



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555
November 13, 1979

MEMORANDUM FOR: Saul Levine, Director
Office of Nuclear Regulatory Research

FROM: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

SUBJECT: LONG-RANGE RESEARCH PLANS

By memorandum dated August 1, 1979, the EDO requested that the user Offices supply RES with a list of long-range research objectives. My staff provided preliminary input to Dr. Tong to assist in the development of a draft plan for water reactor safety research (Enclosure 1). Enclosure 2 provides NRR comments on this draft plan. Enclosure 3 lists additional objectives that were either received too late to be included in Dr. Tong's draft plan or that address topics in other program areas.

A handwritten signature in cursive script, appearing to read "HR Denton".

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosures:
As stated

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ENCLOSURE 1
PLAN FOR WATER REACTOR SAFETY RESEARCH

September 21, 1979

Objectives	A. Research Support Branch	B. Separate Effects Branch	C. LOFT Research Branch	D. Analysis Development Branch	E. Fuel Behavior Branch	F. Metallurgy & Materials Branch
1. Accident Detection & Prevention	* i. Noise Analysis ii. Monitoring Instrumentation Application iii. Valve Testing	i. In-pile Instrumentation	i. In-pile Instrumentation		i. In-pile Instrumentation	i. NDE ii. Leak Detector
2. Separate Effects Tests for understanding & Modeling & Reactor Engineering Review	i. 2D/3D Tests ii. Secondary Reliability Study	* i. Semiscale Tests ii. Heat Transfer Tests iii. Two-phase Flow Tests iv. Sump Test		i. 2D/3D Analysis ii. BWR Containment Analysis iii. BWR Instability	i. Clad and Fuel Studies ii. Hydrogen Study iii. Water Chemistry	i. Fracture Mechanics ii. Environmental Effects on Materials
3. System Evaluation Tests & Reactor Operation & Control Research	i. Fire Protection ii. Qualification Test iii. Human Factor		* i. LOFT Tests ii. Diagnostic Display iii. System Analysis	i. Intelligent Simulator		
4. Analytical Tool Development & Accident Analysis		* i. Phenomenological Model Development		* i. Code Development ii. Code Assessment iii. Code Application iv. Doppler Effect	i. Fuel Code Development, Assessment, & Application	i. Structure Code
5. Accident Consequence Evaluation & Mitigation					* i. Fuel Damage Mechanism & Threshold ii. Core Meltdown	

