

# TMI-1 UFSAR

## CHAPTER 14 – SAFETY ANALYSIS

### TABLE OF CONTENTS

<u>SECTION</u>	<u>TITLE</u>
14.0	SAFETY ANALYSIS
14.1	CORE AND COOLANT BOUNDARY PROTECTION ANALYSIS
14.1.1	ABNORMALITIES
14.1.2	ANALYSIS OF EFFECTS AND CONSEQUENCES
14.1.2.1	UNCOMPENSATED OPERATING REACTIVITY CHANGES
14.1.2.2	STARTUP ACCIDENT
14.1.2.3	ROD WITHDRAWAL ACCIDENT AT RATED POWER OPERATION
14.1.2.4	MODERATOR DILUTION ACCIDENT
14.1.2.5	COLD WATER ACCIDENT
14.1.2.6	LOSS OF COOLANT FLOW
14.1.2.7	STUCK-OUT, STUCK-IN, OR DROPPED CONTROL ROD ACCIDENT
14.1.2.8	LOSS OF ELECTRIC POWER
14.1.2.9	STEAM LINE BREAK
14.1.2.10	STEAM GENERATOR TUBE FAILURE
14.1.2.11	ANTICIPATED TRANSIENTS WITHOUT SCRAM (ATWS)
14.2	STANDBY SAFEGUARDS ANALYSIS
14.2.1	SITUATIONS ANALYZED AND CAUSES
14.2.2	ACCIDENT ANALYSES
14.2.2.1	FUEL HANDLING ACCIDENT
14.2.2.2	ROD EJECTION ACCIDENT
14.2.2.3	LARGE BREAK LOSS OF COOLANT ACCIDENT
14.2.2.3.1	IDENTIFICATION OF CAUSES
14.2.2.3.2	LARGE BREAK LOCA ANALYSIS
14.2.2.3.3	RESULTS - LARGE BREAK LOCA
14.2.2.3.4	ENVIRONMENTAL ANALYSIS OF LOSS OF COOLANT ACCIDENTS
14.2.2.3.5	POST ANALYSIS-OF-RECORD EVALUATIONS FOR LARGE BREAK LOCA
14.2.2.4	SMALL BREAK LOSS OF COOLANT ACCIDENT
14.2.2.4.1	IDENTIFICATION
14.2.2.4.2	SMALL BREAK LOCA ANALYSIS
14.2.2.4.3	RESULTS - SMALL BREAK LOCA
14.2.2.4.4	POST ANALYSIS-OF-RECORD EVALUATIONS FOR SMALL BREAK LOCA
14.2.2.5	MAXIMUM HYPOTHETICAL ACCIDENT
14.2.2.6	WASTE GAS TANK RUPTURE
14.2.2.7	LOSS OF FEEDWATER ACCIDENT
14.2.2.8	FUEL CASK DROP ACCIDENT
14.2.2.9	FEEDWATER LINE BREAK ACCIDENT
14.2.2.9.1	FEEDWATER LINE BREAK OUTSIDE CONTAINMENT
14.2.2.9.2	FEEDWATER LINE BREAK INSIDE CONTAINMENT
14.3	REFERENCES

# TMI-1 UFSAR

## LIST OF TABLES

<u>TABLE</u>	<u>TITLE</u>
14.0-1	EQUIPMENT AND RELATED SYSTEMS ASSUMED TO FUNCTION DURING ACCIDENT ANALYSIS
14.1-1	ABNORMALITIES AFFECTING CORE AND COOLANT BOUNDARY
14.1-2	UNCOMPENSATED REACTIVITY DISTURBANCES
14.1-3	STARTUP ACCIDENT PARAMETER
14.1-4	SUMMARY OF STARTUP ACCIDENT ANALYSIS
14.1-5	ROD WITHDRAWAL ACCIDENT PARAMETERS
14.1-6	SUMMARY OF ROD WITHDRAWAL ACCIDENT ANALYSIS
14.1-7	MODERATOR DILUTION ACCIDENT PARAMETERS
14.1-8	SUMMARY OF MODERATOR DILUTION ACCIDENT ANALYSIS
14.1-9	LOSS OF COOLANT FLOW ACCIDENT PARAMETERS
14.1-10	LOCKED ROTOR ACCIDENT PARAMETERS
14.1-11	SUMMARY OF LOSS OF COOLANT FLOW ACCIDENT ANALYSIS
14.1-11a	DELETED
14.1-12	NATURAL CIRCULATION CAPABILITY
14.1-13	DROPPED ROD ACCIDENT PARAMETERS
14.1-14	LOSS OF LOAD TRANSIENT PARAMETERS AND RESULTS
14.1-14a	LOSS OF ELECTRICAL LOAD PARAMETERS AND RESULTS
14.1-15	LOSS OF ALL A-C POWER EVENT (STATION BLACKOUT) RADIOLOGICAL ANALYSIS PARAMETERS AND RESULTS
14.1-15a	DELETED
14.1-16	STEAM LINE BREAK PARAMETERS
14.1-17	DELETED

