D R A F T

Senior Reactor Operator Level

Instructor Certification Guide

I. CONTENT OF APPLICATIONS

An application for NRC Instructor Certification will contain information similar to that set forth in Section 55.10(a) of Part 55. All items of the application, including transmittal letters and supplementary certifications, will be submitted in triplicate. The application will contain the following information:

1. The full name, citizenship, age, address and present employment. The address should be the applicant's home mailing address. The present employment will include the applicant's position title.

2. The education and pertinent experiences of the applicant. The educational data should be a brief listing of all formal education, including the name of the institution, dates of attendance, subject or major field of study and type of certificate or diploma, if one was awarded. Technical institute participation should also be listed, as well as military schools in subjects which are related to reactor operation (e.g., electronics, physics, radiological safety, etc.). The experience record should include position titles, employers, locations, dates of employment, and a resume conerning the applicant's duties and responsibilities, with particular emphasis placed upon any prior experience in reactor operations. The amount of detail required will vary in accordance with the complexity of the duties performed and the descriptiveness of the position title.

3. The written request by an authorized representative of the B&W Training Center that the operating test be administered to the applicant.

4. Evidence that the applicant has learned to operate the controls in a competent manner and has a need for senior operator level Instructor Certification in the performance of his duties. The evidence concerning operation

of the controls encompasses more than just the aspect of physical manipulation. It should include a certification that the applicant has completed the training required by the B&W Training Center and has demonstrated, to the satisfaction of the B&W Training Center, his ability to operate and train others using the simulator facility. In addition, the certification should include details on the number of hours of training and nature of training received at Babcock and Wilcox. Applicant must have manipulated the controls and demonstrated his ability to train others on the control manipulations listed in Enclosure (4) of Reference (b).

II. ESTABLISHMENT OF AN EXAMINATION SCHEDULE

EXAMINATIONS AT THE B&W TRAINING CENTER

B&W will initiate correspondence approximately 45 days in advance of application(s), in order to establish tentative examination dates. Otherwise, the Commission will proceed to schedule examinations following receipt and review of the applications. The Commission will contact the B&W Training Center to schedule examinations.

III. CONTENT OF THE SENIOR OPERATOR (INSTRUCTOR) WRITTEN EXAMINATION

The content of the senior operator written examination is set forth in Section 55.21 and Section 55.22 of Part 55. The written examination for the senior operator (instructor) will include the topics listed as applicable to the simulator training facility and the reference plant (Ranco Seco).

OPERATOR WRITTEN EXAMINATION SECTION

A. PRINCIPLES OF REACTOR OPERATION

This category contains questions relating to basic nuclear reactor behavior, elementary nuclear reactor theory, technical terminology and an appreciation of processes taking place in a reactor. Answering these questions requires neither

mathematical ability in excess of ordinary algebra nor detailed and advanced knowledge in reactor physics. Questions in this category are about reactors in general or reactors of the appropriate class.

B. FEATURES OF FACILITY DESIGN

This category contains questions about the design features of the reference plant for the particular facility, with emphasis on the reactor systems. The applicant should be able to reproduce, from memory, fairly detailed sketches or descriptions of the nuclear steam supply system including the reactor vessel and core components. Questions are asked about design intent and the more important design parameters. Generally, parameters expressed as limits (e.g., maximum flow, minimum vacuum, maximum pressure, allowable load) or fixed numerical values for fabrication (e.g., enrichment, dimensions) are subjects for questions in this category.

C. GENERAL OPERATING CHARACTERISTICS

This category contains questions on controlled and variable parameters of the reactor systems. Values which are expressed as normal or operating parameters (e.g., purification flow rate, pressurizer temperature, storage tank level) or values which are measured as resultant characteristics (e.g. temperature coefficient, reactivity worth, pressure drop) are asked for in this category. Questions about the way in which power, reactivity, rod worths, or other parameters of this reference plant vary in response to rod manipulations, heatup, core burn up, experiment insertion or other stimuli are also in this category. Further included are questions relating to the traces that one would see on recorders during normal and abnormal transients, with the emphasis on the reference plant behavior rather than instrument characteristics. Secondary system transients that induce reactor transients are also subject for questions in this category.