*Indicates lead branch

OBJECTIVES

A. RESEARCH SUPPORT
BRANCH

B. SEPARATE EFFECTS
BRANCH

1. ACCIDENT DETECTION &
PREVENTION

- *
i. NOISE ANALYSIS
ii. MONITORING INSTRUMENTATION
APPLICATION
iii. VALVE TESTING

i. IN-PILE INSTRUMENTATION

2. SEPARATE EFFECTS TESTS
FOR UNDERSTANDING
& MODELING & REACTOR
ENGINEERING REVIEW

- i. 2D/3D TESTS
ii. SECONDARY RELIABILITY
STUDY

- *
i. SEMISCALE TESTS
ii. HEAT TRANSFER TESTS
iii. TWO-PHASE FLOW TESTS
iv. SUMP TEST
-

3. SYSTEM EVALUATION TESTS
& REACTOR OPERATION &
CONTROL RESEARCH

- i. FIRE PROTECTION
ii. QUALIFICATION TEST
iii. HUMAN FACTORS
-

4. ANALYTICAL TOOL
DEVELOPMENT &
ACCIDENT ANALYSIS

i. PHENOMINOLOGICAL
MODEL DEVELOPMENT

5. ACCIDENT CONSEQUENCE
EVALUATION & MITIGATION

*INDICATES LEAD BRANCH

OBJECTIVES

C. LOFT RESEARCH
BRANCH

D. ANALYSIS DEVELOPMENT
BRANCH

1. ACCIDENT DETECTION &
PREVENTION

i. IN-PILE INSTRUMENTATION

2. SEPARATE EFFECTS TESTS
FOR UNDERSTANDING
& MODELING & REACTOR
ENGINEERING REVIEW

i. 2D/3D ANALYSIS
ii. BWR CONTAINMENT ANALYSIS
iii. BWR INSTABILITY

3. SYSTEM EVALUATION TESTS
& REACTOR OPERATION &
CONTROL RESEARCH

*
i. LOFT TESTS
ii. DIAGNOSTIC DISPLAY
iii. SYSTEM ANALYSIS

i. INTELLIGENT SIMULATOR

4. ANALYTICAL TOOL
DEVELOPMENT &
ACCIDENT ANALYSIS

*
i. CODE DEVELOPMENT
ii. CODE ASSESSMENT
iii. CODE APPLICATION
iv. DOPPLER EFFECT

5. ACCIDENT CONSEQUENCE
EVALUATION & MITIGATION

*INDICATES LEAD BRANCH

OBJECTIVES

E. FUEL BEHAVIOR
BRANCH

F. METALLURGY & MATERIALS
BRANCH

1. ACCIDENT DETECTION &
PREVENTION

i. IN-PILE INSTRUMENTATION

i. NDE
ii. LEAK DETECTOR

2. SEPARATE EFFECTS TESTS
FOR UNDERSTANDING
& MODELING & REACTOR
ENGINEERING REVIEW

i. CLAD AND FUEL STUDIES
ii. HYDROGEN STUDY
iii. WATER CHEMISTRY

i. FRACTURE MECHANICS
ii. ENVIRONMENTAL EFFECTS
ON MATERIALS

3. SYSTEM EVALUATION TESTS
& REACTOR OPERATION &
CONTROL RESEARCH

4. ANALYTICAL TOOL
DEVELOPMENT &
ACCIDENT ANALYSIS

i. FUEL CODE DEVELOPMENT,
ASSESSMENT & APPLICATION

i. STRUCTURE CODE

5. ACCIDENT CONSEQUENCE
EVALUATION & MITIGATION

*
i. FUEL DAMAGE MECHANISM &
THRESHOLD
ii. CORE MELTDOWN

*INDICATES LEAD BRANCH

1. ACCIDENT DETECTION AND PREVENTION

A. RESEARCH SUPPORT BRANCH

I. NOISE DIAGNOSTICS FOR SAFETY ANALYSIS

- PERFORM A FEASIBILITY STUDY OF USING THE ^{252}Cf NOISE ANALYSIS FOR THE DETERMINATION OF REACTIVITY (FY 1982)
- IDENTIFICATION OF DEGRADED PLANT SITUATIONS AND DEVELOPMENT OF APPROACHES AND PROCEDURES TO HANDLE THE SITUATION (FY 1984)
- CONTINUE AND COMPLETE THE DEVELOPMENT OF AN AUTOMATIC SURVEILLANCE MONITORING SYSTEM FOR PLANT SIGNALS (FY 1983)
- CONTINUE AND COMPLETE THE DEVELOPMENT OF A STABILITY MEASUREMENT TECHNIQUE FOR BWRs (FY 1983)
- COMPLETE THE FIELD MEASUREMENTS PROGRAM FOR LOOSE PARTS DETECTION (FY 1982)
- CONTINUE AND COMPLETE THE ASSESSMENT OF LEAK DETECTION METHODS BY APPLYING NOISE DIAGNOSTIC TECHNIQUES TO ACOUSTIC NOISE SIGNALS (FY 1982)

II. MONITORING INSTRUMENTATION APPLICATION

- ASSESS THE EFFICACY OF IMPROVED MONITORING SYSTEMS (FY 1982)
- DEVELOP INSTRUMENTATION IN SUPPORT OF IE RESIDENT INSPECTOR PROGRAM (FY 1984)