## TMI-1 UFSAR

### LIST OF TABLES (cont'd)

14.1-18	RADIOLOGICAL CONSEQUENCES OF MAIN STEAM LINE BREAK ACCIDENT IN CONJUNCTION WITH ACCIDENT-INDUCED STEAM GENERATOR TUBE LEAK (REM)
14.1-19	DELETED
14.1-20	STEAM GENERATOR TUBE FAILURE PARAMETERS
14.1-21	SUMMARY OF STEAM GENERATOR TUBE FAILURE ANALYSIS
14.1-22	COLD WATER ACCIDENT PARAMETERS
14.1-23	DELETED
14.1-24	DELETED
14.2-1	SITUATIONS ANALYZED AND CAUSES
14.2-2	RADIOACTIVE RELEASE FOR THE FUEL HANDLING ACCIDENT
14.2-3	FUEL HANDLING ACCIDENT PARAMETERS AND RESULTS
14.2-4	FISSION PRODUCT INVENTORIES FOR THE CORE, THE AVERAGE ASSEMBLY, AND THE REACTOR COOLANT SYS
14.2-4a	FISSION PRODUCT CORE INVENTORY FOR FHA IN REACTOR BUILDING AND LOCA
14.2-5	RADIOACTIVE RELEASE FOR THE POSTULATED FUEL HANDLING ACCIDENT AND DOSE RESULTS (IN THE REACTOR BUILDING)
14.2-6	ROD EJECTION ACCIDENT PARAMETERS (INITIAL CYCLE)
14.2-7	NOMINAL VALUES OF INPUT PARAMETERS FOR ROD EJECTION ACCIDENT ANALYSIS
14.2-8	COMPARISON OF SPACE-DEPENDENT AND POINT KINETICS RESULTS ON THE FUEL ENTHALPY (INITIAL CYCLE)
14.2-9	SUMMARY OF ROD EJECTION ACCIDENT ANALYSIS
14.2-10	REACTOR VESSEL PARAMETERS
14.2-11	ENVIRONMENTAL EFFECTS OF ROD EJECTION ACCIDENT
14.2-11	REACTOR VESSEL INTERNALS - DISSIMILAR METALS

## TMI-1 UFSAR

### LIST OF TABLES (cont'd)

14.2-13	ASSUMPTIONS AND RESULTS OF CONTROL ROD TEMPERATURE ANALYSIS
14.2-14	LOSS OF COOLANT ACCIDENT ANALYSIS
14.2-15	DELETED
14.2-16	SEQUENCE OF EVENTS OF STUCK OPEN PORV ACCIDENT
14.2-17	DELETED
14.2-18	DELETED
14.2-19	DELETED
14.2-20	ENVIRONMENTAL DOSES RESULTING FROM MHA
14.2-21	WASTE GAS TANK INVENTORY
14.2-22	KEY INPUT PARAMETERS FOR LOFW ANALYSIS
14.2-23	DELETED
14.2-24	DELETED
14.2-25	NOBLE GAS AND IODINE GAP ACTIVITY (10 FUEL ASSEMBLIES) 120 DAY DECAY
14.2-26	SITE BOUNDARY DOSES
14.2-27	LOW PRESSURE INJECTION FLOW VS CORE FLOOD/LPI NOZZLE PRESSURE
14.2-28	HIGH PRESSURE INJECTION FLOW VERSUS HPI NOZZLE PRESSURE
14.2-29	SUMMARY OF ANALYSIS INPUT VALUES

