Tennessee Valley Authority
Browns Ferry Nuclear Plant

ALARA and Radiological Exposure Control Program For The Unit 2 Safe-end Nozzle Replacement Project

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RADIOLOGICAL EXPOSURE CONTROL PROGRAM

1.0. INTRODUCTION

The Tennessee Valley Authority (TVA) at BFN has elected to replace the ten N2 safe-end risers at their unit 2 reactor. This replacement will consist only of approximately ten feet of the riser to safe-end piping. This replacement has been incurred due to the identification of IGSCC and SCC cracking of the riser piping. This piping will be replaced by 316 stainless steel piping. Induction Heat Stress Improvement (IHSI) will also be performed on the new piping once installed to help alleviate a recurrence of this problem in future years. Hydrogen injection water chemistry is also being studied as a possible alternative on the new piping to help prevent cracking in future years. This limited pipe replacement project will be the only major work performed in the unit 2 drywell from December 8, 1986, until completion of the pipe installation.

Due to the nature of the exposure intensive work that is required for safe-end replacements, every effort will be maintained to assure the existing TVA BFN radiological control and As Low As Reasonably Achievable (ALARA) programs are implemented to the fullest extent to assure safe radiological working conditions.

The ultimate goal of the safe-end replacement project is to assure the work is carried out in a safe radiological working environment and yet maintain a cost effective method as not to impede timely removal and installation of the safe-ends. This approach will allow TVA and BFN to meet the requirements of 10 CFR 20, Reg. Guide 8.8, 8.10, and also site working instructions.

2.0. ORGANIZATIONAL STRUCTURE FOR MAINTAINING DOSES ALARA

Radiological control personnel from TVA and contractor organizations will work together and will interact with plant management, crafts, and contractor organizations to maintain doses ALARA.

2.1 Plant Radiological Control (RADCON) Organizations

The plant RADCON organization will be responsible for radiation protection during the outage. These duties will include surveys, approval of radiation work permits, internal and external exposure control, dosimetry, training, respiratory protection, ALARA planning, and work package and procedure review. No modifications of RADCON procedures and practices are anticipated for this outage. Ample RADCON personnel will be assigned to the project.

2.2 Outage RADCON

An outage RADCON group is a part of the plant RADCON organization and reports to the site radiological control supervisor. This outage group will provide day-to-day RADCON coverage for this project.

2.3 ALARA Department

The BFN ALARA group is a part of the plant RADCON organization. This group is directed by an ALARA supervisor who controls the work of several ALARA technicians. Specific functions of this group during the safe-end replacement will be as follows:

2.3.1 ALARA man-rem estimates and preplan reports

2.3.2 Specialized shielding designs and followup installation

2.3.3 Containment tent design and followup installation

2.3.4 Special containment control measures

2.3.5 Ventilation design and implementation

2.3.6 Special high exposure intense job briefings

2.3.7 Review work packages as necessary

3.0. <u>PROCEDURE CONTROLS</u>

The radiological exposure control program is designed to use existing BFN radiological control instructions, letters, and memorandums. However, if existing procedures do not adequately address the specialized requirements of the safe-end replacement project, supplementary procedures will be implemented. If additional procedure controls are needed prior to the start of this job, these controls will be implemented where necessary.

3.1 Controlled Work Packages

The BFN modifications group and its subcontractors will control the safe-end replacement work based on an engineering-designed, controlled work package. The BFN modification group has incorporated work functions into these work packages to ensure work steps and modification controls are strictly adhered to. These work packages are developed and evaluated based on construction, technical, radiological, and practical considerations to ensure the most ALARA and cost effective measures are incorporated into these work plans.

3.2 After development, work packages will be reviewed to ensure all work is staged and performed in a manner which minimizes exposure and that RADCON hold points are specified where required. Consideration is being given to methods used on other pipe replacement projects in order to identify the simplest and most efficient way of performing a task.