1. ACCIDENT DETECTION AND PREVENTION

A. RESEARCH SUPPORT BRANCH (CONTINUED)

III. VALVE TESTING

- PARTICIPATE IN INDUSTRY FULL-SCALE VALVE TESTING AND COOPERATIVE EFFORTS UNDER WAY WITH JAPAN AND GERMANY ON VALVE TESTING (FY 1982)
- ASSESS SAFETY/RELIEF VALVE OPERABILITY AND RELIABILITY INCLUDING FLOW DISCHARGE RATE AND SYSTEM STRUCTURAL EFFECTS (FY 1983)

2. SEPARATE EFFECTS TESTS FOR UNDERSTANDING AND MODELING AND REACTOR ENGINEERING REVIEW

A. RESEARCH SUPPORT BRANCH

I. 2D/3D TESTS

- STUDY INTEGRAL MULTIDIMENSIONAL CORE AND DOWNCOMER HYDRAULIC BEHAVIOR DURING LATE BLOWDOWN AND REFILL AND REFLOOD (FY 1984)
- STUDY UPPER PLENUM DE-ENTRAINMENT AND FALL BACK (FY 1984)
- PROVIDE INFORMATION ON UPPER PLENUM INJECTION (FY 1984)
- PROVIDE INFORMATION ON INFLUENCES OF STEAM GENERATORS (DE-ENTRAINMENT, STORAGE, HEAT TRANSFER, HYDRAULIC LOADS) (FY 1984)
- STUDY EFFECTS OF FLOW BLOCKAGE (FY 1983)

II. SECONDARY SYSTEM RELIABILITY STUDY

- PROVIDE EXPERT TECHNICAL ASSISTANCE TO NRR IN DEVELOPING SPECIFIC AND GENERAL LICENSING SAFETY REQUIREMENTS (FY 1982)
- ASSIST NRR IN RE-EXAMINING AUXILIARY SYSTEMS DESIGN CRITERIA BASED ON STUDIES OF BOP SYSTEM TRANSIENTS (FY 1982)

3. SYSTEM EVALUATION TESTS AND REACTOR OPERATION AND CONTROL RESEARCH

A. RESEARCH SUPPORT BRANCH

i. FIRE PROTECTION

- COMPLETE FULL-SCALE REPLICATION TESTS AND FIRE SUPPRESSION SYSTEM STUDIES (FY 1982)
- OBTAIN DATA ON THE EFFECTIVENESS OF SAFETY-RELATED EQUIPMENT (OTHER THAN CABLE) IN PERFORMING SAFETY FUNCTIONS WHEN SUBJECTED TO EXPOSURE FIRES (START FY 1981, COMPLETE FY 1984)
- STUDY CORROSION OF STAGNANT FLUIDS IN FIRE PROTECTION SYSTEMS (START FY 1982, COMPLETE FY 1986)

ii. QUALIFICATION TESTING EVALUATION

- COMPLETE ASSESSMENT OF THE VARIOUS QUALIFICATION TESTING METHODOLOGIES (FY 1986)
- DEVELOP QUALIFICATION METHODOLOGY FOR QUALIFYING INSTRUMENTS TO FOLLOW THE COURSE OF AN ACCIDENT (FY 1983)
- DEVELOPMENT OF IMPROVED CONSTRUCTION MONITORING AND QUALITY CONTROL TESTING PROCEDURES TO ENSURE THAT HIGH QUALITY CONSTRUCTION IS BEING ACHIEVED (FY 1983)
- PROVIDE SUPPORT ON DEVELOPMENT OF ENVIRONMENTALLY INVULNERABLE HYDRAULIC MOTOR DRIVES FOR IN-CONTAINMENT USE (FY 1984)
- ESTABLISH THE MINIMUM ACCEPTABLE SAFETY AND RELIABILITY REQUALIFICATION REQUIREMENTS FOR TMI-2 EQUIPMENT IN THE PLANT (FY 1982)