# TMI-1 UFSAR

## LIST OF FIGURES

<u>FIGURE</u>	<u>TITLE</u>
14.1-1	STARTUP ACCIDENT FROM $10^{-9}$ RATED POWER USING A 1.5 PERCENT $\delta$ -k/k ROD GROUP; HIGH PRESSURE REACTOR TRIP IS ACTUATED
14.1-2	STARTUP ACCIDENT FROM $10^{-9}$ RATED POWER USING ALL RODS WITH A WORTH OF 10 PERCENT $\delta$ -k/k; HIGH FLUX REACTOR TRIP IS ACTUATED
14.1-3	PEAK THERMAL POWER VS ROD WITHDRAWAL RATE FOR A STARTUP ACCIDENT FROM $10^{-9}$ RATED POWER
14.1-4	PEAK NEUTRON POWER VERSUS ROD WITHDRAWAL RATE FOR A STARTUP ACCIDENT FROM $10^{-9}$ RATED POWER
14.1-5	PEAK THERMAL POWER VERSUS MODERATOR COEFFICIENT FOR A STARTUP ACCIDENT USING A 1.5 PERCENT $\delta$ -k/k ROD GROUP AT $1.09 \times 10^{-4}$ ( $\delta$ -k/k)/S FROM $10^{-9}$ RATED POWER
14.1-6	PEAK THERMAL POWER VERSUS MODERATOR COEFFICIENT FOR A STARTUP ACCIDENT USING A 1.5 PERCENT $\delta$ -k/k ROD GROUP AT $1.09 \times 10^{-4}$ ( $\delta$ -k/k)/S FROM $10^{-9}$ RATED POWER
14.1-7	PEAK THERMAL POWER VERSUS DOPPLER COEFFICIENT FOR A STARTUP ACCIDENT USING ALL RODS AT $7.25 \times 10^{-4}$ ( $\delta$ -k/k)/S FROM $10^{-9}$ RATED POWER
14.1-8	PEAK THERMAL POWER VERSUS MODERATOR COEFFICIENT FOR A STARTUP ACCIDENT USING ALL RODS AT $7.25 \times 10^{-4}$ ( $\delta$ -k/k)/S FROM $10^{-9}$ RATED POWER
14.1-9	ROD WITHDRAWAL ACCIDENT FROM RATED POWER USING A 1.5 PERCENT $\delta$ -k/k ROD GROUP AT $1.09 \times 10^{-4}$ ( $\delta$ -k/k)/S; HIGH FLUX REACTOR TRIP IS ACTUATED
14.1-10	PEAK PRESSURE VERSUS ROD WITHDRAWAL RATE FOR A ROD WITHDRAWAL ACCIDENT FROM RATED POWER
14.1-11	PEAK PRESSURE VERSUS TRIP DELAY TIME FOR A ROD WITHDRAWAL ACCIDENT FROM RATED POWER USING A 1.5 PERCENT $\delta$ -k/k ROD GROUP
14.1-12	PEAK PRESSURE VERSUS DOPPLER COEFFICIENT FOR A ROD WITHDRAWAL ACCIDENT FROM RATED POWER USING A 1.5 PERCENT $\delta$ -k/k ROD GROUP

