NUCLEAR POWER
PLANT SHIFT TECHNICAL ADVISOR

Recommendations for Position Description,
Qualifications, Education and Training

THE
INSTITUTE OF NUCLEAR
POWER OPERATIONS

Revision 0
April 30, 1980

FOREWORD

The Shift Technical Advisor position is generally accepted by the industry and the NRC as being an interim position. Long range criteria (three to five years) require that the qualifications of shift supervisors and senior operators be upgraded with the shift supervisor required to have an engineering degree or equivalent qualifications.

In developing recommendations for the STA position and giving consideration to the current shortage of qualified engineering graduates to fill the interim positions, the working groups attempted to identify those areas of education and levels of experience considered necessary to effectively accomplish the position's most important function - accident assessment. Recognizing that many engineering or scientific degree programs do not normally include the range and depth of technical subjects required for accident assessment, the recommendations included identify the subject areas and depth of study necessary but do not specify through what programs they should be acquired.

The user is cautioned to ensure that the recommended education and training is conducted in a professional manner by competent instructors and at the proper level. Institutions and programs accredited by recognized agencies such as ECPD/ABET or others ensure that adequate standards are met.

The program identified should provide the technical depth necessary to meet long-term qualification requirements of both the Senior Reactor Operator and the Shift Supervisor at the time when the STA position is eliminated. Since the shift supervisor position normally is involved in a broader range of

managerial responsibilities, additional training in non-technical subjects such as technical writing, oral communication, and decision making is recommended.

Development of the technical and language skills at the level recommended along with the applied fundamentals and practical training recommended is considered an acceptable equivalent to an engineering degree insofar as qualifications for Shift Supervisor are concerned.

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1. DEFINITIONS

The definitions given below are of a restricted nature for the purpose of these recommendations.

Academic Training - Successfully completed college-level work which may or may not lead to a recognized degree in a discipline related to the position.

Experience - Applicable work in design, construction, preoperational and startup testing activities, operation, maintenance, or technical services. Observation of others performing these functions shall not be considered acceptable experience.

Licensed Operator - Ary individual who possesses an operator's license pursuant to Title 10, Code of Federal Regulations, Part 55, "Operators' Licenses".

Licensed Senior Operator - Any individual who possesses a senior operator's license pursuant to 10 CFR Part 55.

Manager of Nuclear Power - The individual in the utility organization who is directly responsible for the operation of that utility's nuclear power plants and will usually be the person to whom the Plant Manager reports.

Nuclear Power Plant - Any plant using a nuclear reactor to produce electric power, process steam or space heating.

Nuclear Power Plant Experience - Experience acquired in the preoperational and startup testing activities or operation of nuclear power plants. Experience in design, construction, maintenance, and instructing may be considered applicable nuclear power plant experience and should be evaluated on a case-by-case basis.

(1) Experience acquired at military or production nuclear plants may qualify as equivalent nuclear power plant experience.

(2) Nuclear power plant systems and operations training (classroom, on-the-job or simulator) may qualify as nuclear power plant experience if it applies to the plant at which the position is to be filled or a similar plant.

Nuclear Reactor - Any assembly of fissionable material which is designed to achieve a controlled, self-sustaining neutron chain reaction.

On-The-Job Training - Participation in nuclear power plant startup, operation, maintenance, or technical services under the direction of experienced personnel.

Related Technical Training - Formal training beyond the high school level in technical subjects associated with the position in question, such as acquired in training schools or programs conducted by the military, industry, utilities, universities, vocational schools, or others. Such training programs shall be of a scheduled and planned length and include text material and lectures.

Shall, Should and May - The word "shall" is used to denote a requirement; the word "should" to denote a recommendation; and the word "may" to denote permission - neither a requirement nor a recommendation.

STA - Shift Technical Advisor - That position at a nuclear power plant established to evaluate plant conditions and provide advice to the Shift Supervisor during plant transients and accidents. Inherent in this function is the detection and reporting of potential safety problems.

Utility (Owner Organization) - The organization, including the on-site operating organization, which has overall legal, financial and technical responsibility for the operation of one or more nuclear power plants. This shall include contracted personnel (vendors, consultants, etc.).

2. INTRODUCTION

After the the accident at Three Mile Island, investigations by several committees and the Nuclear Regulatory Commission concluded that certain deficiencies may exist in the level of technical expertise generally available to the shift operating staff prior to, during, and immediately after an accident or severe plant transient. Although adequate expertise may be available some time later, the lack of skilled analytical capability during such occurances may contribute to equipment damage or danger to the plant staff and the public. Subsequent recommendations and regulations require that additional technical expertise be made available to each operating shift. Current regulatory requirements identify those individuals providing this expertise on shift as Shift Technical Advisors (STAs).