3. SYSTEM EVALUATION TESTS AND REACTOR OPERATION AND CONTROL RESEARCH

A. RESEARCH SUPPORT BRANCH

III. HUMAN FACTORS

- DEVELOP BETTER UNDERSTANDING OF THOSE HUMAN FACTORS WHICH ARE IMPORTANT IN ENSURING THAT THE OPERATOR CAN FUNCTION EFFECTIVELY TO CONTINUE OFF-NORMAL EVENTS. THIS SHOULD BE REFLECTED IN CONTROL SYSTEM AND CONTROL ROOM DESIGNS (FY 1983)
- DEVELOP HUMAN FACTORS INPUT TO IMPROVE OPERATOR TRAINING FOR DEGRADED PLANT CONDITIONS (FY 1982)
- COMPLETE THE SAFETY-RELATED OPERATOR ACTION STUDY (FY 1983)

WATER REACTOR SAFETY RESEARCH PLAN

1. ACCIDENT DETECTION AND PREVENTION

B. SEPARATE EFFECTS BRANCH

I. REACTOR INSTRUMENTATION

PWR LIQUID LEVEL IN CORE

- HEATED T.C.
- ULTRASONICS
- SELF-POWERED NEUTRON DETECTOR

PWR PRESSURIZER LEVEL

- ULTRASONIC SOUNDING

STEAM GENERATOR BUBBLE (PRIMARY SIDE)

- GAMMA BEAMS
- ULTRASONICS

NATURAL CIRCULATION FLOW MEASUREMENT

- HEATED T.C.
- PULSED NEUTRON ACTIVATION

2. SEPARATE EFFECTS TESTS FOR UNDERSTANDING AND MODELING AND REACTOR ENGINEERING RENEW

B. SEPARATE EFFECTS BRANCH*

I. SEMISCALE TESTS

- BLOWDOWN REFILL AND REFLOOD, HEAT TRANSFER DATA
- SMALL BREAK TEST DATA
- TMI-2 RELATED EXPERIMENTS
- GHI INTEGRAL SYSTEM TEST
- ECC BYPASS
- LOWER PLENUM VOIDING
- STEAM GENERATOR HEAT TRANSFER DURING REFLOOD

II. HEAT TRANSFER TESTS

- BDIIT (ORNL) FOR SMALL BREAK TRANSIENT, POST-CHF HEAT TRANSFER;
REWET (COMPLETED BY FY 1981)
- PWR FLECHT SEASET (V); SYSTEM EFFECT OF REFLOOD, BLOCKAGE TESTS,
GRID EFFECTS, STEAM GENERATOR TESTS (COMPLETE) BY FY 1982)
- BLOWDOWN AND ECC (GE); BLOWDOWN HEAT TRANSFER AND ECC BEHAVIOR TO
8 X 8 BUNDLE WITH SIMULATED ELECTRICAL RODS (FY 1982)

2. SEPARATE EFFECTS TESTS FOR UNDERSTANDING AND MODELING AND REACTOR ENGINEERING REVIEW

B. SEPARATE EFFECTS BRANCH (CONTINUED)

III. TWO PHASE FLOW TESTS

- STEAM WATER MIXING IN DOWNCOMER TO DETERMINE ECC BYPASS
(BCL AND CREARE, FY 1980)

IV. SUMP TEST (SANDIA)

- TO DETERMINE THE HYDRAULIC BEHAVIOR OF RECIRCULATED
COOLANT FROM CONTAINMENT
- INSULATOR DEBRIS EFFECT ON SUMP PUMP EFFICIENCY

