

TWX INCOMING

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USAEC-HQS-GTWN

CONSUMERS POWER COMPANY

JACKSON MICHIGAN

11-16-71 9-49 AM

1971 NOV 16 11 20

U.S. ATOMIC ENERGY COMMISSION  
TWO UNIT

DR PETER A MORRIS

DIRECTOR OF REACTOR LICENSING

DEAR DR MORRIS-

DOCKET- 50-255

LICENSE DPR-20



THIS TWX IS TO APPRISE YOU OF A RECENT DIFFICULTY WITH SEVERAL OF THE CONTROL ROD DRIVE MECHANISMS AT THE PALISADES PLANT. AT THE TIME THE INITIAL PROBLEM WAS DETECTED, THE PLANT WAS IN A *Ho Ho!* GOLD SHUTDOWN CONDITION WITH THE PRIMARY COOLANT SYSTEM AT 200 PSIG AND DROP TESTING OF THE CONTROL RODS IN PROGRESS.

AS CONTROL ROD NUMBER 27 WAS BEING DROP TESTED FROM 66 INCHES BY MEANS OF THE TEST PANEL SWITCH ON NOVEMBER 5, 1971, IT "APPARENTLY" FAILED TO DROP ACCORDING TO THE PRIMARY ROD POSITION READOUTS. SUBSEQUENT CHECKING ON THE SECONDARY ROD POSITION INDICATION SYSTEM DISCLOSED THE ROD WAS STILL AT ZERO OR FULLY INSERTED POSITION.

THE MOTOR-CLUTCH ASSEMBLY WAS REMOVED AND FOUND TO HAVE A BROKEN CLUTCH ADAPTER SHAFT.

A SPARE UNIT WAS INSTALLED AND CONTROL ROD NUMBER 27 SUCCESSFULLY DROP TESTED AND MOTOR TORQUE MEASUREMENTS OBTAINED WITH NORMAL RESULTS.

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SUBSEQUENT INVESTIGATION INDICATED THE PROBLEM HAD ACTUALLY OCCURRED AT 0317 ON NOVEMBER 1, 1971, WHEN THE CONTROL ROD HAD BEEN TEST DROPPED WITH ATMOSPHERIC PRESSURE ON THE SYSTEM. SUBSEQUENT INVESTIGATION DISCLOSED THAT DAMAGE WAS SUSTAINED IN FIVE ADDITIONAL UNITS.

*Inquiry*

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LK-12/14  
WF 12/14  
RE-11/13  
JK-12/11  
RC-11/14  
JN-11/13

ALL DAMAGED SHAFTS WERE REPLACED WITH NEW PARTS AND THE UNITS RE-  
INSTALLED.

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#### SEQUENCE OF EVENTS

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FILLING OF THE PRIMARY COOLANT SYSTEM TO NORMAL OPERATING LEVEL IN  
THE PRESSURIZER WAS INITIATED ON OCTOBER 29, 1971, FOLLOWING AN  
EXTENDED OUTAGE FOR MODIFICATIONS TO THE SECONDARY PLANT.

PRIMARY COOLANT SYSTEM FILLING OPERATION REACHED THE LEVEL OF THE  
CONTROL ROD DRIVE MECHANISM AUTOCLAVE NUT /84 PERCENT IN PRESSURIZER/  
AT 0400 ON OCTOBER 31, 1971.

CONTROL ROD NUMBER 1 WAS TEST DROPPED FROM 66 INCHES AT 0555 AND 0603,  
HOWEVER, FURTHER DROP TESTING WAS DELAYED DUE TO INABILITY OF THE COM-  
PUTER DROP TIME PROGRAM TO FUNCTION AND A GEAR PROBLEM IN THE MOTOR  
PACKAGE OF NUMBER 1 CONTROL ROD DRIVE. THE MOTOR PACKAGE WAS REPLACED.

AT 1119 ON OCTOBER 31, 1971, NUMBER 2 CONTROL ROD WAS SUCCESSFULLY DROP  
TESTED AND THE TESTING OF OTHER CONTROL RODS CONTINUED.

THE CONTROL ROD NUMBER 27 WAS TEST DROPPED NOVEMBER 1, 1971, AT 0314  
FROM 66 INCHES AND REPEATED AT 0317. THE DROP TIME WAS NORMAL, HOWEVER,  
IN THE SAME MINUTE AS THE SECOND DROP THE COMPUTER PRINTOUT /PRIMARY/  
INDICATED ROD 27 AT 166.5 /POSSIBLE INDICATION OF SHAFT FAILURE/.  
INITIAL COLD DROP TESTING OF ALL DRIVES FROM 66 INCHES WAS COMPLETED  
PRIOR TO 0800 NOVEMBER 1, 1971. PRIMARY SYSTEM /PRESSURIZER/ WATER  
LEVEL WAS MAINTAINED BETWEEN 92-99 PERCENT DURING DROP TESTING OF THE  
CONTROL RODS.