3.3 Radiation Work Permits

The BFN modifications group actual work tasks that are generated from the work packages will be controlled and governed by the BFN RADCON group's Radiation Work Permits (RWP). This RWP method will maintain a safe and controlled radiological working environment. The RWP process will also allow a current and thorough ALARA and RADCON review prior to the work commencing. The RWP process maintains that before issue of the RWP is allowed, all ALARA considerations and requirements are addressed and implemented as required.

3.4 Additional Radiological Procedural Controls That Provide Individual Exposure Safeguards Are Listed Below:

3.4.1 Administrative control of individual's exposure limitations and upgrade authorizations are outlined in RCI-1 and RPP-Rev. 3. These processes will ensure that before upgrades are processed, the proper upper level management reviews are completed.

3.4.2 Exposure will be tracked on a per shift basis of individual's accumulative radiation exposures to assure exposure equalization and prevent excessive exposure accumulation and potential overexposure.

3.4.3 Site capabilities for immediate TLD processing.

3.4.4 Personnel monitoring of each individual which includes one or more of the following measures:

3.4.4.1 Low and high range dosimetry

3.4.4.2 Accumulative digital monitoring for each individual, i.e., alarming dosimetry

3.4.4.3 Extremity and multibadge monitoring where required

3.4.4.4 Radiation Instrument Usage

3.4.4.5 Line of site RADCON coverage where required

4.0 <u>RADIOLOGICAL ENGINEERING CONTROLS</u>

TVA and its contractors will be utilizing many engineering controls in an effort to reduce exposure, airborne activity, and excessive spread of contamination. Reducing these areas of concern will help ensure exposure to all personnel are maintained ALARA.

4.1 Nozzle Hydrolazing

TVA currently plans on investigating hydrolazing the N2 nozzles from the vessel side and drywell side prior to significant work on the N2 nozzles.

Hydrolazing the back side of N2 nozzle/thermal sleeves will be performed by vendor or plant personnel if this option is implemented.

Intense hydrolazing of the N2 safe-ends from the drywell side will be performed by drilling into the N2 riser and using extremely high water pressure to promote crud burst and releases from the thermal sleeve "dead areas."

4.2 Shielding

TVA is currently developing a program for installation of shielding in the drywell in order to reduce radiation levels from sources of radiation that are significantly contributing to exposure levels in the areas of work.

4.2.1 The criteria for determining use of shielding includes:

4.2.1.1 Ensure that the person-rem required to install shielding is justifiable in relation to anticipated exposure savings.

4.2.1.2 Minimizing movement/relocation of shielding once installed, i.e., ideally shielding should only be removed upon completion of work in the area.

4.2.1.3 Ensuring that the shielding is properly supported and component and piping integrity is not jeopardized.

4.2.2 Areas being reviewed for application of shielding include:

4.2.2.1 Localized hot spots - Hot spot shielding will consist of lead blanket or soft brick shielding. Hot spots will be identified prior to work beginning and shielded as identified.

4.2.2.2 Framework area around the N2 nozzles - Framework around the N2 nozzles will house soft brick or lead sheet shielding. This will help reduce exposures from the RPV vessel wall.

4.2.2.3 Internal Nozzle Shielding - Shielding of the internals of the N2 nozzles will consist of lead plugs encased in a stainless steel jacket or the use of soft brick encased in a stainless steel can.

4.2 (Continued)

4.2.2.4 All shielding will be controlled by existing TVA plant-approved procedures. For any specialized or unique shielding to be performed in conjunction with this project, existing shielding procedures will be modified to accommodate new designs.

4.3 Ventilation

Due to the nature of work to be performed, reliable localized HEPA ventilation units will be available for use during the safe-end replacement project.

Current plans dictate that a nominal 500 CFM local ventilation capability exists for each nozzle that requires replacement. Manifolds and multiple suction lines will be used in order to maximize availability of ventilation in immediate work areas.

Existing drywell ventilation will be used to the extent practicable to assist in providing for continuous air turnover in the drywell. This will allow movement of air from less contaminated areas to more contaminated areas.

Additionally, under normal circumstances, the reactor vessel will be kept under negative pressure to try and minimize airborne activity.

All HEPA units will be maintained, tested and serviced in accordance with existing TVA controls and procedures.