4. ANALYTICAL TOOL DEVELOPMENT AND ACCIDENT ANALYSIS

B. SEPARATE EFFECTS BRANCH

I. PHENOMENOLOGICAL MODEL DEVELOPMENT

- HEAT TRANSFER FOR SLOW BREAK TRANSIENT (ORNL, W AND INEL)
INCLUDING HEAT TRANSFER TO WET STEAM, DRY STEAM, LEVEL SWELLING
- POST-CHF HEAT TRANSFER, INCLUDING FILM BOILING, TRANSITION
BOILING AND REWET (ORNL, INEL, LEHIGH BY FY 1981)
- CONDENSATION IN PARALLEL STEAM OF WATER AND STEAM
(NWU, FY 1981)
- VAPOR GENERATION RATE AND CONDENSATION RATE IN DISPERSED FLOW
(BNL AND NWU, BY FY 1981)
- TWO PHASE FLOW IN STEAM GENERATOR (MIT, FY 1982) INCLUDING MULTI-
CHANNEL EFFECT, NATURAL CIRCULATION LOOP
- PHASE DISTRIBUTION AND PHASE SEPARATION IN VARIOUS CHANNEL
GEOMETRY (RPI, FY 1981)

4. ANALYTICAL TOOL DEVELOPMENT AND ACCIDENT ANALYSIS

B. SEPARATE EFFECTS BRANCH (CONTINUED)

- PARALLEL CHANNEL EFFECT IN BWR (RPI, FY 1981)
- TWO FLUID MODEL (ANL, FY 1980)
- DROPLET FLOW PROFILES IN END BOX AND IN BLOCKED BUNDLE
(SUNY FY 1981)

1. ACCIDENT DETECTION AND PREVENTION

C. LOFT RESEARCH BRANCH

1. IN-PILE INSTRUMENTATION

°COMPARISON OF EX-CORE IN CHAMBERS

CLAD THERMOCOUPLES

COOLANT THERMOCOUPLES

GUIDE TUBE THERMOCOUPLES

SELF-POWERED NEUTRON DETECTORS

LIQUID LEVEL TRANSDUCERS

} USED IN LOFT AND RECORDED

DURING CORE UNCOVERIES TO ASSESS

THEIR VALUE IN MEASURING CORE

UNCOVERY DURING ACCIDENT CONDITIONS

°LIQUID SUBCOOLING METER NOW DEVELOPED AND OPERATIONAL IN LOFT

°FOLLOWING NRR AND OTHER NRC ASSESSMENTS OF IN-CORE INSTRUMENTATION CONSIDERED USEFUL TO LWRS, INSTALL AND TEST INSIT THOSE CONTENDERS FOR LWR INSTALLATION.

3. SYSTEM EVALUATION TESTS AND REACTOR OPERATION AND CONTROL RESEARCH

C. LOFT RESEARCH BRANCH

I. LOFT TESTS

LOFT TESTS IN FY 80

- ° COLD-LEG SMALL BREAKS - L3-1 CONTINUED DEPRESSURIZATION (11/79)
- L3-2 HANGUP AT INTERMEDIATE PRESSURE (2/80)
- L3-2 REPRESSURIZATION (7/80)
- L3-4 STUCK OPEN PORV (5/80)

- ° HOT-LEG SMALL BREAKS - L3-5 PRIMARY COOLANT PUMP OFF (3/80)
- L3-6 PRIMARY COOLANT PUMP ON (3/80)

- ° OPERATIONAL TRANSIENT - L6-1 STEAM LINE BREAK (5/80)
- L6-2 LOSS OF PCS FLOW (7/80)

- LONG TERM
- ° COMPLETE LARGE BREAK POWER ASCENSION SERIES
 - ° INTERMEDIATE BREAKS
 - ° ALTERNATE ECCS
 - ° ADDITIONAL SMALL BREAKS AND ANOMALOUS TRANSIENTS

3. SYSTEM EVALUATION TESTS AND REACTOR OPERATION AND CONTROL RESEARCH

C. LOFT RESEARCH BRANCH (CONT'D)

ii. DIAGNOSTIC DISPLAY BEING INSTALLED IN LOFT;

- USES: - STUDY EFFECTIVENESS IN DETECTING PROBLEM ANNUNCIATING, ADVICE TO OPERATOR, AND PREVENTING ACCIDENT
- STUDY MEANS OF PRESENTING INFORMATION TO OPERATE DURING
- A) NORMAL OPERATING CONDITIONS
 - B) COURSE OF AN ACCIDENT SEQUENCE