ON NOVEMBER 3, 1971, CONTROL ROD DRIVE MECHANISM NUMBER 22 WAS INSPECTED  
TO DETERMINE THE CAUSE OF A SUSPECTED SHIFT OF THE ENERGY ABSORBER /HARD  
STOP/.

AIR PRESSURE WAS NOTED IN THE DRIVE HOUSING WHEN THE AUTOCLAVE NUT WAS  
REMOVED, INDICATING THAT PROPER VENTING WAS NOT ACCOMPLISHED DURING THE  
PREVIOUS FILL OPERATION. AT THIS TIME, THE TESTING PROCEDURE WAS CHANGED  
TO INSURE PROPER VENTING /REFERENCE THE CORRECTIVE ACTION SECTION OF  
THIS REPORT/.

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THE MOTOR PACKAGE ON CONTROL ROD DRIVE MECHANISM NUMBER 2 WAS CHANGED ON NOVEMBER 3, 1971 BECAUSE OF GEAR NOISE.

ON NOVEMBER 4, 1971, THE PISTON GUIDE TUBE WAS REPLACED IN MECHANISM NUMBER 22 AS THE ENERGY ABSORBER WAS FOUND TO HAVE MOVED APPROXIMATELY 1.9 INCHES.

ON NOVEMBER 5, 1971, THE PRIMARY SYSTEM PRESSURE WAS BROUGHT TO 200 PSIG AND DROP TIME TESTING AND TORQUE MEASUREMENTS OF CONTROL ROD DRIVES STARTED. AT 2150 THE CLUTCH OUTPUT SHAFT OF CONTROL ROD DRIVE MECHANISM NUMBER 27 WAS DETERMINED TO BE BROKEN AS THE UNIT FAILED TO RESPOND TO TEST SIGNALS.

A SPARE MOTOR CLUTCH UNIT WAS INSTALLED ON CONTROL ROD DRIVE NUMBER 27 BY 0200 NOVEMBER 6, 1971, AND ROD DRIVE TESTING RESUMED. THE DROP TIMES AND TORQUE READINGS WERE NORMAL ON ALL CONTROL ROD DRIVE UNITS.

FURTHER INSPECTIONS AND REPAIRS ARE BEING MADE AND ARE COVERED IN OTHER PORTIONS OF THIS TWX.

#### CAUSE OF INCIDENT

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THE INVESTIGATION TO DATE INDICATES THAT AIR IN THE CONTROL ROD DRIVE MECHANISM, DUE TO INCOMPLETE VENTING, ALLOWED DRY TRIPS TO TAKE PLACE DURING THE DROP TIME TESTING OF THE CONTROL RODS ON OCTOBER 31 AND NOVEMBER 1, 1971.

ALTHOUGH THE PRESSURIZER WATER LEVEL WAS ALWAYS ABOVE THE AUTOCLAVE NUT OF THE MECHANISM, THE AVAILABLE HEAD WAS INSUFFICIENT TO DRIVE THE AIR THROUGH THE PRESSURE SEAL.

THE CONTROL ROD DRIVES ARE DESIGNED TO OPERATE WITH THE BUFFER ZONE AND ENERGY ABSORBER AREAS FILLED WITH WATER SO THAT WHEN A DRIVE IS SCRAMMED IT COMES TO REST GENTLY ON THE HARD STOP AT THE BOTTOM OF ITS TRAVEL. THESE DRIVES ARE ALSO DESIGNED TO WITHSTAND AN ACCIDENTAL TRIP WITH A DRY CONDITION IN THE BUFFER ZONE ENERGY ABSORBER AREA. THIS IS TO PROTECT THE DRIVE FROM EQUIPMENT DAMAGE IF, DURING INITIAL INSTALLATION OR A REFUELING OUTAGE, THE DRIVE WERE TO BE TRIPPED IN A DRY CONDITION AND IS ACCOMPLISHED BY A PRESSED FIT BETWEEN TWO CONCENTRIC CYLINDERS. IF A DRIVE IS TRIPPED FROM A DRY CONDITION IT IMPACTS THE HARD STOP WITH SUFFICIENT ENERGY TO CAUSE MOVEMENT OF THE INNER CYLINDER. THE FRICTION FORCE DECELERATES THE ROD OVER SEVERAL INCHES OF TRAVEL.

