BOILING WATER REACTOR
COLD LICENSED OPERATOR
TRAINING PROGRAM
(22 week)

NINE MILE POINT UNIT TWO SIMULATOR
GENERAL PHYSICS CORPORATION
OSWEGO, NEW YORK
PROGRAM NUMBER BLC-1

PROGRAM OBJECTIVE

The Nine Mile Point Unit Two Operator Cold License Program is designed for the experienced operator who is licensed as a reactor operator or senior reactor operator at Nine Mile Point Unit 1 prior to the initial fuel loading and operation of the plant. Basic system functions and overall operation of a large modern BWR are taught through a combination of classroom instruction and hands-on experience using the Nine Mile Point Unit 2 Simulator. Successful completion of this program in conjunction with required preoperational testing results in certification which is a required element in establishing eligibility for cold license NRC examinations.

FACILITIES

The course is conducted at the Niagara Mohawk Training Center, located near Oswego, New York. The center is one of the most modern and well equipped training centers in the country.

STUDENT PREREQUISITES

Students attending this course must have obtained an operator or senior operator license at the Nine Mile Point Unit 1 Station, and/or have met the prerequisites of NU REG 0737 and H. R. Denton's letter of March 28, 1980. Involvement in preoperational testing while not prerequisite for license training is necessary to sit for the license exam.

SCHEDULE

The following schedule shows training conducted during a five day work week. Provisions can be made to facilitate alternatives schedules which may be better suited to utility need with no reduction in training time.

Week	1	2	3	4
Topic	Plant Systems	Plant Systems	Plant Systems	Plant Systems
Week	5	6	7	8
Topic	Thermodynamics	Thermodynamics	Reactor Theory	Reactor Theory
Week	9	10	11	12
Topic	Basic Electrical Theory/Application	Mitigation of Core Damage	Simulator Training	Simulator Training
Week	13	14	15	16
Topic	Simulator Training	Simulator Training	Simulator Training	Simulator Training
Week	17	18	19	20
Topic	Admin. Procedures Controls & Limitations	Audit Review	Audit Process	License Review
Week	21	22	23	24
Topic	License Review	License Process		

This chart is meant to show training interrelationships as opposed to sequential order of training.

SYSTEMS TRAINING (160 hours)

I. The following systems will be taught during this period:

Reactor Vessel and Internals
Nuclear Fuel and Control Rods
Reactor Vessel Instrumentation
Reactor Recirculation System and Recirculation Flow Control
Control Rod Drive Hydraulic System
Reactor Manual Control System
Rod Worth Minimizer
Rod Sequence Control System
Primary Containment and Support Systems
Secondary Containment and Support Systems
Emergency Core Cooling Systems
Reactor Core Isolation Cooling System
Reactor Water Cleanup System
Spent Fuel Pool Cooling and Cleanup System
Standby Liquid Control System
Reactor Protection System
Nuclear Steam Supply Shutoff System
Neutron Monitoring Systems
Process and Area Radiation Monitoring
Main and Auxiliary Steam
Main Turbine and Auxiliaries
Main Turbine Control Systems
Feedwater Systems
Condensate
Gaseous Waste Treatment
Circulating Water and Cooling Towers
Service Water System
Closed Cooling Water Systems
Plant Air Systems
Main Generator and Auxiliaries
Electrical Distribution
Diesel Generators and Emergency AC Distribution

Fire Protection Systems
Plant Process Computer
Fuel Handling Systems
Radioactive Waste Processing Systems

II. This training will concentrate on control room aspects of system operation including system interrelations.

III. Procedural control and technical specification related topics are inlcuded in the simulator training sessions.

HEAT TRANSFER, THERMODYNAMICS, AND FLUID FLOW (80 hours)

Coverage will include, but not be limited to, the following topical areas:

I. Review of Fundamentals Concepts and Definitions

- A. Specific, sensible and latent heat
- B. Heat capacity
- C. Enthalpy
- D. Entropy
- E. Saturation conditions
- F. Potential and Kinetic Energy
- G. Work, Power, Temperature, Pressure
  - 1. Effects of temperature on the density and pressure of a liquid
- H. Ideal Gas Laws
- I. Internal Energy
  - 1. Conversion between relative and absolute temperature scales
  - 2. Temperature conversions for various scales: Celsius, Fahrenheit, Rankine, and Kelvin
- J. Heat and Heat Transfer
  - 1. Conduction, convection, radiation
  - 2. Intensive and extensive properties
  - 3. Open and closed systems
  - 4. Zeroth Law of Thermodynamics

