WISCONSIN ELECTRIC POWER COMPANY

POINT BEACH NUCLEAR PLANT

CONTROL OPERATOR TRAINING PROGRAM

Revision 1
07-30-80

CONTROL OPERATOR TRAINING PROGRAM

1.0 PURPOSE

To outline the formal and guided training program for the Control Operator Trainee. The following guidelines are not intended to be a rigid detailed list of all training which need to be completed by the Control Operator Trainee and does not restrict the assigned supervisor from making additions, deletions, and/or changes as deemed necessary to accomplish the goal of training competent control operators.

2.0 OBJECTIVES

2.1 To impart to those personnel attending the course the technical information and experience required to operate the Point Beach Nuclear Plant units in a safe and efficient manner.

2.2 To develop in the trainee an insight and understanding about the plant so that their knowledge is not based on rote memory.

2.3 To insure that the trainee has sufficient knowledge to pass the NRC Licensing Examination. This objective will be met when the first two objectives are completed.

3.0 PROGRAM

3.1 The formalized training program will be adminstered during the week of relief shift by a combination of classroom instruction and control board training watches with a NRC Licensed Operator. During the time on shift other than relief shift, the Control Operator Trainee will perform his normal Auxiliary Operator duties. At the discretion of the Shift Supervisor, and as time permits, the Control Operator Trainee may have additional time on the main control boards or for self study during his shift cycle. The principle effort and burden of learning to become a Licensed Operator lies with the Control Operator Trainee and he is expected to study the material in the time span required to insure timely qualification.

3.2 On-the-job training will be conducted in accordance with Appendix "A".

3.3 Specific subjects and outlines for classroom training are listed in Appendices "B"-"M". Sections may be deleted depending on the Control Operator Trainee previous training and experience.

4.0 EXAMINATIONS

4.1 Quizes will be given throughout the training program.

4.2 Written examinations will be administered at the completion of each major section.

4.3 A final written and oral examination will be administered by the Training Supervisor, plus an additional oral examination by an independent licensed supervisor will determine final qualification before taking the NRC examinations.

5.0 RECORDS

5.1 The following records will be maintained by the Training Supervisor:

5.1.1 Subject covered in classroom training.

5.1.2 Hours spent in classroom training

5.1.2 Completed on-the-job training (Appendix "A").

5.2 The following records will be maintained by the trainee.

5.2.1 Control Operator Trainee on-the-job training goals.

APPENDIX "A"

CONTROL OPERATOR - TRAINING
ON-THE-JOB TRAINING PROGRAM

1.0 PURPOSE

To outline the formal and guided on-the-job training program for the Control Operator Trainee. The following guidelines are not intended to be a rigid detailed list of all operations which need to be completed by the COT, and does not restrict the assigned Supervisor from making additions, deletions and/or changes as deemed necessary to accomplish the goal of training competent Control Operators.

2.0 DISCUSSION

The on-the-job training section of the overall COT program is very important in developing the required skills and self-confidence to operate the plant in a safe and efficient manner and to pass the NRC operational examination. In order to accomplish this, the COT must actually perform the evolution himself, under close supervision of a licensed operator, including the required initial preparations and signing off the procedure or checklist, if applicable.

The training can be accomplished during training watches as assigned by the Training Supervisor and on shift under control of the Shift Supervisor. Since many of the evolutions listed in Attachment A only occur on backshifts, it is the responsibility of shift supervision to allot time to accomplish this training.

Some of the items in Attachment A require specific plant conditions (cold shutdown, unit shutdown, etc.) and can only be accomplished when the opportunity arises. In such cases personnel schedule changes may be required to complete the training. Other items, as marked, may be done any time plant conditions allow solely for the purpose of training.

3.0 PROGRAM

3.1 Attachment A will be maintained in the trainee's AO Practical Factor file in the control room and is to be kept up-to-date by the COT.

3.2 The trainee's Shift Supervisor should review Attachment A as necessary to determine which items can be completed on shift.

3.3 Review completed items with the Training Supervisor each relief shift training session.

ATTAC[illegible] [illegible] A

CONTROL OPERATOR-TRAINEE ON-THE-JOB TRAINING GOALS

TRAINING EVOLUTION		DATE COMPLETED			
1.0*	Reactor Startup (OP-1B)				
1.1*	ERP calculation (REI-4)				
1.2*	ICRR calculation (REI-5)				
1.2.1	Source range				
1.2.2	Intermediate range				
1.2.3	Without computer				
1.2.4	With computer				
1.3*	Pre-critical check (CL-1A)				
1.4*	Instrument check				
1.4.1	Source range (ICP 2.9)				
1.4.2	Intermediate range (ICP 2.10)				
2.0	Plant Startup to 20% Power (OP-1C)				
2.1	Reactor control				
2.2	Primary system control				
2.3	Steam generator level control				
2.4	Turbine and generator control				
3.0	Power Operation (OP-2A)				
3.1	Power increase of greater than 10%				
3.2	Power decrease of greater than 10%				
3.3	Xenon follow (greater than 40% power change)				
3.4*	Heat balance (REI-1)				
3.4.1	Computer				
3.4.2	ΔT method				
3.4.3	Condenser pressure/load method				
3.4.4	RCS heatup method				
3.4.5	Secondary calorimetric				
3.4.6	Power range calibration (REI-2)				
3.5*	Leak rate determination (PBNP 4.11)				
3.6*	Reactor coolant system				
3.6.1*	Fill RCP standpipe				
3.6.2*	PRT makeup/drain				
3.6.3*	Equalize pressurizer boron concentration				

TRAINING EVOLUTION		DATE COMPLETED			
3.7*	CVCS operation				
3.7.1*	Shift charging pumps	____	____	____	____
3.7.2*	Increase/decrease letdown flow	____	____	____	____
3.7.3	Establish excess letdown	____	____	____	____
3.7.4	Operate deborating demineralizer	____	____	____	____
3.7.5*	Bypass demineralizers	____	____	____	____
3.7.6*	Vent volume control tank pressure	____	____	____	____
3.8	Miscellaneous				
3.8.1*	SIS accumulators makeup/drain	____	____	____	____
3.8.2	Drain sump "A"	____	____	____	____
3.8.3*	Main generator voltage adjustment	____	____	____	____
3.8.4*	Ice melt temperature adjustment	____	____	____	____
3.8.5	Establish or shift ice melt	____	____	____	____
3.8.6	Start and load Unit 5G	____	____	____	____
3.8.7*	Secure and start PAB ventilation	____	____	____	____
3.8.8	Run flux mapping system	____	____	____	____
3.8.9	Operate unit during I & C analog tests	____	____	____	____
4.0	Shutdown Operation				
4.1	Start reactor coolant pumps	____	____	____	____
4.2	Establish RHR system operation	____	____	____	____
4.3	Take the RCS solid	____	____	____	____
4.4	Draw a bubble in the pressurizer	____	____	____	____
4.5	Control steam generator level with auxiliary SGFP's.	____	____	____	____
5.0*	Fill Out the Following Log Sheets and Forms				
5.1	Control room shift log & Attachment A	____	____	____	____
5.2	Safeguards shift log	____	____	____	____
5.3	Containment vent and purge record	____	____	____	____
5.4	Facade sump drain log	____	____	____	____
5.5	Steam generator blowdown log	____	____	____	____
5.6	Cold shutdown log	____	____	____	____
5.7	Power history chart	____	____	____	____
5.8	Ambient lake temperature log	____	____	____	____
5.9	RCS leakage determination chart	____	____	____	____
5.10	Circulating water data log	____	____	____	____
5.11	Ice melt data log	____	____	____	____
5.12	Shift operational data log	____	____	____	____
5.13	Log of jumpers, lifted wires and bypasses	____	____	____	____
5.14	Main turbine thermal load cycles (CL-1C)	____	____	____	____