## TMI-1 UFSAR

### LIST OF FIGURES (cont'd)

<u>FIGURE</u>	<u>TITLE</u>
14.1-13	PEAK PRESSURE VERSUS MODERATOR COEFFICIENT FOR A ROD WITHDRAWAL ACCIDENT FROM RATED POWER USING A 1.5 PERCENT $\Delta k/k$ ROD GROUP
14.1-14	MAXIMUM NEUTRON AND THERMAL POWER FOR AN ALL-ROD WITHDRAWAL ACCIDENT FROM VARIOUS INITIAL POWER LEVELS
14.1-15	PEAK FUEL TEMPERATURE IN AVERAGE ROD AND HOT SPOT FOR AN ALL-ROD WITHDRAWAL ACCIDENT FROM VARIOUS INITIAL POWER LEVELS
14.1-16	PUMP STARTUP FROM 50 PERCENT POWER AND 50 PERCENT FLOW
14.1-17	PERCENT REACTOR COOLANT FLOW AS A FUNCTION OF TIME AFTER LOSS OF PUMP POWER
14.1-18	DNB RATIO VERSUS TIME FOR A 4 PUMP COASTDOWN ACCIDENT FROM 102% OF RATED POWER
14.1-19	DNB RATIO VERSUS TIME FOR A LOCKED ROTOR ACCIDENT FROM 102 PERCENT OF RATED POWER
14.1-20	0.46 PERCENT $\Delta k/k$ ROD DROP FROM RATED POWER WITH AUTOMATIC RUNBACK TO 60 PERCENT DEMAND IN 12s
14.1-21	0.36 PERCENT $\Delta k/k$ ROD DROP FROM RATED POWER WITH AUTOMATIC RUNBACK TO 60 PERCENT DEMAND IN 12s
14.1-22A	DOUBLE-ENDED RUPTURE OF 24 IN STEAM LINE BETWEEN STEAM GENERATOR AND STEAM STOP VALVE (with Feedwater Isolation)
14.1-22B	DOUBLE-ENDED RUPTURE OF 24 IN STEAM LINE BETWEEN STEAM GENERATOR AND STEAM STOP VALVE (with Feedwater Isolation)
14.1-23	RCS HOT LEG PRESSURE (psia) RESPONSE FOR LOSS OF ALL AC POWER (STATION BLACKOUT)
14.1-24	DROPPED ROD W/ BAYONET FAILURE – RCS PRESSURE RESPONSE
14.1-25	DROPPED ROD W/ BAYONET FAILURE – REACTOR POWER RESPONSE
14.1-26	DROPPED ROD W/ BAYONET FAILURE – PRIMARY TEMPERATURE RESPONSE
14.2-1	PEAK NEUTRON POWER VARIATION WITH EJECTED CONTROL ROD WORTH

## TMI-1 UFSAR

### LIST OF FIGURES (cont'd)

<u>FIGURE</u>	<u>TITLE</u>
14.2-2	PEAK THERMAL POWER AS A FUNCTION OF EJECTED CONTROL ROD WORTH
14.2-3	PEAK ENTHALPY OF HOTTEST FUEL ROD VERSUS EJECTED CONTROL ROD WORTH
14.2-4	EFFECT ON PEAK NEUTRON POWER OF VARYING THE DOPPLER COEFFICIENT FOR AN EJECTED ROD WORTH OF 0.56 PERCENT $\Delta k/k$ AT $10^{-9}$ RATED POWER AND 0.46 PERCENT $\Delta k/k$ AT RATED POWER
14.2-5	EFFECT ON PEAK THERMAL POWER OF VARYING THE DOPPLER COEFFICIENT FOR AN EJECTED ROD WORTH OF 0.56 PERCENT $\Delta k/k$ AT $10^{-9}$ RATED POWER AND 0.46 PERCENT $\Delta k/k$ AT RATED POWER
14.2-6	EFFECT ON PEAK NEUTRON POWER OF VARYING THE MODERATOR COEFFICIENT FOR AN EJECTED ROD WORTH OF 0.56 PERCENT $\Delta k/k$ AT $10^{-3}$ RATED POWER AND 0.46 PERCENT $\Delta k/k$ AT RATED POWER
14.2-7	EFFECT ON PEAK THERMAL POWER OF VARYING THE MODERATOR COEFFICIENT FOR AN EJECTED ROD WORTH OF 0.56 PERCENT $\Delta k/k$ AT $10^{-3}$ RATED POWER AND 0.46 PERCENT $\Delta k/k$ AT RATED POWER
14.2-8	EFFECT ON PEAK THERMAL POWER OF VARYING THE TRIP DELAY TIME FOR AN EJECTED ROD WORTH OF 0.56 PERCENT $\Delta k/k$ AT $10^{-9}$ RATED POWER AND 0.46 PERCENT $\Delta k/k$ AT RATED POWER
14.2-9	PERCENT CORE EXPERIENCING DNB AS A FUNCTION OF EJECTED CONTROL ROD WORTH AT RATED POWER, BOL
14.2-10	LARGE BREAK ANALYSIS CODE INTERFACES
14.2-11	HOT SPOT CLAD TEMPERATURE VS TIME FOR A 36 IN ID, DOUBLE-ENDED, HOT LEG PIPE RUPTURE AND VARIABLE QUENCH COEFFICIENT
14.2-12	LBLOCA LIMIT CASE (BOL) – REACTOR VESSEL UPPER PLENUM PRESSURE
14.2-13	LBLOCA LIMIT CASE (BOL) – BREAK MASS FLOW RATE
14.2-14	LBLOCA LIMIT CASE (BOL – 2.506-FT) – HOT CHANNEL FUEL AND CLAD TEMPERATURE AT PEAK UNRUPTURED LOCATION
14.2-15	LBLOCA LIMIT CASE (BOL – 4.264-FT) – HOT CHANNEL FUEL AND CLAD TEMPERATURE AT PEAK UNRUPTURED LOCATION
14.2-16	LBLOCA LIMIT CASE (BOL – 6.021-FT) – HOT CHANNEL FUEL AND CLAD TEMPERATURE AT PEAK UNRUPTURED LOCATION