(EARLY RESULTS EXPECTED LATE '80)

iii. SYSTEM ANALYSIS

- ° APPLY LOFT TEST RESULTS TO ASSESS AND DEVELOP LOCA AND TRANSIENT CODES

- ° IN PLANNING A TEST, BEST ESTIMATE ANALYSIS COULD IDENTIFY BEHAVIOR AT VARIANCE WITH THAT EXPECTED. THIS SERVES NOT ONLY TO ASSESS ATYPICALITIES IN LOFT, BUT ALSO BRINGS ATTENTION TO UNANTICIPATED BEHAVIOR IN LWRs.

2. SEPARATE EFFECTS TESTS FOR UNDERSTANDING AND MODELING, AND REACTOR ENGINEERING REVIEW

D. ANALYSIS DEVELOPMENT BRANCH

i. 2D/3D ANALYSIS

- PROVIDE COMPUTER MODELS TO DESCRIBE MULTIDIMENSIONAL EFFECTS OF BLOWDOWN, REFILL AND REFLOOD PLUS DE-ENTRAINMENT AND FALLBACK (FY 1984)
- PROVIDE PRETEST PREDICTIONS AND POST-TEST ANALYSES OF 2D/3D TESTS (FY 1984)

ii. BWR CONTAINMENT ANALYSIS

- PROVIDE IMPROVED ANALYTICAL MODELS FOR BWR CONTAINMENT RESPONSE (FY 1983)

iii. BWR INSTABILITY

- DEVELOP ANALYTICAL MODEL TO ANALYZE STABILITY OF BWRS (FY 1983)

3. SYSTEM EVALUATION TESTS AND REACTOR OPERATION AND CONTROL RESEARCH

D. ANALYSIS DEVELOPMENT BRANCH

1. INTELLIGENT SIMULATORS

- DEVELOP INTELLIGENT SIMULATOR TO ASSESS PROBABILITY OF ACCIDENT OCCURRENCE (FY 1986)

4. ANALYTICAL TOOL DEVELOPMENT AND ACCIDENT ANALYSIS

D. ANALYSIS DEVELOPMENT BRANCH *

I. CODE DEVELOPMENT

- DEVELOP STEAM GENERATOR CODES AND MODELS (FY 1980)
- DEVELOP A BWR-LOCA BEST ESTIMATE COMPUTER CODE (FY 1982)
- DEVELOP UHI AND UPI MODELS (FY 1981)
- PROVIDE ANALYTICAL TOOLS FOR A FAST CALCULATING CAPABILITY TO ANALYZE ALL POSTULATED REACTOR SYSTEM TRANSIENTS (FY 1985)
- ESTABLISH A COMPUTER MODEL INPUT DATA BANK (FY 1984)
- PROVIDE FOR REACTOR PHYSICS CODE ACQUISITION, IMPROVEMENT, CHECKOUT AND ASSESSMENT (FY 1984)

II. CODE ASSESSMENT

- COMPLETE ASSESSMENT OF LOCA AND TRANSIENT CODES (FY 1986)
- COMPLETE ASSESSMENT OF BEACON USING NEW SUBCOMPARTMENT TEST DATA (FY 1983)

4. ANALYTICAL TOOL DEVELOPMENT AND ACCIDENT ANALYSIS

D. ANALYSIS DEVELOPMENT BRANCH (CONTINUED)

III. CODE APPLICATION

- ANALYZE EFFECTS OF ECCS LOCATION AND INJECTION TIME
- STUDY ATWS
- PROVIDE ASSISTANCE TO NRR IN APPLICATION OF CODES TO LICENSING ISSUES

IV. DOPPLER EFFECT

- PERFORM ACCURATE DETAILED STUDY OF THE INTERFACE EFFECT OF FISSION PRODUCTS WITH THE MAIN RESONANCE ABSORBERS OF UO_2 FUEL (FY 1983)