TRAINING EVOLUTION			DATE COMPLETED			
6.0*	**Computer Operations (Computer Operator's Manual)**					
6.1	Perform all functions in Appendix A					
6.2	Perform all functions in Appendix B					
6.3	Perform all functions in Appendix C					
6.4	ICRR program					
6.5	Boron follow program					
6.6	General purpose program					
7.0	**Perform the Following Tests and Checklists**					
7.1	High head safety injection system	IT-01				
7.2	Low head safety injection system	IT-03				
7.3	Spray system	IT-05				
7.4	Electric auxiliary feed pump	IT-10				
7.5	Turbine auxiliary feed pump	IT-08				
7.6	Emergency Diesel	TS-01				
7.7	Rod Exercise	TS-05				
7.8	Control room ventilation	TS-09				
7.9	Turbine trip test, TLSD, SD	PC-11				
7.10	Instrument air compressors	PC-9				
7.11	Turbine lube oil system, chg. pump	PC-23				
7.12	Boron update	PC-22				
7.13	Radio & communications check	-----				
8.0	**Other (Write in items performed but not listed)**					

* May be done specifically for training if plant conditions allow

9.0 Hours on Watch in the Control Room

DATE	NO. OF HOURS	LIST TRAINING COMPLETED

Read FSAR

APPENDIX "B"

PRIMARY PLANT SYSTEMS AND COMPONENTS

I. OVERALL PLANT
   - A. Basic Cycles
   - B. Valve Numbering

II. REACTOR COOLANT SYSTEM
   - A. Piping, materials, basic system layout
   - B. Pressure vessel and NDTT
   - C. Pressure vessel internals
   - D. Reactor coolant pumps
   - E. Steam Generators
   - F. Pressurizer (including relief tank)

III. PRIMARY PLANT VALVES AND FILTERS

IV. CHEMICAL AND VOLUME CONTROL SYSTEM
   - A. Charging and letdown
   - B. Purification
   - C. Seal water and RCP seals
   - D. Supply to boric acid evaps.
   - E. Evaporators
   - F. Boric acid system
   - G. Makeup water system

V. COMPONENT COOLING SYSTEM

VI. RESIDUAL HEAT REMOVAL SYSTEM

VII. SPENT FUEL PIT

VIII. SPENT FUEL PIT COOLING PURIFICATION SYSTEM

IX. SAFETY INJECTION SYSTEM
   - A. Safety injection, pumps, accumulators & assoc. piping
   - B. Containment spray system
   - C. RHR (as it applies to SIS)

X. SAMPLING SYSTEM

XI. WASTE DISPOSAL SYSTEM

A. Waste liquids

1. Evaporator

B. Waste gas

C. Clean gas

D. Drumming

XII. REFUELING SYSTEMS

A. Refueling canal and transfer tube

B. Refueling tools

XIII. OPERATING PROCEDURES

APPENDIX "C"

SECONDARY PLANT SYSTEMS & COMPONENTS

I. INSTRODUCTION

- A. Class of systems
  - 1. Fundamental
  - 2. Auxiliary
  - 3. Service
- B. System Equipment
- C. System Instrumentation

II. STEAM GENERATOR

- A. Components
- B. Connections
- C. Design Conditions
- D. Operating Conditions

III. TURBINE

- A. Components
- B. Auxiliaries
- C. Design
- D. Operation
- E. Control
  - 1. Start-up
  - 2. Operation
  - 3. Shutdown

IV. REHEATER

- A. Components
- B. Connections
- C. Design Conditions
- D. Operating Conditions

V. STEAM SYSTEMS

A. Main Steam

1. Measurement

2. Control

3. Protective release

a. Safety Valves

b. Steam dump

4. Blowdown

B. Auxiliary steam

1. Auxiliary feed pump turbine

2. Reheaters

3. Air ejectors

a. Priming ejectors

b. 2-stage ejector

4. Gland seal steam

C. Extraction steam

1. Theory

2. Components

3. Control

VI. CONDENSATE AND FEEDWATER

A. Surface condenser

1. Components

2. Operation

3. Control

B. Condensate

1. Components

2. Equipment

C. Feedwater

1. Components

2. Equipment

3. Control

D. Auxiliary feedwater

1. Components

2. Equipment

3. Operation

4. Control

E. Feedwater heater vents and drains

1. Components

2. Operation

3. Control

VII. PUMPHOUSE AND INTAKE FACILITY

A. Intake structure

B. Intake pipes

C. Fore bay

1. Seal bay

2. Flow control

3. Tee melt

D. Pumphouse

1. Level control

2. Isolation

E. Equipment

VIII. WATER SERVICES

A. Circulating water

1. Components

2. Control

a. Priming

b. Starting intervals

c. Seasonal operation

B. Service water

1. Design

2. Control

a. Normal operation

b. Emergency operation

c. Isolation

C. Fire protection

1. Components

a. Pumps

b. Deluge system

c. Automatic sprinkler

d. Manual sprinkler

2. Control

a. Fire detection

b. Periodic test

IX. AIR SYSTEMS

A. Control and service air

1. Components

2. Operation

3. Control

B. Ventilation

1. Design

2. Control

X. OIL SYSTEMS

A. Lube Oil

1. Components

2. Operation

3. Control

B. Seal Oil

1. Services

2. Control

C. Fuel Oil

1. Services

a. Diesel generators

b. Heating boilers

c. Fire pump

d. Gas turbine

2. Operation

3. Control

XI. GAS SYSTEMS

A. Hydrogen

1. Components

2. Operation

3. Control

B. Carbon Dioxide

APPENDIX "D"

CONTAINMENT AND AUXILIARY SYSTEMS AND COMPONENTS

I. Water Treatment Plant
   - A. System Description
   - B. Chemistry of Water Treatment

II. Containment Structure and Testing
   - A. Foundation, Dome, Walls, Liner
   - B. Testing and Design Criteria
   - C. Drains

III. Containment Equipment Support
   - A. Reactor Vessel
   - B. Reactor Coolant Pumps
   - C. Tanks
   - D. Crane
   - E. Piping

IV. Containment Mechanical Penetrations
   - A. Equipment Hatch
   - B. Personal Hatch
   - C. Piping Penetration

V. Containment Electrical Penetrations

VI. Containment Heating and Ventilation
   - A. System Description
   - B. Components

APPENDIX "E"

GAS TURBINE SYSTEMS AND COMPONENTS

I. REVIEW OF GAS TURBINE PRINCIPLES

- A. Compressor
  - 1. Construction
  - 2. Operation
  - 3. For stability - Bleeds
- B. Combustion
  - 1. Fuel injection
  - 2. Combustion cans
- C. Turbine
  - 1. Materials - Creep
  - 2. Influence of cooling
- D. Starting
  - 1. Fuel
  - 2. Turbine inlet - temp.
  - 3. Compresser discharge pressure
  - 4. Inlet air temperature.