THE DRIVE CONDITIONS EXPERIENCED DURING THE SCRAM TESTING ON OCTOBER 3 AND NOVEMBER 1 WERE SUCH THAT THE BUFFER ZONES RANGED BETWEEN THOSE VENTED ENOUGH TO PROVIDE THE ADEQUATE WATER TO DECELERATE THE ROD NORMALLY TO THOSE POORLY VENTED SUCH THAT THE BUFFER ZONE AREA WAS DRY OR VERY NEARLY DRY. THE CONTROL ROD DRIVES VENT CONTINUOUSLY THROUGH THE SEAL FACES OF THE PRESSURE SEAL. DURING THIS CONTROL ROD DRIVE TESTING THERE WERE ONLY SEVERAL FEET OF WATER PRESSURE AT THE CONTROL ROD DRIVE SEALS AND THE TESTING OCCURRED SHORTLY AFTER FILLING THE SYSTEM. THE DIFFERENCES IN AMOUNTS OF WATER AND AIR IN THE CONTROL ROD DRIVES /UNDER THESE PRESSURE CONDITIONS/ ARE RELATED TO THE INDIVIDUAL SEAL LEAKAGES. THIS INADEQUATE VENTING ALLOWED SOME DRIVES TO IMPACT THE ENERGY ABSORBER /HARD STOP/ WITH SUFFICIENT ENERGY TO CAUSE DAMAGE TO SOME PARTS OF THE MECHANISM. THIS INSTANTANEOUS DECELERATION CAUSED TORSIONAL DAMAGE TO SOME CLUTCH ADAPTER SHAFTS AND DAMAGE TO SOME OF THE COUPLERS. ELEVEN OF THE FORTY-ONE CONTROL ROD DRIVES FELL INTO THIS CATEGORY. WITH THE EXCEPTION OF THE CONTROL ROD DRIVES NUMBERS 1, 2 AND 27, THE DRIVES ALL TESTED NORMALLY WITH NO MAINTENANCE ATTENTION. HOWEVER, ALL ELEVEN BLADES REMAINED COUPLED TO THE CONTROL ROD DRIVE ASSEMBLIES AND EXHIBITED NORMAL COUPLING AND UNCOUPLING CHARACTERISTICS.

SEVERAL COUPLERS THAT REQUIRED REPLACEMENT WERE DEFORMED /EXPANDED IN THE COUPLE AREA/ SUCH THAT THEY INTERFERED WITH THE CONTROL ROD DRIVE THERMAL SLEEVE UPON REMOVAL OF THE CONTROL ROD DRIVE ASSEMBLY PACKAGE. PRIOR TO EXERTING SUFFICIENT FORCE TO REMOVE THESE PACKAGES, COMBUSTION ENGINEERING CALCULATED THE REMOVAL FORCE THAT COULD BE APPLIED WITHOUT CAUSING DAMAGE TO PLANT EQUIPMENT. THESE FORCES WERE MONI-  
TORED DURING REMOVAL AND DID NOT EXCEED THE CALCULATED VALUE.

ALL PREVIOUS CONTROL ROD DRIVE TESTING HAD BEEN PERFORMED WITH THE TOOL FLANGE REMOVED OR THE SYSTEM PRESSURIZED, BOTH OF WHICH PROVIDE GREATER VENTING EFFICIENCY. THE INADEQUATE VENTING WAS DISCOVERED ON NOVEMBER 3, 1971 WHEN AIR PRESSURE WAS RELEASED UPON REMOVAL OF A CONTROL ROD DRIVE /NO 22/ AUTOCLAVE NUT WHILE INVESTIGATING AN UNEXPLAINED SHIFT IN LOCATION OF THE ENERGY ABSORBER UNIT OF 1.9 INCHES ON THAT CONTROL ROD DRIVE

TEN ENERGY ABSORBER UNITS WERE DISPLACED, A TOTAL OF 0.5 INCHES OR GREATER. THESE DISPLACEMENT MEASUREMENTS WERE MADE USING THE PRIMARY ROD POSITION INDICATION.

THE CLUTCH ADAPTER SHAFTS ARE SAE 4140 MATERIAL HEAT TREATED TO ACHIEVE A ROCKWELL "C" 38 HARDNESS. THE SHAFT DIAMETER IS 0.560 INCHES WITH TWO 0.188 INCH WIDE BY 0.110 INCH DEEP KEYWAYS.

#### SUMMARY OF INSPECTIONS AND REPAIRS

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A. SINCE THIS INCIDENT OCCURRED, ALL CONTROL ROD DRIVES HAVE BEEN TESTED FOR MOTOR RUNNING CURRENTS AND SCRAM TIMES. THE RESULTS OF THIS TESTING WERE NORMAL.