1. ACCIDENT DETECTION AND PREVENTION

E. FUEL BEHAVIOR BRANCH

I. IN-PILE INSTRUMENTATION

PBF & LOFT INSTRUMENTATION

FUEL TEMPERATURE

CLADDING TEMPERATURE

FUEL PIN LENGTH

FUEL PIN GAS PRESSURE

2. SEPARATE EFFECTS TESTS FOR UNDERSTANDING AND MODELING AND REACTOR ENGINEERING REVIEW

E. FUEL BEHAVIOR BRANCH

I. CLAD & FUEL STUDIES

- STRESS RUPTURE PROPERTIES OF IRRADIATED CLADDING (1982)
- CYCLIC LOADING OF CLADDING DURING OPERATION (1986)
- MULTI-ROD BURST TESTING (1982)
- FISSION GAS RELEASE AND GAP CONDUCTIVITY AT HIGH BURNUP (1982)
- FUEL RELOCATION EXPTS - HALDEN (1982)
- EXAMINE TMI FUEL (1983)

II. HYDROGEN PROGRAM (1983)

- RADIOLYSIS
- SAMPLING & ANALYSIS
- DETONATION LIMITS
- DETONATION PRESSURES
- HYDROGEN SOURCES FROM COATINGS & CORROSION
- HYDROGEN HANDLING; E.G., EFFECTIVENESS OF VENTING, DEPRESSURIZATION, ETC.

III. WATER CHEMISTRY (1983)

- CORRELATION OF FISSION PRODUCTS IN COOLANT SAMPLES TO CONDITION OF FUEL
- IMPROVED SAMPLING & ANALYSIS METHODS.

4. ANALYTICAL TOOL DEVELOPMENT AND ACCIDENT ANALYSIS

E. FUEL BEHAVIOR BRANCH

1. FUEL CODE DEVELOPMENT, ASSESSMENT & APPLICATION

- MAINTAIN AND ASSESS EXISTING CODES (FRAP; FRAPCON).
INCORPORATE RESULTS FROM NRU & ESSOR.
- DEVELOP MODELS FOR SEVERE FUEL DAMAGE. INCORPORATE
RESULTS FROM PBF.

5. ACCIDENT CONSEQUENCE EVALUATION AND MITIGATION

E. FUEL BEHAVIOR BRANCH*

I. FUEL DAMAGE MECHANISMS AND THRESHOLD

- PBF: SEVERE-DAMAGE TESTING (1986)
 - o DAMAGE MECHANISMS,
 - o ROD-TO-ROD INTERACTIONS,
 - o POST-TEST COOLABILITY
- PBF: INDIVIDUAL EXPERIMENTS TO FILL LICENSING NEEDS
 - o RIA,
 - o LOCA,
 - o PCM,
 - o AOT.
- NRU: FULL-LENGTH BUNDLE HEAT-UP TESTS (1983)
- ESSOR: SMALL AND LARGE BREAK FUEL DAMAGE TESTS (1986)
- NRU OR SGHWR: SEVERE-DAMAGE TESTING OF FULL LENGTH BUNDLES AT COMMERCIAL ENRICHMENT

II. CORE MELTDOWN

- STEAM EXPLOSION ENERGY CONVERSION AT LARGE SCALE (1982)
- MOLTEN CORE/CONCRETE INTERACTIONS CORCON CODE (1982)
- FISSION PRODUCT TRANSPORT CODE VERIFICATION AT LARGE SCALE (1986)
- TMI FISSION PRODUCT RELEASE IN PRIMARY SYSTEM AND CONTAINMENT (1982)
- FISSION PRODUCT SOURCE TERMS FOR SEVERELY DAMAGED FUEL (1986)
- FISSION PRODUCT RELEASE FROM FUEL DEFECTS DURING POWER RAMPS (1986)