II. FUEL SYSTEM

III. LUBE OIL SYSTEM

APPENDIX "F"

PLANT ELECTRICAL SYSTEMS AND COMPONENTS

I. ELECTRICAL THEORY
   - A. Basic Theory and Definitions
   - B. Motor, Generator and Transformer Theory
   - C. Protection Systems

II. WMPCO-WEPCO TRANSMISSION AND DISTRIBUTION

III. POWER SUPPLY OFFICE OPERATIONS
   - A. Interconnections
   - B. System Control

IV. 345 KV SWITCHYARD

V. 19 KV SYSTEM

VI. GENERATOR

VII. 13.8 KV SYSTEM

VIII. 4160 VOLT SYSTEM

X. EMERGENCY DIESEL GENERATOR

XI. SAFEGUARD POWER SUPPLY

XII. 120/208 VOLT AC AND 125 VOLT DC SYSTEMS

XIII. ALARM SYSTEM

APPENDIX "G"

INSTRUMENTATION AND CONTROL

I. BASIC INSTRUMENTATION AND CONTROL

A. Symbols and Terminology

1. Instrumentation and control terminology
2. Standard instrumentation symbols
3. Standard logic symbols
4. Block diagrams
5. Elementary wiring diagrams
6. Coincidence
7. Redundancy
8. Accuracy/reliability