B. ALL MOTOR DRIVE PACKAGES HAVE BEEN INSPECTED, INCLUDING THE FOUR PART LENGTH RODS. THESE INSPECTIONS REVEALED NO DAMAGE TO THE FOUR PART LENGTH RODS, ONE CLUTCH ADAPTER SHAFT BROKEN /NUMBER 27/, FIVE CLUTCH ADAPTER SHAFTS WITH VARYING AMOUNTS OF TWIST AND FIVE CLUTCH ADAPTER SHAFTS WITH BARELY PERCEPTIBLE UPSETTING OF THE CLUTCH ADAPTER SHAFT KEYWAYS. THE REMAINING 29 MOTOR DRIVE PACKAGES SHOWED NO SIGNS OF DAMAGE. THE ONE BROKEN AND FIVE TWISTED CLUTCH ADAPTER SHAFTS HAVE BEEN REPLACED.

C. THE PRIMARY ROD POSITION INDICATION REVEALED THAT THE ENERGY ABSORBER UNITS ON SIX DRIVES HAD BEEN DISPLACED. THE ENERGY ABSORBER WITH THE MAXIMUM DISPLACEMENT WAS REPLACED.

D. THE COMPLETE CONTROL ROD DRIVE PACKAGES LISTED IN THE FOLLOWING TABLE HAVE BEEN ALREADY OR WILL BE REMOVED FOR INSPECTION. THIS TABLE LISTS THE DAMAGE REVEALED THROUGH INSPECTIONS PERFORMED AS OF 1100 NOVEMBER 15, 1971.

CRDM NO	REMOVED /R/	COUPLER CONDITION	SHAFT CONDITION	ENERGY	NUMBER OF TRIPS ON 10/31 AND 11/1
	OR NOT			ABSORBER	
	REMOVED /N/			DISPLACEMENT /INCHES/	
1	R	DEFORMED	TWISTED	0.8	2
2	R	DEFORMED	TWISTED	OK	1
4	R	OK	OK	OK	2
8	N	-	OK	0.5	1
14	N	-	OK	0.7	2
15	N	-	OK	OK	2
18	N	-	OK	1.2	1
19	N	-	OK	OK	1
22	R	OK	OK	1.9	2
23	R	DEFORMED	TWISTED	OK	1
24	R	DEFORMED	TWISTED	OK	2
27	R	DEFORMED	BROKEN	0.5	2
29	N	-	OK	0.9	1
30	R	DEFORMED	TWISTED	OK	1
32	N	-	UPSET	OK	1
33	R	OK	UPSET	OK	1
36	R	OK	UPSET	0.6	1
37	R	DEFORMED	UPSET	OK	1
39	R	DEFORMED	OK	1.3	3
40	N	-	OK	0.5	2
41	R	DEFORMED	UPSET	OK	1

E. ALL CONTROL ROD DRIVES WILL BE TESTED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS AND AS SUMMARIZED IN THE CONCLUSIONS SECTION OF THIS LETTER AFTER THEY HAVE BEEN REASSEMBLED AND PRIOR TO ANY REACTOR CRITICAL OPERATION. CRITICAL OPERATION WILL NOT BE PERFORMED UNTIL THE RESULTS OF THE AFOREMENTIONED TESTING IS NORMAL.

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## SAFETY ANALYSIS

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THE REVISION OF PLANT PROCEDURES PROVIDES ADEQUATE VENTING TO INSURE THAT CONTROL ROD DRIVES WILL NOT BE TESTED OR OPERATED UNDER CONDITIONS SIMILAR TO THOSE DISCUSSED ABOVE. THIS WILL PRECLUDE FURTHER FAILURES OF THE NATURE PREVIOUSLY DISCUSSED. HOWEVER, THIS SAFETY ANALYSIS ASSUMES FURTHER FAILURES OF NATURE DESCRIBED ABOVE COULD OCCUR. A DETAILED FOLLOW-UP REPORT IS CURRENTLY BEING PREPARED AND WILL BE SUBMITTED BY DECEMBER 3, 1971.

ASSUMING THAT A CLUTCH ADAPTER SHAFT ON A CONTROL ROD DRIVE WERE TO BREAK WITH THE REACTOR CRITICAL-

A. IF A CONTROL ROD WAS IN A GROUP THAT IS EITHER FULLY OR PARTIALLY WITHDRAWN, IT WOULD DROP IN TO ITS FULLY INSERTED POSITION /THIS FAILURE ALWAYS CAUSES THE DRIVE TO DROP RATHER THAN IMPEDING IT FROM DROPPING/ AS ON A TRIP WITH THE EXCEPTION THAT THE PRIMARY POSITION INDICATION WOULD BE MEANINGLESS. THIS OCCURRENCE WOULD BE EVIDENT ON BOTH NUCLEAR INSTRUMENTATION AND SECONDARY ROD POSITION INDICATION. IN THE EVENT OF A DROPPED CONTROL ROD, IT WILL BE IMMEDIATELY DETERMINED WHETHER THE DROP IS DUE TO A CLUTCH SEPARATION AS IN A TRIP OR SOME OTHER CAUSE SUCH AS FAILURE OF THE CLUTCH OUTPUT SHAFT. IF THE DROPPED ROD IS DUE TO A MECHANISM OTHER THAN A CLUTCH SEPARATION THE REACTOR WILL BE SHUT DOWN IMMEDIATELY TO MAKE APPROPRIATE REPAIRS. UNTIL THE REACTOR IS SHUT DOWN, IT WILL BE OPERATED IN ACCORDANCE WITH THE TECHNICAL SPECIFICATION LIMITS CONCERNING OPERATION WITH A DROPPED ROD.