4.4 Reactor Configuration

During the pipe cutout and replacement, the reactor and internals will be a major source of radiation. Since the water in the annulus and core barrel will be lowered due to the potential leakage in the jet pump diffusers, the radiation levels around the vessel will be potentially higher than would normally be expected. There are several methods of exposure reduction that will be implemented and/or are being evaluated.

4.4.1 In Vessel Shielding

The in-shroud water level will be maintained just below the jet pump slip joint to take advantage of this shielding value.

4.4.2 The fuel will be removed from the core and stored in the spent fuel storage area.

4.4.3 The control rod blades in conjunction with the attached stellite balls have the potential to create a significant exposure increase in the N2 nozzle regions if not positioned correctly. The blades will be positioned in a configuration to ensure limited exposure increase in the nozzle region.

4.4 (Continued)

4.4.4 The steam dryer and steam separator are also very radioactive. The dryer and separator are normally stored during outages in the equipment pit, which is flooded with the cavity to reduce radiation levels on the refueling floor. However, since the water level in the vessel will be lowered, the equipment pit cannot be easily flooded. Evaluations are being conducted to determine the best methods for shielding the dryer and separator during the outage.

4.4.5 Due to the low water level in the vessel, the exposure rates on the refueling floor could be higher than normal for an outage. Therefore, the vessel will be shielded to reduce exposure levels.

4.5 Video Equipment

Video monitoring equipment will be installed in areas where the major man-hour and man-rem intensive work is performed. This monitoring equipment allows for constant observation of the work in progress and also alleviates drywell personnel traffic control.

4.6 Additional Exposure Reduction Controls And Techniques To Be Utilized, If Applicable, Are As Follows:

4.6.1 Minimize personnel time in radiation areas by planning and preparation.

4.6.2 Review of previous experience with similar projects as available by identifying specialized equipment and support facilities required.

4.6.3 Provide low radiation standby areas that are clearly defined.

4.6.4 The use of floor plans and maps.

4.6.5 Restrict access to the drywell to preclude unnecessary personnel.

4.6.6 Job segregation for radiological controls.

4.6.7 Planning, scheduling, and coordination of tasks to include optimization of crew size and scheduling for critical path items.

4.6.8 Prejob and postjob briefings.

4.6.9 Active monitoring of work in progress by RADCON and ALARA personnel.

4.6.10 Movement of nonessential activities to low radiation areas.

5.0 CONTAMINATION CONTROL

During the safe-end replacement project, several key areas of contamination control will be implemented to assure that airborne levels are kept to a minimum, general area contamination levels are kept within reasonable working guidelines, and equipment and tool control is managed from a contamination control standpoint. By implementation of the contamination controls listed below, TVA and its contractors shall meet the ALARA objectives of maintaining exposures As Low As Reasonably Achievable.

METHODS TO BE UTILIZED ARE:

5.1 Utilization of localized HEPA ventilation units.

5.2 Usage of portable HEPA vacuum cleaners.

5.3 Field erected containment tents on each nozzle.

5.4 Localized decontamination in each work area prior to work commencing.

5.5 Preferential use of mechanical cutting methods for pipe removal. Mechanical cuts will be supplemented with aforementioned HEPA units, catch trays for shavings, and general area drop cloths.

5.6 Capping/covering of contaminated piping as soon as practicable after completion of cutting.

5.7 Maintaining good housekeeping practices in the drywell and throughout applicable areas of the job site.

5.8 Maintaining a negative pressure on the reactor vessel with the usage of HEPA units on the refuel floor.

5.9 One decon crew per shift available for decon work in the drywell.

5.10 Minimization of grinding, flapping, buffing, welding, etc. on ID of contaminated piping. In most cases where this is likely to occur, a mechanical counterbore will already have been performed; thus, rendering the majority of the worksurface free from high levels of fixed contamination. Airborne and loose surface contamination created during polishing/flapping on old pipe surfaces will be controlled through use of contamination containment areas.

5.11 TVA currently maintains tool decon areas in various areas of the plant to maintain positive contamination controls to ensure tools and machinery are kept at workable contamination limits.