B. Tripping Logic and Relaying

1. Logic elements
2. Logic diagrams

C. Measurement

1. Pressure and differential pressure

a) Bourdon elements

b) Helical elements

c) Spiral elements

d) Spring and bellows

e) Manometers

f) Pressure switches

g) Force balance type

1) Pressure

2) Differential pressure

3) Vacuum and absolute pressure

h) Remote indication

2. Temperature

a) Thermocouples

1) Iron-constantan

2) Copper constantan

3) Chromel-alumel

b) Resistance temperature detectors

1) Platinum

2) Nickel

3) Copper

c) Filled-system thermometers

1) Vapor-filled

2) Gas-filled

3) Mercury-filled

d) Bimetal thermometers

e) Thermistors

f) Temperature switches

3. Flow

a) Differential-pressure flow meters

1) Orifice plate

2) Flow nozzle

3) Venturi tube

4) Pitot tube

5) Gentile flow tube

6) Elbow taps

b) Variable-area flow meters

c) Positive-displacement flow meters

d) Magnetic flow meters

e) Turbine flow meters

5. Level

a) Hydrostatic-head devices

1) Differential pressure meter

2) Pressure gauge

3) Diaphragm box

4) Mercury manometer

5) Purge or bubbler

b) Ball float

c) Displacement type

d) Level switches

6. Radiation

a) Gas ionization detectors - General

1) Detector circuit

2) Electric field

3) Collection of ions and pulse formation

4) Function of detector

5) Gas amplification

b) Pulse height vs. applied voltage curve

1) Recombination sub-region

2) Ionization chamber region

3) Proportional region

4) Limited proportional region

5) Geiger-Mueller region

6) Continuous discharge region

c) Gas ionization detectors - Specific

1) Ion chamber detectors

2) Proportional counters

3) Geiger-Mueller tube detectors

d) Scintillation detectors

1) General system

2) Advantages

3) Operation

e) Neutron detection methods

1) Neutron induced transmutations

2) Elastic scattering of neutrors

3) Neutron detection by induced activity

f) Common neutron detectors

1) Boron ^{10}

2) Fission chambers

3) Proton-recoil proportional counters

II. PRIMARY PLANT INSTRUMENTATION & CONTROL

A. Nuclear Infomration

1. Source range

a) Proportional counter tube

b) Cabling

c) Voltage supplies

d) Discriminator, integrator and log amplifier

e) Level indicators

f) Start-up rate indicators

g) Trips and alarms

2. Intermediate range

a) Compensated ion chamber

b) Cabling

c) Voltage supplies

d) Log amplifier

e) Level indicators

f) Start-up rate indicators

g) Trips and alarms

3. Power Range

a) Uncompensated ion chamber

b) Cabling

c) Voltage supply

d) Summing circuits

e) Level indicators

f) Trips and alarms

B. Reactor Coolant System

1. Loop Instrumentation

a) Cold leg temperature

b) Tavg. - ΔT RTD's

c) Head temperature

d) Vessel flange leak-off temperature

e) Coolant pressure

f) Coolant flow

2. Pressurizer Instrumentation & control

a) Pressure

1) Heater control

2) Spray control

3) Power relief valves

4) Trips, alarms, and indication

5) Deadweight pressure tester

b) Level

1) Level controller

2) Trips, alarms and indication

3) Cold calibration

c) Temperature

1) Surge line

2) liquid

3) Vapor

4) Safety valve outlet

5) Relief valve line

d) Instrumentation cubicle temperature control

3. Pressurizer relief tank instrumentation

a) Pressure

b) Level

c) Temperature

4. Reactor coolant pump instrumentation

a) Standpipe level

C. Reactor Control & Protection System

1. Separation of protection & control

a) Protection racks

b) Control racks

2. T_{avg} & ΔT Measurement

a) RTD's and dual current source

b) Channel def ats

c) Alarms

d) Recorders and indicators

3. Overpower trip calculators

a) Flux tilt circuit

b) Equation

c) Trips and rod stops

d) Recorders and indicators

4. Over temperature trip

a) Equation

b) Trips and rod stops

c) Recorders and indicators

5. Rod insertion limit calculators

a) Equation

b) Alarms

6. T_{avg} Controller

   a) Reactor power vs. turbine power input

   b) Tref. calculator

   c) Rod speed and direction

7. Steam Dump Control

   a) Temperature control

   b) Pressure control

   c) Load change interlock

   d) Valve sequence

8. Power Supplies

   a) Rod supply and trip breakers

   b) Instrument power supplies

9. Reactor trip and rod stop logic

   a) Nuclear instrumentation trip signals

   b) Primary coolant system trip signals

   c) Pressurizer trip signals

   d) Steam generator trip signals

   e) Safety injection trip signals

   f) Turbine trip signal

   g) Permissives

   h) Rod stop signals

D. Rod Instrumentation & Control

   1. Mechanisms

      a) Full length rods

      b) Part length rods

3. Digital Position indicators

4. Analog Position Indicators

   a) Coils

   b) Calibration circuit

   c) Indicators

E. Containment Instrumentation

1. Temperature

2. Humidity

3. Pressure

4. Ventilation

5. Penetrations

F. Safeguards Instrumentation

1. Safety Injection

   a) Logic

   b) Pressure

   c) Flow

   d) Containment Sump level

   e) Refueling water storage tank level

2. Accumulators

   a) Level

   b) Pressure

3. Steamline isolation

4. Feedwater Isolation

5. Containment Spray

   a) Spray additive tank inlet flow

   b) Spray additive tank levels

6. Containment Isolation

G. Digital computer system

1. Basic Operation

2. Inputs and outputs

a) Analog inputs

b) Digital inputs

c) Analog outputs

d) Alarm typewriter

e) Trend typewriter

3. Control panel operations

H. In-core instrumentation

1. Thermocouples

a) Installation

b) Indication

2. Flux-mapping system

a) Thimbles

b) Drive units

c) Controls

d) Indication

III. PRIMARY PLANT AUXILIARY SYSTEMS INSTRUMENTATION

A. Chemical and Volume Control

1. Boric acid tanks

a) Levels

b) Heaters

c) Recirculation

2. Batching Tank

a) Level

b) Temperature

3. Blend Control

4. Volume control tank level control

5. Pressures

6. Temperatures

7. Flows

B. Auxiliary Coolant System

1. Spent Fuel Pit

a) Temperature

b) Level

2. Component Cooling

a) Pressures

b) Temperatures

c) Flows

d) Levels

3. Residual Heat Removal

a) Flow

b) Temperature

4. Reactor coolant pump cooling

a) Temperatures

C. Sampling System

D. Fuel Handling System

E. Waste Disposal System

1. Levels

2. Pressures

3. Flows

4. Conductivity

5. Temperatures

IV. RADIATION MONITORING SYSTEM

A. Area System

1. Channels

2. Hardware

B. Operational System

1. Channels

2. Hardware

V. SECONDARY PLANT INSTRUMENTATION

A. Steam and Feedwater System

1. Feedwater Control

a) Level measurement

b) Feedwater measurement

c) Steam flow measurement

d) Controllers

e) Feedwater valves

f) Trips and alarms

2. Steam Generator Feed Pumps

a) Low flow recirculation

b) Seal water temperature and diff. pressure

c) Heater bypass

d) Motor driven auxiliary pumps

e) Turbine driven auxiliary pumps

3. Feedwater Heater Controls

a) Level control

b) Bleeder trip valve control

4. Reheater-Moisture Separator Controls

   a) Level control

   b) Trip valves

5. Miscellaneous Controls & Instrumentation

   a) Main Steam Isolation valves

   b) Atmospheric relief valves

   c) Condensate recirculation

   d) Heater drain tank

   e) Auxiliary steam

B. Steam Turbine Instrumentation & Controls

1. Supervisory Instrumentation

   a) Rotor eccentricity

   b) Rotor vibration

   c) Rotor position

   d) Casing expansion

   e) Differential casing and rotor expansion

   f) Speed and governor valve position

   g) Metal temperature

2. Electro-hydraulic governor system

   a) Control panels

   b) Speed and load control

   c) Valve actuators

3. Miscellaneous Turbine Instrumentation

   a) Hood sprays

   b) Seal steam pressure

   c) Temperature and pressure measurement

4. Turbine trip logic

a) Auto-stop oil trip

b) Trip from generator logic

c) Steam generator feed pump trip signal

d) Trip from reactor logic

e) Low condenser vacuum trip signal

f) Low bearing oil pressure trip signal

g) Thrust bearing failure trip signal

h) Overspeed trip signal

i) Main steam stop closed

C. Generator Instrumentation

1. Temperature

2. Hydrogen cooling

a) Hydrogen temperature control

b) Hydrogen purity

D. Condenser Instrumentation and Control

1. Level control

2. Pressure measurement

3. Temperature measurement

4. Air ejectors

VI. MISCELLANEOUS INSTRUMENTATION AND CONTROL

A. Pump House Instrumentation

B. Emergency Diesel Instrumentation

C. Gas Turbine Instrumentation

D. Fire Protection and Alarm

E. Communications Equipment

APPENDIX "H"

CHEMISTRY

I. FUNDAMENTALS AND BASIC CONCEPTS

A. Matter

1. Properties of matter

2. Changes in matter

3. Elements

4. Compounds

B. Structure of Matter

1. Atoms

2. Subatomic particles

3. Molecules

C. Atomic Structure

1. Nucleus

2. Electron structure

D. Classification of the Elements

1. Inert gases

2. Transition elements

3. Representative elements

E. Periodic System

1. Properties of elements

a) Metals

b) Non-metals

c) Amphoteric elements

F. Chemical Symbols and Formulas

1. Symbols for elements

2. Formulas for compounds

C. Chemical Equations

1. Balancing equations

2. Writing of equations

3. Meaning of chemical equations

4. Calculations

H. Solutions, Ions, and Radicals

1. Definitions

a) Solubility

b) Saturation

c) Ion

d) Radical

2. Ionization of compounds in solution

a) Salts

b) Strong and weak acids

c) Strong and weak bases

d) pH

II. EXTERNAL WATER TREATMENT

A. Water and Sources of Impurities

B. Reason for Treating Water

C. Deleterious Substances and Reason for Removal

1. Silica

2. Calcium and magnesium

3. Iron and manganese

4. Carbon dioxide

5. Chlorides

6. Sulfates

7. Dissolved oxygen

8. Suspended solids

9. Organics

10. Other miscellaneous inpurities

D. Clarifier-softener Operation and Purpose

1. Coagulation process

2. Softening process

a) Reactions

b) Carbonate removal

E. Filtration

F. Cation Exchange and Anion Exchange

1. Reactions

2. Regeneration

G. Deaeration

H. Mixed-Bed Exchange

I. Levels of Impurities after each Step

III. CORROSION AND WEAR

A. Reasons for Corrosion Control

B. Types of Corrosion

1. General

2. Local

a) Stress corrosion

b) Caustic corrosion and hydrogen embrittlement

c) Galvanic corrosion

d) Crevice corrosion

1) Ion concentration cell

2) Oxygen concetration cell

e) Pitting

f) Miscellaneous types

IV. CORROSION CONTROL AND INTERNAL WATER TREATMENT

A. Feedwater Treatment

1. Use of hydrazine

2. Use of morpholine

3. Autom tic control

a) pH

b) Hydrazine-oxygen

4. Instrumentation used

B. Steam Generator Water Treatment

1. Use of phosphates

2. Disadvantages of phosphates

3. Blowdown

4. Zero solids treatment

5. Disadvantages of zero solids

V. RADIOACTIVITY

A. Brief history

B. Review of Atomic Structure

1. Isotopes

2. Symbols and designation

C. Types of Radiation and decay, Nuclear Stability

1. Alpha

2. Beta

3. Gamma and X-rays

4. Positron

5. Electron capture

6. Other

D. Rate of Decay

VI. PRIMARY CHEMISTRY AND RADIOCHEMISTRY

A. Methods of Radioactivity Production by Activation

1. Neutron-gamma
2. Neutron-proton
3. Neutron-alpha
4. Proton-neutron
5. Other

B. Sources of Radioactivity in Reactor Coolant

1. Activation of corrosion products
   a) Transport of crud
   b) In situ activation of crud
2. Induced activity of coolant and impurities
   a) N-16, N-17 production
   b) F-18, Na-24, A-41
3. Interaction of neutrons with additives
   a) Tritium from Li-6
   b) Tritium from B-10
   c) B-10 ( ) Li-7 reaction
4. Fission products
   a) Tritium from ternary fission
   b) Fuel defects and escape mechanisms
   c) Tramp uranium
   d) Diffusion through cladding
5. Radiation-induced chemical reactions
   a) Radiolysis of water
   b) Use of hydrogen

c) Use of hydrazine

1) Decomposition

2) When in use

d) Ammonia

1) Synthesis in reactor

2) Decomposition

3) Ammonia-oxygen reaction

4) Nitric acid synthesis

C. Chemistry of Boric Acid Solutions

1. pH of solutions

2. Partially neutralized solutions

3. Ionization of boric acid

D. Adjusted pH Operation

1. Use of lithium or ammonia

2. Advantages

3. Disadvantages

E. pH of Coolant at Reactor Temperature vs. Room Temperature

VII. PRIMARY SYSTEMS CHEMISTRY

A. Waste Disposal System

1. Waste gas

2. Solids disposal

3. Waste evaporator chemistry

B. Boron Recovery System

1. Ion exchangers

2. Filtration

3. Boric acid evaporation

C. Main Coolant System

1. Chemistry specs.

2. Shutdown specs.

D. Spent Fuel Pit

E. Component Cooling

VIII. POINT BEACH CONTRUCTION MATERIALS

A. Alloys Used

B. Composition

C. Reasons for Use

IX. SAMPLING SYSTEM AND LABORATORY

A. Location of Samples

B. Reasons for each sample

C. Frequency of Sampling

D. Instrumentation used

E. Analysis Required

1. pH methods

2. Conductivity

3. Titrimetric procedures

4. Gas analysis

5. Counting procedures

APPENDIX "I"