B. IF THE AFFECTED CONTROL ROD WAS IN A GROUP THAT WAS IN THE INSERTED POSITION DURING REACTOR OPERATION, IT WOULD BE DETECTABLE BY A COMPARISON OF PRIMARY AND SECONDARY ROD POSITION INDICATION. THE POSITION INDICATION OF CONTROL RODS IN THIS CONFIGURATION WILL BE CHECKED EVERY SHIFT FOR CONFIRMATION THAT THE CONTROL ROD DRIVE ASSEMBLY IS FUNCTIONING PROPERLY. IF IT IS DETERMINED THAT A CONTROL ROD DRIVE MECHANISM IS NOT FUNCTIONING PROPERLY DUE TO A MALFUNCTION OTHER THAN A CLUTCH SEPARATION, THE REACTOR WILL BE SHUT DOWN AS DESCRIBED IN "A" ABOVE.

C. FROM "B" IT IS CONCLUDED THAT IF A FAILURE WERE TO OCCUR IT COULD REMAIN UNDETECTED FOR UP TO 8 HOURS. A FAILURE OF THIS NATURE SEPARATES THE CONTROL ROD DRIVE FROM THE ANTIREVERSE CLUTCH. IN THE UNLIKELY EVENT OF A SEVERE FAILURE OCCURRING IN THE REACTOR PRESSURE BOUNDARY ABOVE THE CONTROL ROD BLADE AT THE SAME TIME A FAILURE IN A CONTROL ROD DRIVE ASSEMBLY EXISTS, IT IS CONCEIVABLE THAT A CONTROL BLADE COULD BE EJECTED FROM THE CORE.

ANALYSES OF CONTROL ROD EJECTION INCIDENTS HAVE BEEN PERFORMED AND PRESENTED IN SECTION 14.16 OF THE PALISADES FINAL SAFETY ANALYSIS REPORT.

A SUMMARY OF THE RESULTS OF THESE ANALYSES ARE PRESENTED BELOW.

TABLE I

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ZERO POWER ROD EJECTION INCIDENT

VARIABLES	BEGINNING OF CYCLE	END OF CYCLE
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DELAYED NEUTRON FRACTION	0.0060	0.0052
MODERATOR TEMPERATURE COEFFICIENT OF REACTIVITY /DELTA RHO/DEGREE F/	0.0	-2.0X10 TO THE MINUS4
EJECTED ROD WORTH PERCENT	0.963	1.17
MAXIMUM PEAK-TO-AVERAGE PWR	9.07	11.7

RESULTS

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AVERAGE ENTHALPY OF HOTTEST PELLET /NO HEAT TRANSFER ASSUMED/ CAL/GM	175.2	257.5

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AVERAGE ENTHALPY OF HOTTEST  
PELLET /WITH HEAT TRANSFER/

CAL/GM	146.0	237.1
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FRACTION OF RODS THAT SUFFER

CLADDING DAMAGE /ENTHALPY	0.0	0.001
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GREATER THAN OR EQUAL TO 200

CAL/GM/

FRACTION OF FUEL HAVING AT

LEAST INCIPIENT CENTER LINE	0.0	0.0
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MELTING /CENTER LINE ENTHALPY

GREATER THAN OR EQUAL TO 250

CAL/GM/

FRACTION OF FUEL HAVING A

FULLY MOLTEN CENTER LINE CON-

DITION /CENTER LINE ENTHALPY

GREATER THAN OR EQUAL TO 310

CAL/GM/	0.0	0.0
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TABLE 2

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FULL POWER /2200 MWt/ ROD EJECTION INCIDENT

VARIABLES	BEGINNING OF CYCLE	END OF CYCLE
-----	-----	-----
DELAYED NEUTRON FRACTION	0.0060	0.0052
MODERATOR TEMPERATURE COEFFI- CIENT OF REACTIVITY /DELTA RHO/DEGREE F/	PLUS 0.5X10 TO THE MINUS 4	-1.5X10 TO THE MINUS 4
EJECTED ROD WORTH PERCENT	0.45	0.54

