test and the 100% rated load operational test (refer ANSI B30.2.0 1967). If testing of the crane to this standard was not performed or records are not available, describe the extent of the testing that will be performed and provide information concerned with frequent and periodic inspection that have been or will be performed on the crane. (Refer to B30.2 1967 for guidance.)

A13. Accomplished de facto by operational performance. The initial installation of the Dresden Unit 2 & 3 reactors and the succeeding fuel cycles have led to a minimum of 12 separate occasions when the reactor pressure vessel head (100 tons) and the drywell cover (65 tons) have been handled by the reactor building crane.

Dresden Unit 2: 2/70, 6/70, 7/70, 3/71, 5/71, 2/72, 4/72

Dresden Unit 3: 1/71, 3/71, 6/71, 3/73, 5/73

7020 29

Reply to AEC Questions

Q14. Define the prelift inspection, testing, and NDE that will be performed immediately before and during the spent fuel cask handling.

A14. As was committed in Special Report No. 28, Page D-1, the crane and hook shall be inspected and tested in accordance with OSHA and Safety Code B 30.2.0.

2120.28

Q15. Since structural and mechanical design and selection of components for the overhead crane handling system are related to performance, duty cycle, and load range which together prescribe the control requirements for the crane's handling system, provide the following additional information:

A. Selection of main hoist drive motor H.P.

B. What were the dynamic impact factors used in the mechanical design of the hoisting machinery.

C. What are the brake ratings in terms of developed torque?

D. What is smallest increment of travel provided on a continuous and repetitive basis for bridge, trolley, hoisting and lowering movements?

E. What is the design stress margin to mechanical failure for mechanical components of the hoisting system.

A15. A. Main hoist horsepower was calculated as follows:

(formula)

$$HP = \frac{[\text{CAPACITY (TONS)} + \text{WEIGHT BLOCK (TONS)}] \times [\text{SPEED (FT/MIN)}]}{(16.5)\ (\text{EFFICIENCY})}$$

$$HP = \frac{[125T + 4T]\ [6\ f/min]}{(16.5)\ (.82)} = 57\ HP,$$

$\therefore$ use 60 HP

2020.24

B. Whiting does not make impact calculation since they use a safety factor of 5.0 for stress calculations, which is adequate margin to include impact stress.

C. There are two brakes rated at 1,000 ft. lbs. each. The motor torque is 730 ft. lbs. Therefore, there is a 300% brake safety factor.

D. It is possible to achieve 1/32" hoist movement and 1/4" trolley and bridge movement increments. The actual increment depends on the individual operator.

E. Whiting always uses a safety factor of 5.0 for stress calculations.

2020.36

Reply to AEC Questions

Q16. Not submitted.

Q17. Describe and define the sequence and operational steps to be provided in the spent fuel cask handling procedure. This should include the loading of spent fuel and the significant details such as instructions and special control measures.

A17. Provided by Special Report No. 28.

2020 31

Reply to AEC Questions

Q16. Not submitted.

Q17. Describe and define the sequence and operational steps to be provided in the spent fuel cask handling procedure. This should include the loading of spent fuel and the significant details such as instructions and special control measures.

A17. Provided by Special Report No. 28.

7020.32

Response to AEC Requests for

Additional Structural Information

1a. The use of shear friction is not allowed in the draft of the joint ACI-ASME concrete code (Section III: Division 2). Demonstrate that the spent fuel pool and the refueling floor can withstand the impact of cask drop including weight of yoke and loadblock with hook, without relying on shear friction.

1a. Answer:

The draft of proposed ACI-ASME concrete code (Section III: Division 2) is applicable only to Concrete Reactor Vessels and Containments. The "ACI Standard Building Code Requirements for Reinforced Concrete" (ACI 318-71) is the only code that is applicable to the Spent Fuel Pool.

EFFECT OF OPERATING TEMPERATURE ON POOL SLAB

The Building Code Requirements for Reinforced Concrete (ACI-71) allows a shear stress of 800 psi where the shear friction theory is applicable. The load factors against cracking presented in the special report #28 (May 1973) are based on the shear friction theory. For the vertical drop case,

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the shear stress across the connection between the pool slab and the pool wall would amount to 704 psi. Although this shear stress of 704 psi is justified as per ACI 318-71, the effect of thermal stresses present during the operation is taken into account.

The estimated pool water temperature is 125^{o}F and the temperature outside the pool is estimated to be 75^{o}F. Thus, the temperature of the top extreme fibers of the pool slab will be 125^{o}F and that of the lower extreme fibers will be 75^{o}F under the operating condition. The initial temperature (temperature during construction) being 75^{o}F, the pool slab will be subjected to a thermal gradient of 50^{o}F across the thickness of the slab.

Considering the slab restrained at the ends the maximum compressive stress of 1162 psi will be experienced by the top fibers, whereas the bottom fibers will not be stressed. This means that no tensile stresses will be set up due to thermal loading.

1b. The depths of penetrations as computed by the modified petry formula are rather large which implies local damage to concrete members. Show that the floors and walls can withstand the impact of the cask, including weight of yoke and hook with loadblock attached, despite such local damage.

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1b. Answer:

1. Decontamination Pit and Refueling Floor 0.337"
2. Spent Fuel Pool Wall (Inclined Drop) 4.64"
3. Spent Fuel Pool Slab (Vertical Drop) 10.03"

The penetration into the refueling floor and decontamination pit being a fraction of an inch, no reduction in the structural capacity of the decontamination pit slab or the refueling floor beams is expected.

In the case of the inclined drop on the top of the pool wall the cask penetrates a very small region of concrete which is provided as a cover for the main reinforcing steel and hence the effect of this penetration is negligible.

The effect of local damage caused by the penetration in the pool slab will be to reduce the Load Factor against cracking due to shear for the vertical drop from 1.44 to 1.36.

The weight of the load block, the hook and the yoke amounts to approximately 7 Kips. This is an increase of 5% to the weight of the cask, and hence in general would tend to reduce the load factors by about 5%. However, in the light of the fact that the increase in the yield strength of reinforcing steel and the compressive strength of concrete due to the higher rate of loading has not been accounted for, the effect of weight can be

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compensated for conservatively.

1c. Justify the assumptions made on the deformation of the structures under cask impact (cask plus weight of yoke plus hook and lifting block) by demonstrating that they are compatible with the actual restraints existing in the structures.

1c. Answer:

The decontamination pit is constructed monolithically with the surrounding slabs on four sides of the pit at elevation 613'-0. This justifies the consideration of the pit as an equivalent fixed ended beam.

The refueling floor beams 5B10 span between columns spaced at 24'-6 and run continuous for six spans, hence because of symmetry and continuity these beams were treated fixed ended. The south end of beam 5B8 is continuous and the north end frames monolithically into the 4'-0 thick pool wall, and hence it was treated as fixed at both the ends. These are the only beams over which the cask will pass while travelling to and from the pool.

The fuel pool slab frames into four pool walls. The north and south pool walls are 6'-0 thick, the east

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wall is 4'-6 thick and the west wall is 6'-6 thick.

The rigidity of the reinforced concrete walls and the presence of hydrostatic pressure justifies the analysis of the pool slab with fixed edges.