HEALTH PHYSICS

I. RADIATION TYPES AND CHARACTERISTICS

A. Alpha particles

B. Beta particles

C. Gamma radiation

D. Neutrons

E. Protons

F. Interaction with matter

G. Radioactive decay

II. DOSE UNITS AND BIOLOGICAL EFFECTS

A. Development

B. Curie

C. Roentgen

D. RAD, REP, REM

E. RBE factors

F. Dose Rate Calculations

G. Biological effects of ionizing radiation

III. MAXIMUM PERMISSABLE EXPOSURES AND CONCENTRATIONS

A. Normal exposure sources

B. Acute exposures

C. Chronic exposures

D. Internal and external exposures

E. Partial and whole body exposures

F. Maximum permissable exposures

G. Maximum permissable concentrations

IV. PRINCIPLES OF RADIATION PROTECTION

A. Time (work time calculation)

B. Distance (inverse square law)

C. Shielding (shielding calculation)

V. RADIATION DETECTION INSTRUMENTS

A. Basic principles of detection instruments

B. Gas ionization instruments (theory & operation)

1. Ionization chamber region

2. Proportional region

3. Geiger-Mueller region

C. Scintillation detectors

D. Neutron detectors

E. Laboratory instrumentation

F. Portable instruments

G. Calibration

VI. RADIATION MONITORING SYSTEM

A. Types of detectors

B. Location of detectors

C. Instrument sensitivity

D. Alarm setpoints

E. MPC considerations

F. Action following alarms

VII. PERSONNEL MONITORING - one hour

A. Purpose

B. Individual responsibilities

C. Supervisors responsibilities

D. Film badges

1. Limitations
2. Energy dependence
3. Types of films
4. Special badges

E. Dosimeters and pocket chambers
1. Beta-gamma
2. Neutron (thermal)

F. Special monitoring devices
1. Threshold detectors

G. Exposure records

VIII. CONTAMINATION AND CONTAMINATION CONTROL

A. Sources of contamination

B. Fixed and removable contamination

C. Control areas

D. Contamination limits

E. Radiation work permits

F. Radiation warning signs

G. Access control points

H. Transport of radioactive materials and equipment

I. Swipe surveys

J. Protective clothing

K. Respiratory equipment

L. Area preparation

IX. PLANT SHIELDING

A. Radiation from Reactor Operations
1. Gamma photons

2. Fast neutrons

3. Thermal neutrons

B. Gamma Sources

1. Operating core sources

a) Fission prompts

b) Fission products

c) Capture gamma

2. Secondary gamma (outside core)

3. Coolant activation gamma

a) O^{16} (n_1p) N^{16}

4. Shut down core fission products

5. Residual coolant activities

a) Corrosion products

b) Leaked fission products

6. Activation gamma sources - structural

7. Accident case gamma fission product sources

C. Fast Neutron Sources

1. Fission

2. Photo neutron

3. Delayed group

4. O^{17} (n_1p) ---N^{16} + O^{n^1}

D. Shield Design and Function

1. Primary Shield

a) Operating function

b) Shutdown function

2. Biological Shield

a) Operating function

b) Accident function

E. Plant Shielding Arrangement

1. Primary shield

2. Secondary shield

3. Fuel handling shield

4. Auxiliary shielding

X. REGULATIONS, RECORDS & REPORTS

A. Code of Federal Regulations (10CFR 20, etc.)

B. Records, reports & notifications

XI. RADIOACTIVE WASTE MANAGEMENT

A. Types of Waste (liquid, solid, gaseous)

B. Liquid waste processing

C. Solid waste processing

D. Gaseous waste processing

E. Release limits (liquid & gaseous)

F. Solid waste packaging limitations

G. Waste disposal records & reports

XII. ENVIRONMENTAL MONITORING PROGRAM

A. Development

B. Purpose

C. Sample types & locations

D. Sample analysis

E. Reporting procedures

XIII. EMERGENCY PROCEDURES - one hour

A. Review & analysis of Emergency Plan

B. Emergency monitoring

C. Location of emergency equipment

XIV. SURVEY TECHNIQUES - PORTABLE SURVEY EQUIPMENT

A. Portable Instruments (operation & practical use of)

1. Beta-gamma (G.M. tube)

2. Gamma (ion chamber)

3. Neutrons - fast & thermal

4. Alpha meter

B. Calibration sources

C. Calibration procedures (work inverse square calculation)

XV. LABORATORY INSTRUMENTATION

A. Scaler operation

1. Operating voltage

2. G.M. tube plateau

3. Operating checks

B. Counting techniques

1. Efficiency determinations

2. Statistics of counting

3. Activity calculations

XVI. AIR ACTIVITY DETERMINATIONS

A. Natural background activity

B. Inversion activity

C. Air sampling equipment

1. Line operated samplers

2. Battery operated samplers

D. Air activity calculations

E. Plot sample decay

XVII. CONTAMINATION SURVEY TECHNIQUES

A. Area swipe survey procedures

B. Equipment swipe surveys

C. Sample counting & activity determinations

D. Decontaminations techniques

XVIII. RESPIRATORY PROTECTIVE EQUIPMENT

A. Types & Limitations of each

1. Half face respirator

2. Full face respirator

3. Air line respirator

4. Self-contained breathing apparatus

B. Operation of self-contained breathing apparatus

APPENDIX "J"

REACTOR ENGINEERING

I. MATH

A. Units, Conversion Factors, Symbols and Definitions

1. Units

a) Description of various systems

b) Systems used in the course

1) Cgs. for nuclear work

2) Engineering for most other aspects

2. Conversion Factors

a) Hand-out list and tables

b) How they are used

1) Units must cancel out properly

2) Must be compatible with unit system used

3. Symbols

a) Describe and name Greek letters

1) Hand-out list

2) Upper case

3) Lower case

b) Common usage of English letters as symbols

c) Subscripts and superscripts

1) Mathematical applications

2) Nuclear and other applications

d) Some of the mathematical "shorthands"

1) Function notation

2) Use of brackets

3) Summation symbol and notation

4. Definitions

a) Hand-out of prepared "dictionary"

1) Explanation of terms that are defined differently for different uses.

B. Algebra

1. Algebraic equations

a) Definition

b) Sum and product equations

c) Equation development

1) Understanding others equations

2) Developing our own equations

2. Symbolic manipulation

a) Equation manipulation

3. Powers and exponents

4. Real number system

a) Zero

b) Infinity

c) Negative numbers

d) Using and understanding the real number system

1) Addition, subtraction, multiplication, division

2) Multiplication of two negative numbers

3) Multiplication and division by zero

4) Multiplication and division by infinity

5) Large and small numbers

6) Scientific notation

5. Significant Figures, errors, and standard deviation

a) Definition

b) Use of

C. Geometry

1. Definition of frequently used terms (hand-out)

2. Trigonometric functions

a) Sine

b) Cosine

c) Tangent

D. Graphs

1. Parts of a graph and definitions

a) Ordinate

b) Absissa

c) Coordinate

2. Types and use

a) Linear

b) Semi-log

c) Log-log

d) Special types and hand-outs

E. Mathematical terms commonly used with nuclear reactors

1. Definition of terms and examples

a) Slope

b) Derivative (differential)

c) Integral (integration)

d) Differential equations

2. Exponential growth and decay

a) Examples

b) Origin of

F. Logarithms

1. Definition

2. Base 10

a) Use of logarithms

1) Characteristic

2) Mantissa

b) Anti-logs

3. Other bases

a) Natural logarithms

G. Calculations

1. How to use the various functions

II. ATOMIC PHYSICS

A. Atomic Structure

1. History and development
2. Parts of the atom

a) Electron

b) Proton

c) Neutron

3. Energy levels

a) Atoms exist at discrete energy states

b) Changes of state

1) Ionization

2) X-rays

B. Nuclear structure

1. Atomic number Z
2. Atomic mass A
3. Neutron number N = A-Z
4. Elements and Symbols
5. Isotopes, isobars, and isotones

C. Atoms and molecules

1. Molecules

a) Structure

b) Valance and bonds

2. Molecular properties vs. atomic properties

a) Atomic weight

b) Atomic mass unit

c) Molecular weight

d) Avogodro's number

D. Periodic Chart

1. Hand-out and description

III. NUCLEAR PHYSICS

A. Nuclear Stability

1. Nuclear Forces

a) Short range

b) Common to all nucleons

c) Density of nucleus

2. Neutron-proton ratio

a) Relative size of forces

b) Curve

c) Liquid drop model

3. Binding energy

a) Mass-energy relationship ($E = mc^2$)

b) Mass defect

c) Binding energy

d) Binding energy per nucleon

1) Curve

2) Fission

3) Fusion

B. Radioactivity

1. Particle and ray emission

a) Alpha particle (α)

b) Beta particle (β)

c) Gamma ray

d) Combination

2. Stability curve and radioactive decay

a) Chart of the nuclides

b) Neutron heavy nuclides

1) Type of decay

c) Neutron light nuclides

1) Type of decay

C. Radioactive Decay

1. Equation
2. Decay constant
3. Radioactive decay law
4. Half life
5. Decay chains

D. Interaction of radiation with matter

1. Ionization and ion pairs
2. Specific ionization

a) Alpha (α)

b) Beta (β)