MAXIMUM PEAK-TO-AVERAGE PWR

5.15

5.50

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# RESULTS

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AVERAGE ENTHALPY OF HOTTEST PELLET /NO HEAT TRANSFER AS- SUMED/ CAL/GM	227.2	273.9
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AVERAGE ENTHALPY OF HOTTEST PELLET WITH HEAT TRANSFER/ CAL/GM	197.0	243.7
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FRACTION OF RODS THAT SUFFER CLADDING DAMAGE /ENTHALPY GREATER THAN OR EQUAL TO 200 CAL/GM/	0.0	0.003
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FRACTION OF FUEL HAVING AT LEAST INCIPIENT CENTER LINE MELTING /CENTER LINE EN- THALPY GREATER THAN OR EQUAL TO 250 CAL/GM/	0.0	0.001
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FRACTION OF FUEL HAVING A FULLY MOLTEN CENTER LINE CON- DITION /CENTER LINE ENTHALPY GREATER THAN OR EQUAL TO 310 CAL/GM/	0.0	0.0
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THIS INVESTIGATION OF BOTH THE ZERO-POWER AND FULL-POWER ROD EJECTION INCIDENTS INDICATES THAT THERE IS NO GROSS CENTER LINE MELTING OF THE FUEL FOLLOWING A ROD EJECTION AT ANY TIME OF CYCLE LIFE AND THAT THE RESULTANT FUEL CLADDING DAMAGE IS MINIMAL.

D. FOUR OF THE FORTY-FIVE CONTROL ROD DRIVE ASSEMBLIES ARE TERMED "PART LENGTH RODS." THESE FOUR ASSEMBLIES ARE ESSENTIALLY IDENTICAL IN CONSTRUCTION TO THE OTHER FORTY-ONE ASSEMBLIES EXCEPT THAT THEY DO NOT HAVE A CLUTCH ASSEMBLY AS THEY HAVE NO TRIP FUNCTION. ASSUMING THEY ARE SUSCEPTIBLE TO FAILURES OF THE CONTROL ROD DRIVE MECHANISM, A FAILURE SIMILAR TO THE FAILURE OF CONTROL ROD DRIVE NUMBER 27 WOULD ALLOW THE INSERTION OF A PART LENGTH ROD. IN THE EVENT THAT A CONTROL ROD DRIVE MECHANISM FAILURE CAUSED A PART LENGTH CONTROL ROD TO DROP INTO THE CORE, IT IS POSSIBLE THAT REACTIVITY WOULD BE INSERTED. REACTIVITY IS AVAILABLE BECAUSE THE THIRTY-ONE INCH ACTIVE LENGTH OF THE CONTROL ROD HAS A HIGHER WORTH WHEN PLACED NEAR THE AXIAL MID-PLANE OF THE CORE THAN WHEN PLACED IN THE LOWER FLUX REGION AT THE BOTTOM OF THE CORE.

TO EVALUATE THE CONSEQUENCES OF A PART LENGTH ROD DROP, USE WAS MADE OF THE RESULTS OF THE PALISADES ZERO POWER PHYSICS TEST. WITH ALL OTHER RODS WITHDRAWN, THE FOUR PART LENGTH RODS HAVE A MAXIMUM WORTH AT 50 INCHES. THE INSERTION OF THE FOUR RODS TO ZERO INCHES /ALL IN/ ADDS 0.144 PERCENT IN REACTIVITY. ANOTHER TEST, MADE WITH THE GROUPS 3 AND 4 REGULATING RODS INSERTED, YIELDS AN INSERTION OF 0.155 PERCENT IN REACTIVITY BETWEEN 46 INCHES WITHDRAWN AND FULL INSERTION. USING THIS LATTER VALUE, EACH PART LENGTH ROD HAS THE POTENTIAL FOR INSERTING APPROXIMATELY 0.039 PERCENT IN THE EVENT IT DROPS.

REACTIVITY INSERTIONS OF THIS ORDER ARE QUITE ROUTINE IN REACTOR MANEUVERING. THE RESULTANT PERIOD, APPROXIMATELY 180 SECONDS, IS EASILY CONTROLLABLE BY ROUTINE OPERATOR ACTION. IT MAY BE CONCLUDED, THEREFORE, THAT THE DROP OF A PART LENGTH CONTROL ROD FROM ANY POSITION IN THE CORE HAS NO NEGATIVE SAFETY IMPLICATIONS.

AS THE WORTH OF A PART LENGTH ROD IS LESS THAN THAT OF A FULL LENGTH ROD, A ROD EJECTION ACCIDENT WOULD BE LESS SEVERE THAN THAT ANALYZED IN "C" ABOVE. HOWEVER, AS A POTENTIAL FOR A ROD EJECTION ACCIDENT DOES EXIST IF A FAILURE OF THE DRIVE SHAFT WERE TO OCCUR, THE SAME TESTING AND OPERATIONS CRITERIA WILL BE APPLIED TO THESE FOUR RODS AS ARE DISCUSSED AND COMMITTED TO IN "A" AND "C" ABOVE.

