ONTARIO HYDRO'S PROGRAM FOR ENVIRONMENTAL QUALIFICATION OF IN-SERVICE PLANTS

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INTRODUCTION

The purpose of Environmental Qualification (EQ) is to demonstrate that essential safety-related equipment required to mitigate the consequences of a design basis accident (DBA) will perform as intended when exposed to the harsh environmental conditions of the accident at any time during the station life. Ontario Hydro has undertaken to review the environmental qualification of the Bruce and Pickering stations. It is intended that this program will verify the qualification and make upgrades where necessary. International EQ experience and current research findings will be incorporated. The impact of aging on component life will be established. Component change out schedules will be determined where the qualified life is shorter than the plant life.

Environmental Qualification is only one of several factors to be considered in plant life assurance. Environmental Qualification primarily addresses the potential failure of non-metallic safety related components and must be combined with other programs to establish plant life assurance.

An estimated 100,000 components in Pickering GS A&B and Bruce A&B require qualification. These components are spread across 1200 unique equipment types supplied by 300 equipment manufacturers.

The many facets of verification and maintenance of EQ require close cooperation between equipment suppliers, designers and plant operators. Within Ontario Hydro, EQ will draw on the expertise of procurement and materials management staff, research, engineering, operations and maintenance. The close integration of the expertise and experience of all of these groups will be necessary to establish and maintain an effective EQ program.

STATUS

A pilot project and definition phase study for the Environmental Qualification Program were completed in 1990 and 1991. The Board of Directors of Ontario Hydro approved the initial portion of the program including front end Engineering and Field work in December of 1991. The full program is planned to be released in early 1994 when a more complete and accurate estimate is available. Implementation of the full program will take 10-12 years.

METHODOLOGY

A comprehensive methodology (see Figure 1) has been adopted to determine the requirements for qualification. The method of establishing qualification and the changes necessary to assure long term qualification will be reviewed. The purpose of the methodology is to ensure that the end product is complete, verifiable and maintainable.

Safety Requirements Matrix

The Safety Requirements Matrices (SRM) are organized on a system basis. They establish the major components of the system which are credited to perform specific safety functions. A mission time is established for each safety function. It should be noted that the same piece of equipment may be credited with the same or different safety functions for different DBA's.

Harsh Environment Components List

The Harsh Environment Components List (HECL) is a list of all support devices located in potentially harsh areas which are necessary for the equipment identified on the SRM (SRM devices are also listed) to perform its credited safety function. This includes devices which are either mechanically or electrically connected as well as those devices which are logically connected to a piece of equipment. (An example of a logically connected device would be a sump pump which is provided to limit flooding levels.) The HECL is the list which is used to control modifications to the plant. It is the characteristics of the equipment identified on the HECL which are critical to assure the capability of the equipment to perform its safety function.

Typically, the HECL contains information gathered from drawings, bills of material, and other engineering information. The following data forms part of information associated with each HECL device:

-Equipment Code as tagged in the field
-associated SRM device
-location including elevation
-manufacturer ,model,serial number
-stock code
-specification reference

Environmentally Qualified Components List

The Environmentally Qualified Components List (EQL) is identified from the HECL and represents those components which may fail in an unsafe manner due to post accident environmental stresses. Typically such components as all metallic valves are not transferred from the HECL to the EQL since they would not be adversely affected by the post accident environment. The EQL is the list of components which require formal qualification.

Walkdowns

Walkdowns are the process of verifying that the components are of the type specified by Engineering. The configuration of the equipment is also verified during walkdowns to determine that installation details necessary to assure qualification have been implemented correctly in the field. Walkdowns are organized to reduce field labour and radiation exposure.

Environmental Conditions

The Environmental Conditions identify the stressors which impact on component performance. These conditions result from normal service and from postulated DBA's. The normal service conditions are established for all areas of the plants which contain equipment requiring qualification. These conditions are based on readings recorded over a period of time during normal plant operation.

The accident conditions are determined for potentially harsh areas for a set of DBA's. The conditions associated with each DBA are recorded for affected plant locations. The selected DBA's are those which represent the worst case conditions for any one set of equipment. A complete set of accidents is required to establish the minimum level of stress for plant equipment necessary to mitigate a specific accident scenario. In new plant design it is appropriate to specify bounding environmental conditions for component qualification. These bounding conditions cover all areas of the plant and free the designers, in most cases, from the complications of providing different specific qualification for each device application. This program for in-service plants establishes the specific needs for each device, where needed, to minimize the impact on plant operations by minimizing maintenance requirements and reducing the scope of component replacement.

The following harsh conditions are recorded for each DBA where needed:

-Temperature vs time
-Beta Radiation vs time
-Gamma Radiation vs time
-Peak Humidity
-Pressure vs time

Environmental Qualification Assessment

Environmental Qualification Assessments (EQA's) are the auditable records which demonstrate the capability of equipment to perform its safety function. Equipment is qualified when it can be demonstrated, usually by testing or analysis that the component will perform its safety functions under the postulated harsh accident conditions. The EQA normally contains the following information:

- -Radiation damage assessment
- -component qualified life and aging assessment
- -submergence assessment if applicable
- -equivalency between accident and qualification conditions
- -similarity analysis between assessed and installed devices
- -instrument accuracy under harsh conditions
- -test report review and/or material degradation analysis
- -synergistic effects

Maintenance activities necessary to retain qualification in the long term, are clearly identified and documented. Should the EQA process identify any shortcomings in the qualification of a component, a recommendation is made on the most effective means to achieve qualification.

The usual options to achieve qualification are component replacement or upgrading. However, other techniques such as relocation, radiation shielding, operator action or modification to system design are only a few of the alternatives which may be successfully utilized.

Seismic Qualification and Environmental Qualification

The seismic qualification of equipment is not being addressed as part of this EQ program. Operational feedback from facilities which have experienced seismic activity with equipment similar to that found in CANDU plants has demonstrated that for most types of equipment seismic withstand capability does not degrade with age. However, adverse environmental conditions (other than seismic vibration) are included in the EQ program (eg seismically induced steam environment).

BENEFITS

The initial work on the Environmental Qualification Program has identified several areas for improvement in both equipment and human performance. It is Ontario Hydro's goal to take advantage of this potential to achieve the optimum safety and economy from the in-service nuclear facilities.

The development of predictive piece part change out requirements for components based on the stresses of normal service conditions provides an opportunity to identify materials which need frequent replacement. The substitution of these short life items with new

items made with material more suitable for the conditions than those supplied by the original manufacturer of the component will reduce future replacements.

The development of generic standards for the procurement of products will assist in the material substitution program. The benefits of generic procurement standards are in decreasing the number of unique items purchased, inspected and stored. Generic standards for procurement provide for consistency in materials used in the replacement process.

A typical generic material type has a range of activation energies. Degradation analysis for materials/components is based on the most conservative value when a better value cannot be demonstrated. By improving the assurance of material properties through generic procurement standards, the accuracy of the degradation analysis is increased. Improved accuracy of activation energies and degradation analysis will reduce the calculated maintenance interval for parts subject to normal service degradation.

REFERENCES

(1) CHADHA J.A.,ANDREEFF B.T.,ROLFE B.A.,"Canadian Programs for Understanding and Managing Nuclear Plant Aging Degradation" ASME Conference, San Diego California, June 1991