II. Properties of Matter

- A. Solid, liquid, and gaseous states of liquids
- B. Heat of fusion and vaporization
- C. Quality and moisture content
- D. Subcooled liquid
- E. Phase diagram
  - 1. P-T and T-h diagrams
  - 2. P-v diagrams

F. Steam tables and Mollier Diagram
   1. Use and interpolation

III. Heat, Work, and the First Law of Thermodynamics

A. First Law for open and closed system
B. Cyclic processes
C. Enthalpy

IV. Applications of the General Energy Equation

A. Transfer of heat energy into or out of the system
B. Work done on or by the system
C. Calculations for reactor, turbine, pump, and condenser (heat exchanger)

V. Second Law of Thermodynamics

A. Limitations of the first law
B. Entropy
C. Turbine and pump efficiencies
D. Second Law
E. Carnot Cycle
F. T-s diagram

VI. Power Plant Cycles

A. Rankine cycle
B. Pressure and temperature effects on Rankine cycle
C. Regenerative cycle
D. Reheat cycle
E. Real Rankine cycle

VII. Fluid Flow

A. Basic properties of fluids

1. Density
2. Specific weight
3. Buyouancy
4. Compressibility
5. Viscosity
6. Mass flow rate and volumetric flow rate
7. Sub-cooled liquid
8. Static pressure
9. Pressure distribution in a static fluid
10. Effects of pressure and temperature on the density and specific volume of a liquid
11. Computation of fluid mass flow rate and volumetric flow rate

B. Principles of fluid flow

1. Laminar and turbulent flow
2. Recirculation ratio
3. Single phase and two phase flow
4. Flow velocity profiles
5. Continuity of flow and Bernoulli's principle (equation)
6. Fluid friction and headloss
7. Presence of non-condensible gases or steam and their effects on fluid flow

C. Pumps

1. Net positive suction head
2. Cavitation
3. Gas binding
4. Pump runout
5. Shutoff head (effect on pump)
6. Carry over and carry under
7. Calculations relating pump head, fluid velocity, power, and speed

8. Centrifugal pump characteristic curve
    a. Determining system operating point
    b. Series and parallel pump operation
    c. Factors affecting characteristic curve
9. Effects of radial and axial thrust on pump operation
10. Positive displacement pump characteristic curve

D. Flow Measurements
1. Manometer
2. Pitot tube
3. Venturi flow meter
4. Orifice flow meter

VIII. Heat Transfer Mechanisms

A. Conductive heat transfer
1. Specific heat, heat flux, thermal conductivity
2. Fuel characteristics

B. Convective heat transfer
1. Natural
2. Forced
3. Normal and accident condition effects on convection

C. Radiative heat transfer

IX. Boiling Water Reactor Heat Transfer

A. Pool boiling curve
B. Heat transfer regimes
C. Thermal-hydraulics
1. Friction pressure drop
2. Acceleration pressure drop
3. Two phase pressure drop
4. Static pressure drop
5. Core orificing

D. Quality and void fraction

X. Critical Power

A. Transition boiling
B. Critical quality
C. GEXL correlation
D. Critical power ratio

XI. Linear Heat Generation Rate

A. Linear and average heat generation rate
B. Peaking factors
   1. axial, radial, and local
C. MFLPD

XII. Average Planar Linear Heat Generation Rate

A. MAPLHGR
B. MAPRAT

XIII. Reactor Heat Balance

A. Calculation
B. OD-3

REACTOR PHYSICS AND REACTOR OPERATING CHARACTERISTICS (80 hours)

The following topics will be covered as a minimum:

I. Atomic and Nuclear Structure

- A. Stucture of matter
- B. Properties of Substances
- C. Composition and characteristics of atoms
- D. Nuclear Structure

II. Radioactive Decay and Nuclear Reactions

- A. Mass-Energy equivalence
- B. Types of radiation
- C. Radioactive decay modes
- D. Decay rates and half-lives
- E. Nuclear Reactions
- F. Neutron interactions

III. Cross-Sections, Flux and Reaction Rates

- A. Neutron interactions and cross-sections
- B. Neutron flux
- C. Neutron reaction rate

IV. Binding Energy and the Fission Process

- A. Binding energy
- B. Liquid drop model
- C. Energy release from fission
- D. Fission product yields
- E. Prompt and delayed neutrons

