Application Of The ALARA Principle To The Bleed Condenser Relief Valve Replacement Project

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Abstract

Darlington Nuclear Generating Division's achievements in radiation dose performance can be attributed, in part, to adherence to the ALARA principle. The station's ALARA program, which is an integral part of the safety culture, derives its strength from a strong and unwavering commitment by the site Vice President. This commitment is supported by performance standards and an accountability system which holds managers and supervisors responsible for dose performance. A LAN-based hazard and dose information system with site-wide accessibility was established to facilitate work planning and exposure control. The principle of dose optimization is fully integrated into the work management process and includes work planning, progress monitoring and post-job review. An integrated performance assessment and reporting system also provides timely feedback to management on dose performance.

An example of the ALARA program was the bleed condenser relieve valve replacement project. Pre-job ALARA review meetings for the project were held with supervisory staff and technicians to discuss job details and dose reduction measures. All work groups were required to prepare a detailed step by step task safety analysis (TSA). The trades and engineering staff were requested to critique the TSA and suggest ways of reducing dose. Over 30 practical ALARA suggestions were received and adopted for implementation. Daily meetings were held to review job progress and the effectiveness exposure control. A post-job ALARA review was held at the conclusion of each project to obtain feedback and lessons learned. All improvement suggestions were review for implementation during subsequent installations. As a result of the ALARA initiatives, significant dose savings were achieved. The normalized dose expenditure has been reduced from 9.6 rem for the first installation to 6.9 rem for the fourth and last installation.

The Darlington Nuclear Generating Station consists of four CANDU reactor units each rated at 935 MWe. All four units were in commercial service by 1993. During the past three years (1994 - 1996), the station operated with an average net capacity factor of 86.2%.

Between 1994 to 1996, Darlington's average collective dose was 25 rem/unit. This ranks Darlington as the best of all CANDU reactors and puts it near the top among the best in the world. The average individual dose during this time was 0.12 rem/year. In the past three years, there were only 7 workers with annual doses exceeding 1.0 rem. With the exception of one case involving an unplanned tritium exposure, all exposures over this level were carefully evaluated by the line supervisors and the ALARA Co-ordinator before approvals were sought from the responsible managers.

The station's achievements in dose reduction can be attributed to:

- robust design

- high chemistry standards
- conservative fuel handling strategies
- ALARA controls

Darlington's ALARA program consists of four main components. The first and the most important, is a strong and unwavering commitment by the upper management. This commitment is supported by a set of dose targets benchmarked against the best in the world and the inclusion of dose performance targets in supervisors and managers performance contracts. The station's drive to establish a safety culture has created an environment in which the ALARA approach is shared and assumed by every level of the management chain, from the Site Vice President to the worker on the shop floor.

The second component of Darlington's ALARA program is the ready availability of information tools for dose management and exposure control. The in-house information systems consisting of a dose management system (DMS), radiological hazard information system (RHIS) and electronic exposure permit system (REP), are LAN-based "Windows" applications. This ensures user friendliness and site-wide accessibility to all station staff. The system's real-time dose and hazard tracking capability provides an invaluable tool to planners, supervisors and workers in work planning and dose management.

The third component of the ALARA program is the application of work management techniques in the dose optimization process. The work planning process includes techniques such as pre-job safety analysis, mock-up training, use of specialized tooling, and post-job review. To ensure that all practical dose reduction measures have been applied, all Zone 3 (which contains radioactive systems) work must be reviewed by Radiation Control technicians and jobs with an estimated dose of 0.5 rem or higher must be reviewed by the ALARA Co-ordinator. Reviews consist of discussions with engineering staff, walk-downs at the job site, and pre-job planning meetings with work groups involved in job execution. As part of the review process, the ALARA Co-ordinator may refer the case to the site Central Safety Management Committee (CSMC), an oversight group consisting of the site Vice President and all department managers for review and approval. Individual doses are also carefully controlled. In addition to Ontario Hydro Nuclear 2 rem/year administrative dose limits, an exposure control hold-point of 1.0 rem/year is applied at the site. Department manager's approval is required to exceed this level and doses above this level without approval will be investigated. The DMS also contains an auto-mailer feature which automatically sends out an e-mail to the responsible supervisor and the ALARA Co-ordinator when a worker's dose exceeds 0.85 rem/year.