## TMI-1 UFSAR

### LIST OF FIGURES (cont'd)

<u>FIGURE</u>	<u>TITLE</u>
14.2-17	LBLOCA LIMIT CASE (BOL – 7.779-FT) – HOT CHANNEL FUEL AND CLAD TEMPERATURE AT PEAK UNRUPTURED LOCATION
14.2-18	LBLOCA LIMIT CASE (BOL – 9.536-FT) – HOT CHANNEL FUEL AND CLAD TEMPERATURE AT PEAK UNRUPTURED LOCATION
14.2-19	LBLOCA LIMIT CASE (BOL – 2.506-FT) – HOT CHANNEL FUEL AND CLAD TEMPERATURE AT PEAK RUPTURED LOCATION
14.2-20	LBLOCA LIMIT CASE (BOL – 4.264-FT) - HOT CHANNEL FUEL AND CLAD TEMPERATURE AT PEAK RUPTURED LOCATION
14.2-21	LBLOCA LIMIT CASE (BOL – 6.021-FT) – HOT CHANNEL FUEL AND CLAD TEMPERATURE AT PEAK RUPTURED LOCATION
14.2-22	LBLOCA LIMIT CASE (BOL – 7.779-FT) – HOT CHANNEL FUEL AND CLAD TEMPERATURE AT PEAK RUPTURED LOCATION
14.2-23	LBLOCA LIMIT CASE (BOL – 9.536-FT) – HOT CHANNEL FUEL AND CLAD TEMPERATURE AT PEAK RUPTURED LOCATION
14.2-24	LOCA LIMIT AXIAL POWER SHAPES
14.2-25	SBLOCA COMPARISON OF RCS PRESSURE (0.01 – 0.06 FT <sup>2</sup> BREAKS)
14.2-26	SBLOCA COMPARISON OF RCS PRESSURE (0.07 – 0.10 FT <sup>2</sup> BREAKS)
14.2-27	SBLOCA COMPARISON OF RCS PRESSURE (0.15 – 0.75 FT <sup>2</sup> BREAKS)
14.2-28	SBLOCA COMPARISON OF REACTOR VESSEL COLLAPSED LIQUID LEVEL (0.01 – 0.06 FT <sup>2</sup> BREAKS)
14.2-29	SBLOCA COMPARISON OF REACTOR VESSEL COLLAPSED LIQUID LEVEL (0.07 – 0.10 FT <sup>2</sup> BREAKS)
14.2-30	SBLOCA COMPARISON OF REACTOR VESSEL COLLAPSED LIQUID LEVEL (0.15 – 0.75 FT <sup>2</sup> BREAKS)
14.2-31	SBLOCA COMPARISON OF PEAK CLAD TEMPERATURES (0.01 – 0.06 FT <sup>2</sup> BREAKS)
14.2-32	SBLOCA COMPARISON OF PEAK CLAD TEMPERATURES (0.07 – 0.10 FT <sup>2</sup> BREAKS)
14.2-33	SBLOCA COMPARISON OF PEAK CLAD TEMPERATURES (0.15 – 0.75 FT <sup>2</sup> BREAKS)