D. INSTRUMENTS AND CONTROLS

This category contains questions on the characteristics and interrelationships of the nuclear and process instrumentation and control systems. These questions will inquire into the principles of operation of detectors, location and setpoints of instruments, diagrammatic representation of instrument and control systems and details of control rod drives design and operation. An applicant is not expected to have the knowledge of an instrument technician but his answers should indicate the ability to recognize the indications and consequences of improper instrument performance (e.g., over-compensation, power failure, air supply failure, signal failure) including the traces that recorders would show. He should also be able to make use of all available instrumentation to provide checks or verification of observed readings.

E. SAFETY AND EMERGENCY SYSTEMS

This category contains questions on the design, construction, operation and interrelationships of the systems most directly associated with reactor safety, such as reactor trip and other power reduction systems, pressure relief, suppression and containment, poison systems, spray systems, emergency power systems, and systems that are intended to mitigate the consequences of the accidental release of radioactive materials. Annunciated malfunctions are also covered in this category. The applicant should demonstrate thorough knowledge of detailed design, characteristics, and operating methods for these systems. He should also be familiar with the conditions which require the use of such systems and the reasons why such protection is required.

F. STANDARD AND EMERGENCY OPERATING PROCEDURES

This category contains questions on the procedures for the operation of the reactor and auxiliary systems, including technical specifications. In general, an appli-

cant must demonstrate complete understanding of the symptoms, automatic actions and immediate action steps specified by off-normal or emergency operating procedures. The applicant should be able to describe generally the objectives and methods used in the normal, off-normal and emergency operating procedures including how to perform the manipulations or verifications. Operating restrictions and limitations of the reference plant, including technical specifications, may be included, to the extent they are directly applicable to an operator.

G. RADIATION CONTROL AND SAFETY

This category contains questions on terminology, radiation hazards, radiological safety practices, and fixed and portable radiation monitoring equipment. The applicant should demonstrate knowledge of the type and magnitude of radiation hazards which might be expected to be present and of measures to cope with them. He should know the general provisions and precautionary procedures of 10 CFR Part 20.

H. PRINCIPLES OF HEAT TRANSFER AND FLUID MECHANICS

This category contains questions on the fundamentals of heat transfer and fluid mechanics. Questions concerning basic properties of fluids, principles of fluid dynamics, properties of water (saturation, subcooled, and superheat concepts) and principles of heat transfer by conduction convection and radiation will be included. Answering these questions will require application of fluid mechanics and heat transfer principles to the reactor core, reactor systems and steam generator to explain their behavior.

SENIOR OPERATOR WRITTEN EXAMINATION SECTION

I. REACTOR THEORY

This category contains questions on principles of reactor theory including details of the fission process, neutron multiplication, source and control rod effects and

criticality indications. It has more advanced content than the operator category A, but is not advanced to the level of a nuclear physicist or engineer. The applicant should be able to demonstrate quantitative as well as qualitative knowledge of reactor behavior. He should be able to understand and use mathematical expressions regarding reactor behavior; however, these expressions (or formulae) and nuclear constants (fission factors, half lives, etc.) usually need not be committed to memory and will be supplied in the examination when questions requiring them are included. Further, this category may contain questions, as applicable to the facility, concerning some aspects of basic reactor engineering (e.g., heat transfer and fluid flow) which affects the safety of the reactor core and vessel. The primary emphasis throughout will be on understanding and practical application of the theory rather than mere memorization of technical facts.

J. RADIOACTIVE MATERIAL HANDLING, DISPOSAL AND HAZARDS

This category contains questions on radiation hazards which may arise during operation. Close familiarity with the provisions of 10 CFR Part 20 is required as well as a good common sense approach to radiological safety situations. Questions may include calculations involving inverse square law, decay rates, half-value thicknesses and conversions of measured radiation intensities to rem, as well as other calculations of a similar nature. Here, operational "Rules of Thumb" methods of calculations are acceptable wherever applicable.