E. IT IS NOT CONSIDERED CREDIBLE TO HAVE TWO OR MORE CONTROL ROD DRIVE ASSEMBLIES FAIL AT THE SAME TIME, IN A MANNER SUCH THAT THE ANTIREVERSE CLUTCH IS DISABLED.

THE TECHNICAL SPECIFICATIONS REQUIRE REACTOR SHUTDOWN IN THE EVENT OF MORE THAN ONE CONTROL ROD DRIVE MALFUNCTIONING. AS THE DAMAGE TO THE CONTROL ROD DRIVES OCCURRED DURING TRIP TESTING, FURTHER DATA WILL BE OBTAINED DURING TRIP TESTING TO INSURE THE ROD INSERTIONS ARE NORMAL. THIS DATA WILL BE OBTAINED BY RECORDING ROD POSITION VERSUS TIME DURING ROD TRAVEL WHEN IT IS TRIP TIME TESTED. A NORMAL TRIP /THE BUFFER ZONE AND ENERGY ABSORBER FILLED WITH WATER/ HAS A "CHARACTERISTIC TAIL" WHEN THE DRIVE DECELERATES IN THE BUFFER ZONE AREA. IF THE DRIVE WERE TO AGAIN BE TRIPPED WITHOUT PROPER VENTING OF THE BUFFER ZONE AND ENERGY ABSORBER AREA, THE "CHARACTERISTIC TAIL" WOULD BE MISSING.

THIS ADDED SURVEILLANCE WILL ELIMINATE ANY POSSIBILITY OF UNDETECTED DRY TRIPS DURING TESTING.

THE ENERGY ABSORBER UNITS ARE DESIGNED TO HAVE 3 INCHES OF TRAVEL. TEST STAND MEASUREMENTS YIELD AN AVERAGE DISPLACEMENT OF THE ENERGY ABSORBER OF 2.7 INCHES ON A COMPLETELY DRY TRIP.

THE MINIMUM AVAILABLE REMAINING TRAVEL OF THE ENERGY ABSORBER UNITS DISPLACED IS 1.7 INCHES. THIS IS SUFFICIENT TO SLOW A DRIVE ON A DRY TRIP SUCH THAT IT IS HIGHLY IMPROBABLE THAT THE DRIVE WOULD SUFFER ANY DAMAGE.

A TEST ASSEMBLY HAS BEEN TESTED BY COMBUSTION ENGINEERING. THE DEFORMATION OF THE COUPLER ON THIS TEST ASSEMBLY WAS GREATER THAN THAT OBSERVED IN THE COUPLERS THAT HAVE BEEN INSPECTED. THE COUPLING AND UNCOUPLING ABILITY OF THE TEST ASSEMBLY WAS NOT DESTROYED. THERE WAS NO APPARENT DAMAGE TO THE STRUCTURAL INTEGRITY OF THE TEST ASSEMBLY BLADE DUE TO THIS TESTING. A SLIGHT UPSETTING OF THE BLADE LOAD BEARING SURFACES WAS OBSERVED. AS THE WORST CASES OF COUPLER DAMAGE DURING THE CONTROL ROD TESTING PERFORMED ON OCTOBER 31 AND NOVEMBER 1 WERE LESS SEVERE THAN THE TEST ASSEMBLY COUPLER DAMAGE, IT IS CONCLUDED THAT NO DAMAGE TO THE BLADES EXISTS. THE BLADES WILL BE INSPECTED FOR EVIDENCE OF UPSETTING OF THE LOAD BEARING SURFACES THE NEXT TIME THE REACTOR VESSEL HEAD IS REMOVED.

IN THE UNLIKELY EVENT THAT A DRY TRIP WAS AGAIN TO OCCUR AND THE ENERGY ABSORBER UNIT HAD BEEN PREVIOUSLY DISPLACED ITS FULL THREE INCHES OF TRAVEL AND NOT RESTORED TO NORMAL, IT IS POSSIBLE THE CONTROL ROD BLADE MIGHT BE DETACHED FROM THE COUPLER. THE MECHANISM IS THAT AS THE BLADE REACHES ITS FULLY INSERTED POSITION AND IMPACTS THE HARD STOP IT IS DECELERATED INSTANTANEOUSLY AS THE ENERGY ABSORBER UNIT HAS NO FREEDOM TO TRAVEL. THE FORCE APPLIED BY THE CONTROL ROD BLADE TO THE COUPLER MAY BE SUFFICIENT TO CAUSE THE COUPLER TO RELEASE THE BLADE. IF THIS WERE TO OCCUR, THE BLADE WOULD CONTINUE TO TRAVEL DOWNWARD UNTIL IT IMPINGED UPON THE CORE SUPPORT PLATE. THERE WOULD BE NO DAMAGE TO THE FUEL AS THE CONTROL ROD BLADE IS NOT RELEASED FROM THE COUPLER UNTIL IT REACHES THE FULLY INSERTED POSITION AND IT IS TRAVELING STRAIGHT DOWN WHEN IT IS RELEASED. ANY DAMAGE THAT OCCURS WILL BE LIMITED TO THE TIP OF THE BLADE ITSELF.