5.12 Wrapping of contaminated materials, items, components, or tools in plastic bags or sheeting shall be adhered to for contamination control. This practice is effective in minimizing contamination and airborne activity when transporting materials to different zones.

5.13 Good housekeeping shall be practiced throughout the project. Cleanliness reduces contamination spreading, lowers background radiation, prevents airborne activity, and reduces industrial safety hazards.

ADDITIONAL STRINGENT CONTAMINATION CONTROL MEASURES WILL BE IMPLEMENTED IN THE FOLLOWING AREAS:

5.14 Respiratory Protection Considerations:

Welding and cutting operations have the potential for generating airborne radioactivity. Pipe cutting techniques will be selected, if feasible, to reduce the potential for airborne radioactivity. If airborne radioactivity levels cannot be kept below the levels specified in 10 CFR 20, respiratory protective devices will be provided in accordance with 10 CFR 20.

Adequate drywell ventilation will be provided to remove potentially contaminated air from the drywell and the worker's breathing zone.

5.15 Alpha Contamination:

TVA has an established operating facility at its Muscle Shoals office that can effectively handle and identify alpha contaminants produced from airborne generating activities and system breaches. This facility has approved working procedures in effect to handle this consideration in a timely manner.

5.16 Radioactive Waste:

There will be one major source of radioactive waste generated from this pipe replacement project and that is the section of the safe-end and riser piping system being replaced. Additionally, the normal LSA waste products will also be generated during this project.

All waste generated from the aforementioned activities will be handled with existing radwaste controls and procedures. All waste will be disposed of at a licensed burial facility under the allocation space disposal plan of the affected licensed facilities.

6.0 TRAINING

6.1 All personnel reporting to BFN for employment during the safe-end replacement project will be required to receive the proper General Employee Training (GET). GET for workers at TVA involves the proper instructions regarding the safeguards and requirements when working in radiologically controlled areas. The ALARA concept is strongly addressed in these training programs to ensure each individual realizes the responsibilities of meeting the ALARA objectives. Additionally, TVA GET programs cover such topics as plant orientation, safety, security, plant work rules, quality control programs, and compliance measures.

6.2 Mock-up Training and Methodology

Extensive mock-up training of work crews is essential for efficient performance in the field. Training of both supervisory and craft personnel will ensure that all personnel on the safe-end replacement project understand the objectives and work methods for successful implementation and follow through of proper working techniques.

Because complicated operations are to be carried out in high radiation fields, mock-up training will be used extensively in preparation for the project. The first objective is to accustom personnel to the expected work conditions and environment.

TVA's approach is to perform a portion of the mock-up training with fully instituted radiological controls and involvement. The second objective is to develop effective field working techniques. Methods will be perfected and mistakes corrected during mock-up training. This approach will minimize field problems, reduce exposure, and provide good quality work. Training on full-scale mock-ups will be used to obtain the following:

6.2.1 Verification of work plans and procedures including methods, techniques, and equipment suitability.

6.2.2 Final determination of parameters that will be utilized in field conditions that will control cutting speeds and weld machine settings.

6.2.3 Time verifications of scheduled work to ensure work tasks and overall project scheduling are consistent with current projections.

6.2.4 Complete familiarization of workers with expected radiation fields and working conditions including interferences and access constraints.

6.2.5 Ensure worker proficiency in the operation and maintenance of special tooling to reduce exposure time in high radiation fields.

6.2.6 Develop workers' abilities and confidence levels to successfully perform work in a radiologically controlled working environment, i.e., protective clothing, respiratory protection, etc.

6.2.7 Ensure documentation of mock-up training on each worker is maintained to provide assurance of worker competence and also meet the requirements of a successful ALARA program.

6.2.8 Identify the most proficient and skilled craftsmen to perform exposure intensive critical tasks.

6.3 Mock-ups To Be Utilized Including Mock-up Training Methods Are Listed Below:

6.3.1 Multiple nozzle mock-ups for training on the installation, use, and removal of remotely operated cutting and weld preparation equipment. The cutting mock-ups will include cutting on previously welded mock-up coupons to simulate actual conditions.