K. SPECIFIC OPERATING CHARACTERISTICS

This category contains questions on specific operating characteristics of the reactor and auxiliary systems, including nuclear, thermal, electrical and coolant chemistry. Questions regarding quantitative as well as qualitative explanations of causes, limitations, effects and consequences of changes are included. This category includes questions on the understanding and use of curves depicting

reactor behavior which may be beyond the scope of knowledge needed by operators for routine operation. These may include, as applicable, differential and integral control rod worth curves (single or group), period vs reactivity curves, temperature and power coefficient curves, and poison (Xenon, Samarium, Boron, etc.) worth curves. The curves will be given with the examination questions. Whenever possible, actual curves of the reference plant will be utilized; otherwise, applicable sample illustrative curves will be prepared.

This category includes questions on the transient behavior of the reference plant. Questions concerning plant transient behavior will require a thorough understanding of the reactor and reactor systems response. An understanding of how auxiliary and electrical systems can induce transients on the reactor and reactor systems is also required.

This category includes questions regarding the use of installed plant systems to control or mitigate an accident in which the core is severely damaged. Questions will require a knowledge of the use of vital instrumentation to determine plant parameters and how the parameters are used to determine core conditions.

L. FUEL HANDLING AND CORE PARAMETERS

This category contains questions regarding fuel and core loading, including procedures and limitations concerning core loading and detection and prevention of criticality. Questions relating to fuel element characteristics and limitations include consideration of reactivity worths, fuel burnup, thermal hot spots, cladding rupture detection, effects of boiling and control rod programming. The applicant should be able to determine the reactivity status of the reactor based on reference plant parameters and coefficients.

Curves and mathematical expressions my be utilized to the extent describe in category K.

M. ADMINISTRATIVE PROCEDURES, CONDITIONS AND LIMITATIONS

This category contains questions on administrative, procedural and regulatory items which affect operation of the reference plant. Included are questions on design and operating considerations and limitations as specified for the reference plant, including technical specifications. Questions concerning the technical specifications will require a thorough knowledge of what items are addressed in the specifications including how to comply with the requirements. The operating limits and the bases for the specifications should be understood. The exact details, numbers and surveillance requirements contained therein are not expected to be memorized.

N. THEORY OF FLUIDS AND THERMODYNAMICS

This category contains questions on fluids, fluid flow, thermodynamics and heat transfer mechanisms applicable to the operation of the reference plant. Questions in this category are more advanced in content than operator category H and will include questions on heat balance concepts, boiling water heat transfer concepts, critical heat flux considerations, flow instability, natural circulation and reactor heat transfer limitations. The applicant should be able to demonstrate quantitative as well as qualitative knowledge of heat transfer thermodynamic and fluid flow principles. The primary emphasis throughout will be on understanding rather than mere memorization of technical facts.

IV. RELATIONSHIP OF CATEGORIES

The nature of a facility for which NRC Instructor Certification is sought influences the knowledge and duties of an operator at that facility, and correspondingly affects the relative emphasis between categories in the examination. For the certification of simulator training center instructors at the B&W Training Center, the examination should emphasize the reactor and reactor systems design and design

criteria, the transient and accident response of the reactor and reactor systems, and the safety and transient analysis of the reactor and safety systems. Questions relating to plant specific administration procedures, maintenance procedures and plant support systems should receive less emphasis in this case.

V. OPERATING TEST ADMINISTRATIVE CONSIDERATIONS

Certain administrative premises remain in force during the operating test. Among these are the following:

A. During his manipulation of controls in an examination, all directions to the applicant will emanate from the simulator instructor. The examiner will only interrogate and make requests for actions.

B. In order to ensure the integrity of an examination the number of persons present should be minimized. Other than the applicant and NRC personnel, only the minimum number of Training Center staff that are necessary for the examination to be performed should be present.

C. The applicant may refer to and use any applicable material normally provided for simulator operations. These include system operating procedures, alarm, off-normal and emergency procedure followup actions, technical specifications, operating curves, system prints and other relevant material.