V. Neutron Travel and Neutron Sources

A. Neutron travel and slowing down
B. Moderators
C. Neutron Sources

VI. Neutron Multiplication and the Six Factor Formula

A. Steady State neutron balance
B. The neutron cycle
C. Neutron multiplication factor
D. Four and Six factor formulas
E. Moderator - fuel ratio

VII. Reactivity, Shutdown Margin, and Excess Reactivity

A. Reactivity
B. Shutdown margin
C. Excess reactivity

VIII. Subcritical Multiplication

A. Definition
B. Determination of level
C. Subcritical multiplication factor
D. Count rate vs. neutron level
E. Fuel loading

IX. Prompt and Delayed Neutron Fractions

A. Prompt neutron production
B. Delayed neutron production
C. Average neutron generation time
D. Core delayed neutron fraction
E. Effective delayed neutron fraction

X. Reactor Period

A. Describing rate of change of power
B. Period equation and reactivity
C. Prompt critical
D. Use of period equation for negative reactivity insertion

XI. Reactivity Coefficients

A. Moderator temperature
B. Void content
C. Fuel temperature
D. Reactivity defect

XII. Control Rod Worth

A. Control rods
B. Differential and integral rod worth
C. Factors affecting rod worth

XIII. Fission Product Poisions

A. The poisoning process
B. Samarium production, removal, and transient behavior
C. Xenon production, removal, and transient behavior

BASIC ELECTRICAL THEORY AND PLANT APPLICATIONS (40 hours)

I. Fundametal Concepts of Electricity
   - A. Magnets
   - B. Methods of producing a voltage

II. DC Circuits
   - A. Ohm's Law
   - B. Series and parallel circuit analysis

III. AC Circuits
   - A. Basic Concepts
     1. Cycle
     2. Frequency
     3. Period
     4. Inductance and inductive reactance
   - B. Series and parallel circuit analysis
   - C. Power and power factor

IV. Generators
   - A. Basic construction
   - B. Principles of operation
   - C. Voltage regulators

V. Motors
   - A. AC Induction motor
   - B. DC motor

VI. Transformers
   - A. Single phase
   - B. Three phase

TRAINING FOR MITIGATING CORE DAMAGE (40 hours)

I. Review of Heat Transfer (*)

A. Modes of Heat Transfer
   1. Conduction
   2. Convection
      a. Natural
      b. Forced
   3. Radiation

B. Boiling Regime
   1. Subcooled
   2. Nucleate
   3. Bulk
   4. Film
   5. Transition

C. Flow
   1. Single Phase
   2. Two Phase
      a. Bubble flow
      b. Slug
      c. Annular
      d. Mist

D. Cooling Mechanics
   1. Flood
   2. Steam

E. Core Thermal Characteristics
   1. Thermal Hydraulics
      a. Laminar flow
      b. Turbulent flow

2. Thermal Parameter
    a. MCPR
    b. LHGR
    c. APLHGR
3. Fuel Pin Heat Transfer
    a. Normal
    b. Accident

II. Heat Transfer Systems

A. Review of Thermal Cycles (*)
1. Open cycle
2. Closed cycle

B. Normal Systems (*)
1. Main Feed and Steam System
2. Shutdown Cooling System
3. Clean-Up System
4. TBCLC
5. RBCLC
6. Service Water
7. Circulating Water
8. Control Rod Drive
9. Drywell Coolers

C. Abnormal Heat Removal Systems and Capacities (*)
1. Emergency Condensers
2. HPCI
3. Core Spray
4. Containment Spray
5. Raw Water Injection
    a. Feedwater
    b. Core spray
    c. Containment spray

D. Degraded Heat Removal Modes and Capacities

1. Feed and Bleed Methods
   a. CRD, Clean-up
   b. Core Flood - Blowdown via reliefs
   c. Other
2. Containment Flooding

III. Process Instruments

A. Review Critical Parameters (*)

1. Level
   a. Vessel
   b. Containment
2. Pressure
   a. Vessel
   b. Containment
3. Temperature
   a. Vessel
   b. Containment
4. Reactor Flux
5. System Flows
6. Radiation Process Monitors

B. Critical Parameter Measurement

1. Level
   a. Types of instruments and ranges
   b. Alternate methods of measurement
   c. Failure mode
   d. Recovery
2. Pressure
   a. Types of instruments and ranges
   b. Alternate methods of measurement
   c. Failure modes
   d. Recovery