3. Gamma ray (γ) interaction

a) Photoelectric effect

b) Compton scattering

c) Pair production

4. Attenuation

a) Concept and equation ($I = I_o e^{-\mu x}$)

b) Linear absorption coefficient

c) Half thickness

d) Mass absorption coefficient

e) Application to shielding

E. Neutron Interactions

1. Scattering

a) Elastic

b) Inelastic

2. Capture reaction
3. Capture with particle ejection
4. Nuclear fission

5. Activation reaction in the coolant

F. Neutron cross-sections

1. The cross-section concept
2. Microscopic (σ)
   a) Measure of the probability of interaction
   b) Barn unit
   c) A function of three factors
   d) Magnitudes
   e) Barn book
3. Microscopic cross section (Σ)
4. Types
   a) Scattering
      1) Elastic scattering
      2) Inelastic scattering
   b) Capture
   c) Fission
   d) Absorption
   e) Total
5. Energy dependence
   a) 1/v relationship
   b) Resonance region
   c) Threshold effects

G. Neutron flux

1. Physical definitions
   a) Spherical surface
   b) $\emptyset = n\ v$
   c) Surface of 1 cm^2
   d) Collimated beam
2. Neutron density
3. Energy levels
   a) Thermal flux

1) Equilibrium with surroundings

2) Statistical distribution

b) Epithermal flux

c) Fast flux

H. Neutron Current

I. Reaction Rate

1. Equation

2. Types

J. Neutron slowing down and diffusion

1. As related to a thermal reactor

a) Neutron energy level resulting from fission

2. Energy losses

a) Elastic or billiard ball collision

b) Inelastic collision

c) As a function of target mass

3. Slowing down - Fermi age

4. Diffusion Length

5. Migration area

6. Diffusion coefficient

IV. REACTOR PHYSICS

A. Fission

1. Liquid drop model

2. Critical energy

3. Spontaneous fission

4. Fertile and fissile materials

a) Even-odd nuclides

5. Fission products

a) Fission fragments

1) Neutron-proton ratio

2) Distribution

c) In terms of power

7. Fast fission
8. Thermal fission
9. Moderation

B. Chain reaction

1. Critical mass

C. Multiplication factor or reproduction factor

1. Definition

a) K_∞

b) K

c) K_{eff}

2. Subcritical
3. Critical
4. Supercritical

D. Four factor formula

1. $K_\infty = \eta\epsilon pf$ for infinite reactor
   a) η(eta) = neutron production factor
   b) ϵ (epsilon) = fast fission factor
   c) p = resonance escape probability
   d) f = thermal utilization factor
2. Neutron generation problem

E. Leakage

1. Leakage in a finite sized reactor
2. The neutron leakage factors
   a) Fast leakage factor
   b) Thermal leakage factor
3. Critical equation for bare homogeneous finite reactor

F. Reflector and reflector savings

G. Buckling

1. Definition
2. Geometric
3. Material

H. Relation between neutron flux level and power

1. Equation
2. Power level changes

a) Period

b) Equation

I. Reactivity (ρ)

1. Definition
2. Reactivity value for subcritical, critical, and supercritical reactor

J. Sources

1. Primary
2. Secondary
3. Purpose

K. Subcritical multiplication

1. Equation - multiplication (M)
2. Inverse countrate ratio (1/M)
3. Mathematical model breaks down near criticality

L. Reactor Loadings

1. Inverse countrate ratios (ICRR)

a) Implies 1/M

b) Loading to criticality

c) Loading subcritical reactor

d) Sample problem

2. Geometric effects

a) Source too close to detector

b) Changing geometry

V. REACTOR KINETICS

A. Theory Review

1. Neutron balance and K_{eff}

2. Reactivity

   a) K_{ex}

   b) Δk

   c) ρ

3. Exponential behavior and period

4. Prompt neutrons

   a) Neutron lifetime

5. Delayed neutrons

   a) Delayed neutron fraction

B. Delayed neutrons and reactor control

1. Delayed neutron groups

   a) Bi - six groupings

   b) $\bar{B}$ - one group treatment

2. Neutron kinetics and the multiplication factor

   a) Mathematical model of reactor kinetics

   b) In-hour equation

3. Transient effects in a reactor

   a) Prompt jump

   b) Delayed neutron effect

4. Units of reactivity

   a) $\Delta k/k$

   b) % $\Delta k/k$

   c) pcm

   d) \$ and ¢

   e) In-hours

5. Plot of in-hour equation

C. Reactivity Calculations

1. Time behavior based on one group model

2. Negative reactivities and period

   a) Longest delayed group

   b) 80 sec. period

3. One group model equations

a) For $\rho<\beta$

b) For $\rho>\beta$

c) For $\rho>>\beta$

d) For $\rho\sim\beta$

4. Sample Calculations

5. Variations of reactivity and period for various β fractions

D. Effective delayed neutron fraction

$\beta_{eff} = \gamma\beta$

E. Description of power level change rates

1. Period
2. Doubling time
3. Startup rate (decade time)
4. Mathematical relations

F. Prompt critical

VI. REACTOR AND REACTIVITY CONTROL

A. Reserve or Excess reactivity requirements

1. What is EOL
2. U loading for energy burnup
3. U required for criticality at EOL

B. Fuel depletion

C. Fission product poisoning

1. Xe and Sm
2. Fission products

D. Methods of reactor control

1. Rods
2. Boron
3. Boron burnable rods

E. Control rod material and lifetime

F. Functions of Control Rods

a) Shutdown

b) Startup

c) Power control

G. Chem Shim

H. Inherent reactivity effects in a PWR reactor

1. Temp. feedback
2. Doppler feedback

I. Shutdown reactivity requirements

1. Shutdown margin
2. Stuck rod

J. Flux distribution in a reactor

K. Power distribution in a reactor

L. Rising Neutron Flux

1. K_{eff} greater than 1
2. Reactor startup rate
3. Reactor period

M. Decreasing Neutron Flux

1. How initiated
2. Delayed neutron effect
3. Source level

N. General Reactor Control

a) Startup

b) Operating

c) Shutdown

VII. REACTOR CHARACTERISTICS

A. Core Mechanical Design

1. Reactor vessel and internals

a) Core

b) Baffle

c) Support plate

d) RCC, guide tubes, and mechanism

2. Uranium fuel

a) Fuel assemblies

1) Dimension and Mass

2) Fuel cladding

3) Pellet design

b) Flow control devices

1) Flow mixers

2) Grids

c) Sources and boron glass rods

3. Rod control clusters (RCC)

a) Types

1) Full length

2) Partial length

b) Physical structure

c) Material

d) Number in core and location

e) Rod grouping

4. Reactor coolant

a) Description

b) Moderator

B. Reactor Thermal and Hydraulic Parameters

1. Thermal power level

2. Programmed T_{AVE}

3. Loop temperatures and core bypass

4. Fuel temperatures

5. Reactor coolant

a) Flow

b) Chemistry

C. Control Rods

1. Types and functions

a) Shutdown
b) Control
c) Partial length

2. Control rod worths

a) Shutdown
b) Control

3. Control rod reactivity worth curves

a) Differential
b) Integral
c) Use

D. Reactivity Coefficients

1. Reactor moderator coefficients

a) Pressure coefficient
b) Temperature coefficient
1) Boron and temperature effects