The purpose of this document is to describe the position and identify specific areas of formal education, plant training and experience necessary to assure an advanced level of analytical ability on shift. These recommendations will provide a level of technical ability that is essential to improved operational safety and are consistent with regulatory requirements. This Institute position was developed in conjunction with representatives of utilities, equipment vendors and engineering educators, giving consideration to specific contributions the function must make to shift operations.

For convenience, the necessary contributions are identified in the form of a position description. Although this format suggests that the function will be performed by a new position, it is not intended to pre-empt management's prerogative to accomplish the function through other qualified individuals within an existing organizational structure.

It should be noted that the areas of formal education identified are not normally included in any one course or in the courses for any one established engineering or related scientific degree program. Rather, the areas and depth of study are those needed to effectively perform the function. The areas identified do provide a basis for either exempting certain subject areas for qualified engineering graduates or for establishing developmental programs for non-graduates or graduates of a degree program that does not include the requisite subject areas.

3. OBJECTIVE

The objective of creating the STA position is to improve the quality of plant technical management and operation by providing additional on-shift expertise in the area of operational safety, thus reducing the probability of abnormal or emergency condition occurrences and mitigating the consequences of these conditions if they do occur.

4. POSITION DESCRIPTION

The responsibilities of the Shift Technical Advisor should be documented in such a way that the incumbent clearly understands the duties and responsibilities of the position. The following position description is a suitable method for describing the work to be performed and the measures of incumbent performance.

Function

Provide advanced technical assistance to the operating shift complement during normal and abnormal operating conditions.

General Qualifications

(1) That combination of educating, training and nuclear plant experience identified in Sections 5 and 6.

(2) An in-depth understanding of nuclear plant equipment, systems and operating practices and procedures.

(3) Well developed analytical skills and the ability to make sound judgements under stressful conditions.

General Duties

(1) During assigned tour of duty be cognizant of plant and equipment status.

(2) Maintain independence from normal plant operations as necessary to make objective evaluations of plant operations and to advise or assist plant supervision in correcting conditions that may compromise the safety of operations.

(3) Be readily available to provide appropriate assistance to the normal shift complement.

Typical Responsibilities

(1) During transients and accidents, compare existing critical parameters, (i.e. neutron power level; reactor coolant system level, pressure and temperature; containment pressure, temperature, humidity and radiation level; and plant radiation levels) with those predicted in the Plant Transient and Accident Analysis, to ascertain whether the plant is responding to the incident as predicted.

Report any abnormalities to the Shift Supervisor immediately and provide assistance in formulating a plan for appropriate corrective action.

(2) Make a qualitative assessment of plant parameters during and following an accident in order to ascertain whether core damage has occurred.

(3) During emergencies be observant of critical parameters, ascertain that there is adequate core cooling including availability of a heat sink for the coolant system, and, in the event that critical parameters become unavailable due to instrument failure, perform calculations or through other means determine approximate values for the parameters in question.

(4) Investigate the cause(s) of abnormal or unusual events occurring on assigned shift and assess any adverse affects therefrom. Recommend changes to procedures or equipment as necessary to prevent recurrence.

(5) Evaluate the effectiveness of plant procedures in terms of terminating or mitigating accidents and make recommendations to the Shift Supervisor when changes are needed.

(6) Assist the operations staff in interpreting and applying the requirements of Technical Specifications.

(7) Perform an early review of the planned activities for the upcoming shift to ascertain whether special considerations or precautions are warranted and make appropriate recommendations to the Shift Supervisor. This review should include scheduled surveillance tests and major maintenance items.

(8) Evaluate effectiveness of plant instructions and recommend needed changes to the appropriate Supervisor.

(9) Evaluate core power distribution during and following load changes. Perform hot channel factor and/or rod program analyses as required.

(10) Review abnormal and emergency procedures.

(11) Prepare special reports when requested by the Operations Superintendent.

(12) Provide an engineering evaluation of Licensee Event Reports from other plants as assigned.

Accountability

The STA is accountable for the following end results:

(1) Contributes to maximizing safety of operations by independently observing plant status and advising shift supervision of conditions that could compromise plant safety.

(2) Contributes to maximizing plant safety during transient or accident situations by independently assessing plant conditions and by providing the technical assistance necessary to mitigate the incident and minimize the effect on personnel, the environment, and plant equipment.

5. GENERAL EDUCATION AND EXPERIENCE

5.1 EDUCATION AND TRAINING

The Shift Technical Advisor shall meet the education and training requirements of Section 6.

5.2 EXPERIENCE

The Shift Technical Advisor shall have a minimum of 18 months of nuclear power plant experience, at least two months of which shall be at an operating nuclear plant.

A maximum of six months of this experience may be obtained in the military or at a production nuclear plant and should be evaluated on a case-by-case basis.

A maximum of three months of systems and operations training may be applied toward these experience requirements.