THIS SITUATION WILL NOT OCCUR BECAUSE AT LEAST 1.7 INCHES OF TRAVEL REMAIN ON ALL ENERGY ABSORBER UNITS. HOWEVER, ENERGY ABSORBER UNITS WILL BE MONITORED FOLLOWING ALL SCRAMS AND CONTROL ROD DRIVE TESTING TO INSURE THAT THEY HAVE NOT BEEN DISPLACED. THIS MONITORING WILL BE ACCOMPLISHED BY READING THE PRIMARY ROD POSITION INDICATION WHEN THE RODS ARE FULLY INSERTED AND COMPARING THE READINGS OBTAINED TO PREVIOUS KNOWN VALUES. THE ENERGY ABSORBER UNITS THAT ARE DISPLACED GREATER THAN 0.5 INCHES WILL BE REPLACED BY THE COMPLETION OF THE FIRST REFUELING OUTAGE.

#### CONCLUSIONS

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FROM THE FOREGOING DESCRIPTION AND ANALYSIS OF THIS INCIDENT AND DISCUSSIONS WITH AND TESTING PERFORMED BY COMBUSTION ENGINEERING, IT IS CONCLUDED THAT THE CAUSE OF THE INCIDENT HAS BEEN CORRECTED. THE DAMAGE TO THE CONTROL ROD DRIVE MECHANISMS WILL BE REPAIRED AS DISCUSSED ABOVE PRIOR TO REACTOR CRITICAL OPERATIONS.

THE RESULTS OBTAINED DURING THE TESTING OF THE CONTROL ROD DRIVES ON NOVEMBER 5 AND 6 DEMONSTRATE THE RELIABILITY OF THE CONTROL ROD DRIVE SYSTEM. THESE RESULTS WERE NORMAL WITH ONE EXCEPTION /NUMBER 27/ WITHOUT PERFORMING ANY MAINTENANCE ON THE CONTROL ROD DRIVE MECHANISMS.

THE SAFETY ANALYSIS ASSUMES THAT FURTHER FAILURES COULD OCCUR. BASED ON THIS SAFETY ANALYSIS, IT IS CONCLUDED THAT THE FAILURE OF THE CLUTCH OUTPUT SHAFT ON CONTROL ROD DRIVE NUMBER 27 OR FUTURE SIMILAR FAILURES OF A CONTROL ROD DRIVE MECHANISM DO NOT INVOLVE AN UNREVIEWED SAFETY ITEM. THIS SAFETY ANALYSIS TOOK CREDIT FOR INCREASED SURVEILLANCE AND OPERATING LIMITATIONS IN CERTAIN AREAS, NAMELY-

A. IF A CONTROL ROD IS DROPPED AND THE CAUSE OF THE ROD DROPPING IS OTHER THAN A CLUTCH SEPARATION, THE REACTOR WILL BE SHUT DOWN IMMEDIATELY /SAFETY ANALYSIS, PARAGRAPHS A, B, AND D/.

B. ADDED ROD POSITION INDICATION COMPARISONS AND VERIFICATION /SAFETY ANALYSIS, PARAGRAPHS B AND D/.

C. ADDED SURVEILLANCE WHEN TESTING CONTROL ROD DRIVES /SAFETY ANALYSIS, PARAGRAPH E/.

D. ADDED SURVEILLANCE OF HARD STOP LOCATIONS /SAFETY ANALYSIS/.

THESE ADDED SURVEILLANCE COMMITMENTS AND OPERATIONAL LIMITATIONS WILL REMAIN IN EFFECT UNTIL A DETAILED REPORT OF THIS INCIDENT IS SUBMITTED TO THE DIVISION OF REACTOR LICENSING. IT WILL BE SUBMITTED BY DECEMBER 3, 1971.

YOURS VERY TRULY

ROBERT L. HAUETER

ELECTRIC PRODUCTION SUPERINTENDENT - NUCLEAR

END/HO/MAA

USAEC-HQS-GTWN

EVERYTHING OK

NO GARBLING ANYWHERE

GA PLS

IF ANY QUESTIONS OR GARBLING PLS CALL 517-788-1989

**TWX INCOMING**

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