## TMI-1 UFSAR

### LIST OF FIGURES (cont'd)

<u>FIGURE</u>	<u>TITLE</u>
14.2-34	CFT LINE BREAK SYSTEM PRESSURE
14.2-35	CFT LINE BREAK COLLAPSED LIQUID LEVELS
14.2-36	CFT LINE BREAK MIXTURE LEVELS
14.2-37	CFT LINE BREAK HOT CHANNEL CLAD TEMPERATURES
14.2-38	HPI LINE BREAK SYSTEM PRESSURE (OPERATOR ACTION)
14.2-39	HPI LINE BREAK COLLAPSED LIQUID LEVELS (OPERATOR ACTION)
14.2-40	HPI LINE BREAK MIXTURE LEVELS (OPERATOR ACTION)
14.2-41	HPI LINE BREAK HOT CHANNEL CLAD TEMPERATURES (OPERATOR ACTION)
14.2-42	HPI LINE BREAK SYSTEM PRESSURE (NO OPERATOR ACTION)
14.2-43	HPI LINE BREAK COLLAPSED LIQUID LEVELS (NO OPERATOR ACTION)
14.2-44	HPI LINE BREAK MIXTURE LEVELS (NO OPERATOR ACTION)
14.2-45	HPI LINE BREAK HOT CHANNEL CLAD TEMPERATURES (NO OPERATOR ACTION)
14.2-46	SBLOCA SPECTRUM – PCT VERSUS BREAK SIZE
14.2-47	CRAFT 2 NODING DIAGRAM FOR SMALL BREAK
14.2-48	BREAK SPECTRUM-AVERAGE SYSTEM VOID FRACTION WITH THE RC PUMPS OPERATIVE AND 2 HPI PUMPS
14.2-49	PRESSURE VS TIME – SMALL BREAKS WITH EMERGENCY FEEDWATER
14.2-50	PRESSURIZER LEVEL VS TIME – SMALL BREAKS WITH EMERGENCY FEEDWATER
14.2-51	PRESSURIZER LEVEL VS TIME FOR SMALL BREAK IN PRESSURIZER
14.2-52	0.01 FT <sup>2</sup> COLD LEG BREAK WITH NO EFW, 2 HPI'S & STUCK PORV AT 20 MIN-NODE 14 PRESSURE VS TIME
14.2-53	0.01 FT <sup>2</sup> COLD LEG BREAK WITH NO EFW, 2 HPI'S & STUCK PORV AT 20 MIN-PRESSURIZER LIQUID LEVEL

## TMI-1 UFSAR

### LIST OF FIGURES (cont'd)

<u>FIGURE</u>	<u>TITLE</u>
14.2-54	0.01 FT <sup>2</sup> COLD LEG BREAK WITH NO EFW, 2 HPI'S & STUCK PORV AT 20 MIN-UPPER PLENUM LIQUID LEVEL
14.2-55	0.01 FT <sup>2</sup> COLD LEG BREAK WITH NO EFW, 2 HPI'S & STUCK PORV AT 20 MIN-PORV LEAK FLOW
14.2-56	0.01 FT <sup>2</sup> COLD LEG BREAK WITH NO EFW, 2 HPI'S & STUCK PORV AT 20 MIN-PORV LEAK FLOW QUALITY
14.2-57	0.01 FT <sup>2</sup> COLD LEG BREAK WITH NO EFW, 2 HPI'S & STUCK PORV AT 20 MIN-COLD LEG BREAK FLOW
14.2-58	0.01 FT <sup>2</sup> CLOLD LEG BREAK WITH NO EFW, 2 HPI'S & STUCK PORV AT 20 MIN-COLD LEG BREAK LEAK FLOW QUALITY
14.2-59	SYSTEM PRESSURE VS TIME – SMALL BREAKS W/O EMERGENCY FEEDWATER
14.2-60	PRESSURIZER LEVEL VS TIME – CLASS 3 BREAKS W/O EMERGENCY FEEDWATER
14.2-61	INTEGRATED DIRECT DOSE FOLLOWING MHA WITH 3-1/2 FT REACTOR BULDING WALL THICKNESS
14.2-62	DELETED
14.2-63	BORON DILUTION AND PLATEOUT

# TMI-1 UFSAR

## APPENDICES

14 A	DESIGN REVIEW FOR CONSIDERATION OF EFFECTS OF PIPING SYSTEM BREAKS OUTSIDE CONTAINMENTS	
14 B	DELETED	
14 C	DELETED	
14 D	DELETED	
14 E	DELETED	