At least 12 months of this experience shall be at the station at which the position is to be filled. This may be waived in part when two essentially identical plants are involved.

Experience gained at a nuclear station prior to initial fuel loading is acceptable, if the individual actively participates in preparation and review of plant procedures and test programs, and is on-site for at least one year during the preoperational test phase.

5.3 ABSENCES FROM STA DUTIES

Persons not actively performing the STA functions for a period of thirty (30) days or longer shall, prior to assuming responsibilities of the position, as a minimum receive training sufficient to ensure he is cognizant of facility/procedure changes that occured during his absence.

Persons not performing the STA function for a period of six (6) months or longer shall, prior to assuming the responsibilities of the position, receive the annual requalification training described in this document.

6. EDUCATION AND TRAINING REQUIREMENTS

A waiver for any of the required education or training shall be granted only by the Manager of Nuclear Power and should be evaluated on a case-by-case basis. Such waivers may be considered when a candidate has documented accredited college courses or can demonstrate an acceptable level of knowledge through comprehensive examinations in the area to be waived.

For courses completed at an accredited college, a semester credit hour shall be considered equivalent to approximately 15 contact hours in a full-time training program.

When courses prescribed in Sections 6.1.2 and 6.2 are not administered by an accredited college or university the curriculum and instructor shall be certified by the INPO.

6.1 EDUCATION

6.1.1 Prerequisites Beyond High School Diploma It is assumed that many candidates may have received previous training and are qualified to begin the coursework prescribed in 6.1.2. Prerequisite education considered necessary for successful completion of the advanced coursework is identified below. This coursework may be waived without formal documentation of specific course completion.

	Contact Hours
Mathematics	
Trigonometry, Analytical Geometry, College Algebra	90
Chemistry	
Inorganic Chemistry	30

Physics

Engineering Physics (heat, mechanics, light sound, electricity and magnetism)	150
TOTAL	270

6.1.2 College Level Fundamental Education

	Contact Hours
Mathematics	90
Engineering mathematics through the introduction to ordinary differential equations and the utilization of Laplace transforms to interpret control response.	
Reactor Theory	100
Atomic and Nuclear Physics Statics, through 2-group Diffusion Theory Dynamics, Point Kinetics, Reactivity Feedback	
Reactor Chemistry	30
Inorganic Chemistry (as related to reactor systems) Corrosion - Reaction Rates	
Nuclear Materials	40
Strength of Materials Reactor Material Properties (phase diagrams, fuel densification)	

Thermal Sciences (for nuclear systems)	120
Thermodynamics	
Laws of Thermodynamics	
Properties of Water and Steam	
Steam Cycles and Efficiency	
Fluid Dynamics	
Bernoulli's Equation	
Fluid Friction and Head Loss	
Elevation Head	
Pump and System Characteristics	
Two Phase Flow	
Heat Transfer	
Methods of Heat Transfer	
Boiling Heat Transfer	
Heat Exchangers	
Electrical Sciences	60
Electronics (Circuit theory, digital electronics)	
Motors, Generators, Transformers, Switchgear	
Instrumentation and Control Theory	
Nuclear Instrumentation and Control	40
Radiation Detectors	
Reactor Instrumentation	
Reactivity Control and Feedback	
Nuclear Radiation Protection and Health Physics	40
Biological Effects	
Radiation Survey Instrumentation	
Shielding	
TOTAL	520

6.2 APPLIED FUNDAMENTALS - PLANT SPECIFIC

In addition to the general education requirements described in Section 6.1, all STAs shall complete the following training at the college level tailored to the specific plant at which the STA is assigned or a plant of similar design. It may be presented separately from or may be integrated with the education described in Section 6.1.

Subject/Topics	Contact Hours
Plant Specific Reactor Technology (including core physics data)	
Plant Chemistry and Corrosion Control	
Reactor Instrumentation and Control	
Reactor Plant Materials	
Reactor Plant Thermal Cycle	
TOTAL	120

6.3 MANAGEMENT/SUPERVISORY SKILLS

Subject	Contact Hours
Leadership	
Interpersonal Communication	
Motivation of Personnel	
Problem and Decisional Analysis	
Command Responsibilities and Limits	
Stress	
Human Behavior	
TOTAL	40

6.4 PLANT SYSTEMS

The training program shall cover the following systems along with others considered necessary for a specific plant.