6.3.2 A mock-up for riser templating methods and techniques.

FOR CUTTING, THE INDIVIDUALS WILL BE TRAINED TO:

6.3.3 Install, align, and clamp the equipment to the pipe and/or nozzle.

6.3.4 Identify, install and change out various tool bits.

6.3.5 Operate the equipment visually as well as from the remote control stations that will be providing continuous monitoring by video equipment.

6.3.6 Perform complete disassembly and removal of the effected cutting equipment.

FOR WELD PREPARATION, THE INDIVIDUALS WILL BE TRAINED TO:

6.3.7 Install, align, and clamp the equipment to the pipe and/or nozzle.

6.3.8 Install and change the various tool bits.

6.3.9 Machine the weld preparation.

6.3.10 Machine the inside of a pipe and/or nozzle.

6.4 After the completion of the intensive mock-up training program supervision will be able to decide and formulate the correct and most efficient working teams. When the working teams are formulated additional mock-up training will be provided to ensure worker and team compatibility. Once the aforementioned phase of the mock-up training is completed, all workers should be able to perform the associated cutting and welding tasks required to complete the safe-end replacement project in a quality work manner. Mock-ups will be maintained during the entire course of the project to provide capabilities to solve unanticipated problems that might occur.

6.5 Shielding and Containment Tent Mock-up Training Objectives:

6.5.1 Understanding the reasoning for the implementation and usage of radiological equipment of this nature.

6.5.2 Identify and locate the correct staging and rigging path areas for shield and containment tent movement in relation to the final destination.

6.5.3 Develop and familiarize the workers with N2 bio-shield frame installation and removal.

6.5.4 Familiarize the workers with all shield materials to be utilized in a project of this nature.

6.5.5 Develop and familiarize the workers with N2 nozzle internal shielding including installation and removal.

6.5.6 Develop and familiarize the workers with installation and removal of the soft brick shield material in conjunction with the bio-shield frames.

6.5.7 Ensure all workers are familiar with installation and removal of lead blanket shielding in conjunction with general area and hot spot shielding.

6.5.8 Ensure all workers are familiar with installation and removal of containment tents including set-up, repair, and modifications.

6.5.9 Ensure all workers are trained in all aspects of shield and containment tent installation before they are allowed to perform these tasks in the drywell.

6.5.10 Ensure all of the aforementioned training is properly documented to verify proper worker competence.

7.0 ALARA ESTIMATES

7.1 An ALARA estimate consists of an assessment by RADCON personnel of the expected total person-rem that will be received during the performance of a work activity or job task. ALARA estimates identify those activities which will contribute most significantly to accumulated personnel radiation exposure. These activities will then receive the utmost attention with respect to finding and applying exposure reduction techniques.

ALARA estimates are performed and used by the ALARA and RADCON groups to assist in prejob planning and decision making during the preoutage work package development process.

7.1 (Continued)

During the safe-end replacement project the current ALARA estimates will serve as a benchmark by which exposure reduction efforts will be measured and maintained. Activities that appear to be significantly exceeding their respective estimates will be reviewed and analyzed to determine the root cause of why the estimate is incorrect or if additional exposure reduction techniques can be utilized. If work and job scope activities increase or decrease, estimates will be adjusted to reflect the corrected man-hours and person-rem estimated.

7.2 Dose estimates for the major tasks and support work associated with this project have been formulated. The safe-end replacement project was broken down into three separate phases for estimate purposes and RWP controls. The three phases are as follows:

Phase 1 - Drywell Preparation
Phase 2 - Safe-end Removal and Replacement
Phase 3 - Drywell Restoration

When performing man-rem estimates in conjunction with the aforementioned phases the following exposure evaluation methodology was utilized.

1. Man-hours to perform task

2. Average millirem/hr in work field

3. Shielding correction values

4. Decontamination reduction activities

Based on the aforementioned criteria, the current man-rem estimate for the Browns Ferry unit 2 safe-end replacement project is 309 man-rem.