VI. SCOPE OF OPERATING TEST FOR SENIOR OPERATOR (INSTRUCTOR)

The scope of the operating test for senior operators (instructors) shall closely follow the requirements of Section 55.23 of 10 CFR Part 55 and is administered to the extent applicable to the B&W Simulator Training Center. The applicant is expected to demonstrate senior operator level of knowledge of the items listed in this section.

The applicant is expected to demonstrate his competence as an operator for a reactor startup, as an operator for selected simulated emergencies and as a senior operator in directing plant operation in selected simulated emergencies. An evaluation of the applicant's ability to train others will be made based on the operating and oral examination.

The applicant will be asked to describe the operation and pertinent design and construction features of selected reactor and auxiliary systems and to display substantial familiarity with the simulator facility, including the ability to locate and identify significant controls and instrumentation.

The following examination sections will normally be included in the operating-oral examinations for the instructor certification. The specific characteristics of the B&W simulator facility will be taken into consideration to ensure the examination accomplishes its objectives:

1. Reactor Operator Startup Examination

    a. The applicant will be asked to perform a prestartup check on the reactor and any other checks (e.g., daily, recovery from scram) that a licensed operator would normally perform.

    b. The applicant will be asked to identify selected nuclear instrumentation channel components and be able to describe the basic principles of operation for the nuclear detectors associated with each channel.

    c. The applicant will be asked to start up the reactor from a substantially subcritical condition and raise power to a preselected value requested by the examiner which is sufficient to utilize selected nuclear instrumentation channels and to introduce effects on reactivity (e.g., temperature increase).

d. The applicant will be asked to describe his actions and responses to selected alarm and annunciator signals and indicate the probable causes and significance thereof. The applicant should show a high degree of familiarity with the procedures of this nature and should distinguish between actions or checks which he must take immediately and those actions which are logical followups depending on the circumstances.

e. The applicant will be asked to predict the approximate readings of pertinent instrumentation for the conditions at which he will operate and to verify that his predictions are accurate.

f. The applicant will be asked to describe the response of the system to control changes and verify that his description is correct. Normally, the applicant will be asked to make one or more changes of power level on a period requested by the examiner.

g. The applicant may be asked to perform standard calculations (e.g., estimated critical prediction, period, etc.).

h. The applicant will be asked to align and start, or describe the procedure for aligning and starting, several of the pertinent auxiliary and emergency systems applicable to the B&W Simulator facility.

2. Reactor Operator Level Operating Examinations

a. The applicant will be asked to demonstrate his actions and describe his responsibilities for simulated emergencies as an operator. The applicant will be asked to describe symptoms of off-normal and emergency conditions and will be asked to demonstrate familiarity with resultant automatic and immediate actions without reference to control room reference material.

This will include location of controls and indications which require manipulation or verification. A high degree of familiarity with the emergency procedures is required, and the applicant should be able to distinguish between those actions he must take immediately as an operator, those which are followup actions for operators and those which other personnel at the facility would be expected to follow. The applicant will be asked to demonstrate his immediate and followup actions expected of an operator for simulated emergencies to the point at which assistance in plant operations from another operator, senior operator, shift supervisor and other support personnel would be normally be expected. For most simulated emergencies this assistance would be expected to be available within ten minutes.

b. The applicant should demonstrate familiarity with and follow all operating procedures and standards of the simulator facility.

c. The applicant should demonstrate a familiarity with the contents of the technical specifications, including operating restrictions and limitations.

3. Senior Operator Level Operating Examination

a. The applicant will be asked to demonstrate his actions and describe his responsibilities for simulated emergencies as a senior operator. The applicant will be asked to describe symptoms of off-normal and emergency conditions and demonstrate a thorough knowledge of resultant automatic and immediate actions without reference to control room reference material. A thorough understanding of the emergency procedures is required, and the applicant should be able to direct reactor operators to accomplish immediate actions and to direct the followup actions using applicable control room

reference material in placing the plant in a cold shutdown configuration. The applicant will be asked to demonstrate the ability to direct plant operations to the point at which assistance from other management and support personnel would normally be expected. most simulated emergencies this assistance would be expected to be available within twenty minutes.

b. For Instructor Certification examination at the senior operator level the reactor operator and auxiliary operator positions will be manned by simulator training center staff personnel.