3. Temperature
    a. Types of instruments and ranges
    b. Alternate methods of measurement
    c. Failure mode
    d. Recovery
4. Flux
    a. Types of instruments and ranges
    b. Alternate methods of measurement
    c. Failure mode
    d. Recovery
5. Flow
    a. Types of instruments and ranges
    b. Alternate methods of measurement
    c. Failure mode
    d. Recovery
6. Radiation Monitors
    a. Types of instruments and ranges
    b. Alternate methods of measurement
    c. Failure mode
    d. Recovery
7. Hydrogen and Oxygen Monitors
    a. Types of instruments and ranges
    b. Alternate methods of measurement
    c. Failure mode
    d. Recovery

C. Process Computer
1. Capabilities
2. Usage During Accidents and Transients
3. Sensor Failures

IV. Recognizing Core Damage

A. Symptoms of Core Damage
   1. Hi Radiation Alarms
   2. Core Hot Spots
   3. H_2 and O_2 Increase - Drywell and Off-Gas
   4. Coolant Activity
      a. Isotopic analysis to determine extent of damage

B. Gas Generation
   1. Sources
      a. Metal - Water
      b. Water disassociation
      c. ZrO_2 - UO_2 eutectic
   2. Associated Problems
      a. Gas binding
      b. Noncondensable gas accumulation
      c. H_2 combustion
      d. Radiation hazards

C. Coolant Activity Problems
   1. Radiation/Contamination Problems

V. Mitigation of Core Damage

A. Potentially Damaging Operating Conditions
   1. Limiting Transient Conditions with Complicating Equipment Failures

B. Core Recriticality
   1. ATWS
   2. SBLC

C. Review Emergency Procedure Guidelines, Including Cautions and Basis

VI. Site Emergency Plan and Procedures; Administrative Procedures (*)

A. Site Emergency Plan and Procedures

1. EPP-1, EPP-6, EPP-12, EPP-13, EPP-20

B. Administrative Procedures

1. APN-21
2. APN-2, 2A, 2B

NOTE: Asterisked items are covered in other training weeks. They will be covered as review topics (if necessary) but not taught on an introductory basis. This ensures the material can be presented in the alloted 40 hours.

SIMULATION TRAINING (240 hours)

Simulator training is an integration of classroom instruction and actual simulator time per day of simulator training. The plant systems previously identified will be reviewed and applicable operating procedures, surveillance procedures, casualty procedures, and technical specifications will be discussed and/or performed. Additional topics to be taught include reactor plant transients and accident analysis.

The following control manipulations shall be performed by the students as a minimum:

Plant or reactor startups including noticeable reactivity feedback from heat addition and establishing of heatup rate
Plant shutdown
Manual control of feedwater during startup and shutdown
Significant (10%) power deviations in manual rod control or recirculation flow
Significant (10%) power deviation by means of load limit control
Loss of coolant including large and small breaks, inside and outside containment breaks, and leak rate determination
Loss of instrument air
Loss of electrical power
Loss of core flow/natural circulation
Loss of condenser vacuum
Loss of service water
Loss of shutdown cooling
Loss of component cooling systems or cooling to a component
Loss of feed or feed system failure (normal)
Loss of all feed (normal and emergency)
Loss of reactor protection system channel
Mispositioned control rod or dropped rod
Inability to drive control rods
Conditions requiring standby liquid control system
Fuel cladding failure or high activity in reactor water or off gas
Turbine or generator trip
Reactor scram

Main steam line break (inside or outside containment)
Malfunction of automatic control systems which affect reactivity
Malfunction of reactor coolant pressure/volume control system
Failure of nuclear instrumentation

The simulator training will also include hands-on training for important theoretical concepts.

ADMINISTRATIVE PROCEDURES, CONDITIONS, AND LIMITATIONS

During this period the following procedures and topics will be taught:

I. Administrative Procedures
II. Radiation Protection Procedures
III. Site Emergency Plan and Procedures
IV. Title 10 CFR applicable sections
V. Standing Orders
VI. Shift Turnover Procedures
VII. Technical Specifications
VIII. Leadership Training (SRO candidates only)

AUDIT REVIEW WEEK (40 hours)

Review noted weak areas identified from weekly quizzes and exams.

Review current licensing exams from other facilities and from Unit 2, as available, to answer typical questions.

AUDIT (40 hours)

Monday - Audit Exam

Tuesday through Friday - Simulator demonstrations; Control room and plant walkthroughs; Self study

LICENSE REVIEW WEEKS (80 hours)

Review items noted as deficiencies from the audit process.

Review past exams.

Simulator demonstrations on noted audit weaknesses.