1. ACCIDENT DETECTION AND PREVENTION

F. METALLURGY AND MATERIALS RESEARCH BRANCH

i. NONDESTRUCTIVE EXAMINATION

- ACOUSTIC EMISSION FOR MONITORING WELDING (1980)
- ACOUSTIC EMISSION FOR ON-LINE MONITORING PRIMARY SYSTEM COMPONENTS (1982)
- IMPROVED EDDY CURRENT INSPECTION TECHNIQUES TO CHARACTERIZE FLAWS IN STEAM GENERATOR TUBING (1981)
- IMPROVED ULTRASONIC FLAW CHARACTERIZATION (SAFT-UT) FOR ISI OF PRESSURE BOUNDARY (1981)
- NEW ISI TECHNIQUES-(INTERNAL FRICTION FOR ON-LINE MONITORING OF PRESSURE BOUNDARY)(1982)
(NEW METHODOLOGY FOR DETERMINING RESIDUAL STRESSES) (1983)
- IMPROVED ULTRASONIC FLAW DETECTION (1984)

ii. LEAK DETECTION

- RELIABLE, HIGH-SENSITIVITY ON-LINE LEAK DETECTION FOR PRIMARY SYSTEM COMPONENTS (1983)

2. SEPARATE EFFECTS TESTS FOR UNDERSTANDING AND MODELING, AND REACTOR ENGINEERING REVIEW

F. METALLURGY AND MATERIALS RESEARCH BRANCH

I. FRACTURE MECHANICS

- ELASTIC-PLASTIC TEST METHODS FOR DUCTILE STEELS (1980)
- STRUCTURAL INTEGRITY OF DEGRADED PIPING (1981)
- REEVALUATION OF CRITERIA FOR PIPING SYSTEM DESIGN AND OPERATION (1981)
- VALIDATION OF LEFM AND E/P METHODOLOGY FOR ACCIDENT ANALYSIS (1982)
 - THERMAL SHOCK
 - STEAM LINE BREAK
- DATA BASE FOR THICK-SECTION HIGH-STRENGTH STEELS (1986)
- EVALUATION OF NEW WELDING AND FABRICATION PROCESSES (1984)
- STRESS INTENSITY ANALYSIS METHODS FOR COMPLEX CRACK FRONTS (1984)

II. ENVIRONMENTAL EFFECTS

- ENVIRONMENTALLY ENHANCED CRACK GROWTH RATES (1983)
- FRACTURE TOUGHNESS OF IRRADIATED VESSEL STEEL AND WELDS (1981)
- MECHANISMS OF CORROSION AND DEGRADATION OF STEAM GENERATORS (1985)
- METHODS FOR PREDICTING DOSIMETRY AND EMBRITTLEMENT FROM SURVEILLANCE (1984)
- ENVIRONMENTAL MECHANISMS OF STRESS CORROSION CRACKING
 - BWR PIPING (1984)
 - PWR FEEDWATER PIPING (1984)
 - STEAM GENERATOR TUBES (1984)
- EFFECTS OF HYDROGEN ON STRUCTURAL INTEGRITY (1981)
- ANNEALING TO MITIGATE IRRADIATION EMBRITTLEMENT (1981)

4. ANALYTICAL TOOL DEVELOPMENT AND ACCIDENT ANALYSIS

F. METALLURGY AND MATERIALS RESEARCH BRANCH

1. STRUCTURE ANALYSIS METHOD

- VALIDATION OF TEARING INSTABILITY METHOD FOR STRUCTURAL ANALYSIS
 - PIPING (1981)
 - PRESSURE VESSELS (1983)
- PROBABILISTIC METHODOLOGY FOR PIPE BREAKS (1982)
- COMPUTER-INTERACTIVE PIPING SYSTEM DESIGN AND OPERATION EVALUATION CAPABILITY (1985)
- PROBABILISTIC EVALUATION OF FLAW DETECTION, AND STRUCTURAL IMPLICATIONS (1984)

ENCLOSURE 2