System	Contact Hours
Emergency Core Cooling	
Emergency Cooling Water	
Emergency Electrical Power, AC and DC	
Reactor Protection	
Reactor Coolant	
Reactor Coolant Inventory and Chemistry Control	
Containment System (including Containment Cooling)	
Closed Cooling Water	
Nuclear Instrumentation	
Non-Nuclear Instrumentation	
Reactor Control	
Containment Hydrogen Monitoring and Control	
Radioactive Waste Disposal (liquid, gas, solid)	
Emergency Control Air	
Condensate and Main Feedwater	
Auxiliary Feedwater	
Steam Generator Level Control (PWR)	
Reactor Vessel Water Level Control (BWR)	
Main Steam	
Loose Parts Monitoring (PWR)	
Status Monitoring (including Process Computer)	
Seismic Monitoring	
Residual Heat Removal	
Radiation Monitoring	
Plant Ventilation	
Main Turbine and Generator	
TOTAL	200

6.5 ADMINISTRATIVE CONTROLS

Subject	Contact Hours
Responsibilities for Safe Operation and Shutdown	
Equipment Outages and Clearance Procedures	
Use of Procedures	
Plant Modifications	
Shift Relief Turnover and Manning	
Containment Access	
Maintaining Cognizance of P ant Status	
Unit Interface Controls (multi-unit plants with one or more units still under construction)	

Physical Security
Control Room Access
Duties and Responsibilities of the STA
Radiological Emergency Plan
Code of Federal Regulations (appropriate sections)
Plant Technical Specifications (including bases)
Radiological Control Instructions

TOTAL 80

6.6 GENERAL OPERATING PROCEDURES

Subject	Contact Hours
Startup	
At Power Operations	
Shutdown	
Xenon Following While on Standby	
ECP and S.D. Margin Calculation	
TOTAL	30

6.7 TRANSIENT/ACCIDENT ANALYSIS AND EMERGENCY PROCEDURES

Subject	Contact Hours
Transient and Accident Analyses	
Plant Abnormal and Emergency Procedures	
TOTAL	30

6.8 SIMULATOR TRAINING

The plant evolutions, transients and events listed below shall be conducted along with any others deemed necessary. The primary objective should be to demonstrate plant and operator response to a given condition or event and not necessarily to develop the control manipulation expertise of the trainee. The trainee/ instructor ratio should not exceed 4:1.

Simulator exercises should be preceeded by a period of discussion of the planned exercises addressing expected response of the plant and applicable plant procedures to be used. Approximately 100 contact hours are required with about 50 hours in the classroom and 50 hours on the simulator.

Following each exercise demonstrating a transient or emergency event, an incident critique discussion should be held to enhance the trainees' understanding of that particular exercise. When the simulator is not plant-specific, the training shall be tailored to the specific plant as much as practical.

PWR Simulator Exercises

Reactor and Plant Startup
Load Changes at Power
Shutdown to Cold Condition
Demonstration of Steam Generator Level Manual Control
Load Rejections of Greater than 10%
Failure of Rod Control System
Failure of Automatic Steam Generator Level Controls
Failure of Pressurizer Level and Pressure Automatic Controls
Turbine Trip from Full Power
Reactor Trip from Full Power
Loss of Normal Feedwater at Full Power
Failure Open of Power Operated Relief Valve
Stuck Open Pressurizer Safety Valve
Loss of Reactor Coolant Pumps at Full Power and Demonstration of Natural Circulation
Failure Open of One or More Turbine Bypass Valves While at a) Full Power, b) Hot Standby
Loss of All Feedwater (normal and emergency)
Loss of Reactor Coolant (small and DBA)
Steam Generator Tube Rupture (small and large)
Loss of RHR Shutdown Cooling with the RCS Temperature 200° to 300°F
Inadvertent Safety Injection While at Power
Loss of Offsite Electrical Power
Loss of One Train of Onsite Electrical Power

BWR Simulator Exercises

Reactor and Plant Startup
Load Changes at Power (using flow control when applicable)
Shutdown
Load Rejection of Greater than 10%
Turbine Trip from Full Power
Turbine Bypass Valve Failure to Open Following Trip
Inadvertent Isolation of MSIV's While at Power
Reactor Scram from Full Power
Reactor Pressure Control Failure
Dropped Control Rod While at Power
Cold Water Transient at Power
Inadvertent Opening of Relief Valve
Loss of Main Feedwater Pumps at Power
Inadvertent Start of Idle Recirculation Pump
Inadvertent Trip of Recirculation Pump(s)
Loss of Reactor Coolant (small break - large break)
Steam Line Break (inside-outside containment)
Loss of Offsite Power
Loss of Shutdown Cooling with RCS Temperature 200° - 300°F
Demonstration of Natural Circulation Capabilities
Malfunction of Reactor Water Level Automatic Controls

6.9 ANNUAL REQUALIFICATION TRAINING

Subject Material	Hours Required
Review of transient and accident analyses of FSAR condition III and IV events emphasizing the individual's role in accident assessment. Review selected industry events and LERs that could have led to more serious incidents.	40 (Lecture)
Simulator exercises related to the transients in Section 6.8 conducted so as to emphasize the role of the STA.	40 (Simulator)
TOTAL	80