2. Boron coefficient (worth)
3. Power coefficient
4. Ph reactivity effect
5. Xenon reactivity worth

E. Hot channel factors

1. Types

a) Engineering
b) Nuclear

2. Enthalpy Hot Channel Factor

a) Definition
b) How used

3. Axial hot channel factor

a) Definition
b) How used

4. Heat flux hot channel factor

a) Definition
b) How used

5. Other hot channel factors that are used and their relationship to those given above

a) Radial peaking factor

b) Local peaking factor

F. Departure from Nucleate Boiling

1. Definition
2. How used

VIII. CORE STATIC AND DYNAMIC BEHAVIOR

A. Initial Core Loading

1. Fuel movement
2. Loading sequence
3. Core monitoring

B. Initial Criticality

1. Plant Conditions

a) Primary

b) Secondary

2. Instrumentation and monitoring

a) Nuclear

b) Primary

c) Reactor Coolant Chemistry

3. Initial Critical Approach

a) Method used

1) Rod withdrawal

2) Boron dilution

b) Monitoring the critical approach

1) Count rate multiplication

2) Startup rate

3) Inverse count rate plotting

c) Geometric effects

1) Source and detector location effects
2) Relecting and shadowing of neutron from detectors by fuel and control rods

d) Indication of criticality

1) Startup rate
2) Flux level indication

C. Subsequent Critical Approaches

1. Monitoring required
2. Estimating just critical conditions

D. Physic Testing Programs

1. Zero power
2. Power escalation
3. Recurrent test series

E. Reactor at Power

1. Thermal Power vs Electrical Power

a) Plant efficienty
b) Calorimetrics
c) As a function of load and back pressure

2. Transient plant behavior for load changes

a) In automatic control

1) Step load changes
2) Ramp load changes
3) Reactor trips

b) Manual control

1) Inherent power stabilization

3. Long-term behavior for load changes

a) Xenon transient
b) Samarium
c) Boron

F. Reactor Shutdown From Power

1. Reactivity Requirements

a) Temperature

b) Doppler

c) Margin

d) Xenon

2. Programmed Shutdown

a) In automatic control

b) Manual

3. Reactor Trip shutdown

a) Causes

b) Plant behavior

4. Core decay heat

a) Function of previous power history

b) Magnitude

G. Core Reactivity Follow

1. Definition

2. Purposes

a) EOL prediction

b) Detection of unexplained reactivity changes

3. Reference conditions

4. Corrections to reference conditions

a) Power level

b) Rod position

c) Boron concentration

d) Temperature

5. Typical curves

H. Core Stretch-Out

1. Definition

2. Reactivity gains resulting from new operating conditions

a) Reduced power level

b) Reduced T_{AVE}

3. Stretch-out economics

I. Reactor Accident Analysis

J. Refueling

1. Monitoring
2. Fuel movements

APPENDIX K

THERMODYNAMICS AND HEAT TRANSFER

A. Terminology and Definitions

1. Pressure
    a) Absolute
    b) Gauge
    c) Atmospheric
2. Enthalpy
3. Entropy
4. Specific volume
5. Specific gravity
6. Temperature - heat
7. Energy
8. Work
9. Power

B. Thermodynamics

1. Energy
    a) External forms
        1) Potential energy
        2) Kinetic energy
    b) Internal form
        1) Chemical
        2) Molecular
        3) Nuclear
2. Thermodynamic System
    a) Boundary
    b) Closed and open
    c) Reversible Processes
3. Phases
    a) Solid
    b) Liquid
    c) Gaseous
    d) Triple Point
    e) Saturated Liquid and Saturated Vapor
    f) Subcooled liquid

C. Fluid Flow

1. Mass flow rate
2. Laminar flow
3. Turbulent flow
4. Reynolds number
5. Boundary layer
6. Free convection
7. Forced convection
8. Two phase flow

D. Thermodynamic Cycles

1. Used in power plants

E. Heat Transfer

1. Temperature

   a) Bulk temperature
   b) Surface or cladding temperature
   c) Temperature gradient

2. Heat

   a) Heat flux
   b) Volumetric thermal source strength, q‴ (power density) (function of flux)
   c) Specific power and linear power

3. Thermal conductivity

   a) Equation

4. Convective heat transfer

   a) Newton's law of cooling
   b) Heat transfer coefficient
   c) Prandtl number
   d) Nusslet number
   e) Heat transfer correlations

F. Boiling heat transfer

1. Nucleate boiling
2. Flim boiling
3. Departure from nucleate boiling (DNB)

C. Coolants

1. Types
2. Desirable properties
3. Water

   a) Advantages

   b) Disadvantages

H. Temperature variations in a reactor

1. In a coolant channel
2. At fuel assembly outlets

APPENDIX L

REGULATING DOCUMENTS AND MISCELLANEOUS PAPERWORK

I. Technical Specifications
   - A. Definitions
   - B. Safety Limits
   - C. Limiting Conditions for Operation
   - D. Surveillance Requirements
   - E. Design Features
   - F. Administrative Controls
   - G. Non-Radiological Technical Specifications

II. QA Manual
   - A. Sections
     - 3.1
     - 3.4
     - 3.18
     - 3.19
     - 3.24
     - 3.29
     - 4.0
     - 9.3

III. Reportable Occurrences and Significant Operating Events

IV. Standing Orders and Special Orders

V. Operating Instructions

VI. Operating Procedures

VII. Refueling Procedures

VIII. Emergency Procedures

APPENDIX M

PLANT TRANSIENTS/ACCIDENT ANALYSIS AND MITIGATION OF CORE DAMAGE

I. PLANT TRANSIENT ANALYSIS

- A. Uncontrolled Dilution
- B. Startup of Idle Reactor Coolant Pump
- C. Opening of Feedwater Heater Bypass Valve
- D. 10% Load Increase

II. PLANT ACCIDENT ANALYSIS

- A. Loss of Flow
  - 1. Two pumps
  - 2. One pump
  - 3. Locked rotor
- B. Loss of Load
- C. Loss of Feedwater
- D. Loss of AC Power
- E. Steam Generator Tube Rupture
- F. Steam Line Rupture
  - 1. Inside containment
  - 2. Outside containment
- G. Feed Line Break
- H. Loss of Coolant Accident
  - 1. Large
  - 2. Small
    - a. Liquid space
    - b. Steam space (TMI accident)

3. Voids

   a. Formation, indication, prevention

III. TRANSIENTS ON CONTROL SYSTEMS

A. I & C Review of Control Systems

1. Rod control
2. Steam dump
3. Pressure control
4. Level control
5. Steam generator level control

B. Control Systems Responses

1. 10% step increase
2. 10% step decrease
3. 100% trip

IV. ACTUAL PBNP TRANSIENTS

A. Reactor Coolant System Flow Coastdown

B. Loss of One Reactor Coolant Pump

C. Start of Inactive Loop

D. Turbine Trip from 70%

E. Turbine Trip from 40%

F. Rod Drop

G. 50% Runback

H. 10% Step Increase

I. 10% Step Decrease

J. 5%/Minute Ramp Increase

K. 5%/Minute Ramp Decrease

L. PBNP Recorder Traces

M. Flux Map Traces

V. MITIGATION OF CORE DAMAGE

A. Use of Incore Instrumentation

1. Fixed incore detectors

2. Movable incore detectors

3. Incore thermocouples

a. Methods of range extension

b. Methods of direct reading

4. Use of P-250 computer

B. Excore Instrumentation (Nuclear)

1. Determination of void formation

2. Determination of void location

C. Vital Instrumentation

1. Instrumentation response in accident environment

2. Instrumentation failure sequence

3. Indication reliability

4. Alternative methods of measurement

a. Flow

b. Pressurizer level

c. Temperature

d. Pressure

D. Primary Chemistry

1. Expected results with severe core damage
2. Radiological hazards
3. Expected isotopic breakdown
   a. Fuel damage
   b. Clad damage
4. Corrosion effects

E. Radiation Monitoring

1. Detector response
   a. Saturation
   b. Direct measurement
   c. Accuracy
2. Use of detectors to determine core damage
3. Dose rate determinations
   a. Measurements inside containment
   b. Measurements outside containment

F. Gas Generation

1. Methods of hydrogen generation
2. Other gas sources (Xe, Kr)
3. Disposal of noncondensibles
4. Hydrogen flammability and explosive limits
5. Sources of oxygen inside containment

Name _____

ON-SHIFT TRAINING AND REVIEW FOR CONTROL OPERATOR TRAINEES

Instructions

1. This training can be accomplished on shift when the COT is assigned to the turbine hall watches. Some amount of time should be spent on training during each turbine hall watch, dependent, of course, upon plant status, on backshifts and weekends.

2. Any licensed operator can conduct the training, but the signoff is the responsibility of the Shift or Operating Supervisor.

3. Sign off the attached sheets when completed.

4. Document time spent on training on the OJT form.

5. Knowledge of the following areas should be demonstrated before signing off a system:

   a. Normal operation and parameters.

   b. Remote controls and indications.

   c. Auto control (basic knowledge).

   d. Interfaces with other systems.

   e. Interactions with other systems.

   f. Basic understanding of associated operating procedures, emergency operating procedures, and operating instructions.

   g. Ability to make a basic diagram, including main flow path, remote-operated valves, crossconnects, etc., i.e., NRC-type drawings.

6. The following areas should be covered on procedures:

   a. General knowledge of operating procedures including the reasons for the precautions and limitations.

   b. Detailed knowledge of symptoms and immediate actions for the emergency operating procedures. General knowledge of subsequent actions.

   c. General knowledge of the operating instructions which pertain to control room operations.

COT SYSTEMS REVIEW

Name_____

Complete by_____

PRIMARY SYSTEM	Supvr. Init.	Date
1. Reactor coolant system*		
a. Pressurizer level control		
b. Pressurizer pressure control		
c. Rod control system		
2. CVCS*		
a. VCT level control		
3. Safety injection system*		
4. Containment spray system*		
5. Residual heat removal*		
6. Spent fuel pit cooling		
7. Component cooling*		
8. Fuel handling system		
9. Containment ventilation* & PACVS (M-224)		
10. Containment structure		
11. Sampling system		
12. Waste disposal system liquid**		
13. Waste disposal system gaseous**		

* NRC-required drawings from memory

** Block diagram from memory

SECONDARY SYSTEMS	Supvr. Init.	Date
1. Main & reheat steam (M-201)	_____	_____
a. Steam dump control	_____	_____
2. Condensate & feedwater (M-202)	_____	_____
a. Steam generator level control	_____	_____
3. Extraction steam (M-203)	_____	_____
4. Feedwater heater vents & drains (M-204, 205)	_____	_____
5. Gland steam & drains (M-206)	_____	_____
6. Service water (M-207)*	_____	_____
7. Fire water (M-208)*	_____	_____
8. Instrument air (M-209)	_____	_____
9. Heating & ventilation (M-215, 144)	_____	_____
10. Circulating water (M-212)	_____	_____
11. Lube oil system		
a. Turbine lube oil	_____	_____
b. EH oil	_____	_____
12. Auxiliary feedwater (M-217)*	_____	_____
13. Fuel oil (M-219)	_____	_____
14. Electrical systems*	_____	_____

POINT BEACH NUCLEAR PLANT

ON-SHIFT DISCUSSTION TECHNICAL SPECIFICATION

NAME _____

INSTRUCTIONS

1. This checklist is to be completed by _____
2. Non-shift personnel may complete these items on an individual basis.
3. The basis for each specification is required for Senior Operators License.

TITLE	DATE COMPLETED	INITIALS	TITLE	DATE COMPLETED	INITIALS
15.1			15.4.10		
15.2.1			15.4.11		
15.2.2			15.4.12		
15.2.3			15.4.13		
15.3.1(I)			15.4.14		
15.3.1(II)			15.4.15		
15.3.2			15.5.1		
15.3.3			15.5.2		
15.3.4			15.5.3		
15.3.5			15.5.4		
15.3.6			15.6.1		
15.3.7			15.6.2		
15.3.8			15.6.3		
15.3.9			15.6.4		
15.3.10			15.6.5		
15.3.11			15.6.6		
15.3.12			15.6.7		
15.3.13			15.6.8		
15.3.14			15.6.9		
15.4.1			15.6.10		
15.4.2			15.6.11		
15.4.3			15.6.12		
15.4.4			16.1		
15.4.5			16.2		
15.4.6			16.3		
15.4.7			16.4		
15.4.8			16.5		
15.4.9			16.6		

POINT BEACH NUCLEAR PLANT

ON-SHIFT DISCUSSION OPERATING PROCEDURES

NAME _____

INSTRUCTIONS

1. This checklist is to be completed by _____

2. Non-shift personnel may complete these items on an individual basis.

TITLE	DATE COMPLETED	INITIALS	TITLE	DATE COMPLETED	INITIALS
OP-1A			OP-6A		
OP-1B			OP-7A		
OP-1C			OP-7B		
OP-1D			OP-8A		
OP-2A			OP-9A		
OP-3A			OP-9B		
OP-3B			OP-9C		
OP-3C			OP-9D		
OP-4A			OP-11A		
OP-4B			OP-13A		
OP-4C			OP-14A		
OP-4D			OP-16A		
OP-5A			Special Orders		
OP-5B			Standing Orders		
OP-5C					
OP-5D					

TR-07
(01-80)

POINT BEACH NUCLEAR PLANT

EMERGENCY AND MISCELLANEOUS PROCEDURES

NAME _____

INSTRUCTIONS

1. This checklist is to be completed by _____.

2. Non-shift personnel may complete these items on an individual basis.

TITLE	DATE COMPLETED	INITIALS	TITLE	DATE COMPLETED	INITIALS
EOP-1A			EOP-11A		
EOP-2A			EOP-11B		
EOP-3A			EOP-12A		
EOP-4A			EOP-13A		
EOP-5A			RP-1A		
EOP-5B			RP-1B		
EOP-6A			RP-1C		
EOP-6B			RP-1D		
EOP-6C			RP-2A		
EOP-6D			RP-2B		
EOP-7A			RP-2C		
EOP-8A			RP-3A		
EOP-8B			RP-3B		
EOP-8C			RP-4A		
EOP-8D			RP-4B		
EOP-9A			RP-5A		
EOP-9B			QA Manual (SRO Only)		
EOP-9C			Emergency Plan Manual		
EOP-9D			HP Manual		
EOP-10A					