The fourth component of the ALARA program is an assessment and reporting system which provides feedback to supervisors and managers on dose performance and identifies areas of weakness. Monthly ALARA reports are produced detailing the station's dose performance and potential problem areas. Regular presentations are also made to the

CSMC on the stations overall dose performance, future trends and dose reduction strategies.

An example of the ALARA dose optimization process was the bleed condenser relief valve replacement project. This project, which will be performed on all four units, was initiated in response to an event at Pickering NGD in December 1994 which resulted in a large spill of D_2O when the bleed condenser relief valves failed to reseat during an over-pressure event. Pre-job ALARA review meetings for the project were held with supervisory staff and technicians to discuss details of job-task analysis and identify methods which could be used to reduce exposures to workers. The combined work force was made up of Technicians, Pipe Fitters, Electricians, Carpenters, Laborers, Iron Workers, and Painters. A total of 2,150 person-hours coupled with average exposure rates of 5.6 mrem/hour led to a estimated dose of 12 rem/unit or a total dose of 48 rem for the station. This triggered a detailed presentation by the ALARA Co-ordinator to the Central Safety Management Committee. The committee reviewed the dose target and ALARA controls and requested that the Project Manager re-examine the dose reduction measures, especially where more extensive use of shielding structures and better work management strategies could be made to reduce time in the radiation fields. With diligent application of the ALARA process, the Committee felt that it should be possible to reduce the dose by a further 25%.

The project team responded to the Central Safety Management Committee's suggestions with a unanimous decision to lower the target from 12 rem to 9.0 rem. This required all work groups to prepare a detailed step by step Task Safety Analysis with particular attention given to job sequencing to enable logical separation of vault and non-vault tasks. To the extent practical, only experienced staff were used and great care was taken to match individuals with appropriate tasks.

The trades and engineering staff were asked to critique the TSA and make suggestions on which job steps could be done outside of the radiation area and what techniques and specialized tooling could be used to lessen time in the radiation area and reduce dose. Some 30 practical ALARA suggestions were received and adopted for implementation. These included:

- Containment air dryer operating procedures were modified to ensure that all four dryers were operational to reduce tritium concentrations from an expected average of 100 MPCa to a target of 40 MPCa or less.

- Mock up training sessions were conducted with sheet metal RV's and an engineered cart to identify interference and facilitate hoisting when moving the actual 816 kg RV's into place.

- Where possible, tubing was prefabricated outside of the radiation area.

- Radiography of components was done in the fabrication shop or in low dose locations prior to being brought into radiation area. This greatly reduced the number of welds that had to be radiographed in the radiation area.

- Engineered scaffolds (250lbs/ft^2) were constructed to hold lead shielding blankets sufficient to provide a 32-fold reduction in exposure rates (from 1000 mrem/hour to 30 mrem/hour).

- Detailed surveys in the radiation area were conducted to identify local hot spots and low dose rate "wait areas". Job sequencing was optimized to reduce "idle times" and workers were not allowed into the radiation area until they were needed.

- A rubber area was set up outside of the radiation area where contaminated piping was prepared and welded. Many pipe supports were tack welded to the required dimensions before being moved into the radiation area for welding. This not only reduced time spent in radiation area to perform the welding operation but also reduced the time required for inspection and testing.

- The hangers attached to the RV support were changed from the underside of the tank to the top thereby greatly improving welder access.

- A tool kit assembled for the job based on input from all the trades. This reduced clutter in the work area and eliminated tool-related delays in the work.

- Specialized tools were used to reduce time at the work site (e.g. a tool was used to accurately and quickly prepare the carbon steel piping, a grommet gun was used to facilitate hanging of local fire blankets, a power hacksaw with modified blades was obtained to facilitate cutting in cramped areas).

Daily tailboard meetings were held to provide an opportunity to evaluate the ALARA practices and determine if additional exposure controls should be implemented. At the conclusion of the project, a post-job ALARA review was held with workers involved in the hands-on installation and a list of improvement suggestions were obtained. All improvement suggestions were reviewed for practical implementation during subsequent installations in Units 2, 3 and 4.

As a result of the ALARA initiatives, significant dose savings were achieved. The normalized dose expenditure for the first installation (Unit 1) was 9.6 rem which is slightly above the dose target of 9.0 rem but 20% below the original dose estimate. The dose expenditure was reduced to 8.1 rem during the second installation (Unit 4) and further reduced to 7.2 rem during the third installation (Unit 2). The dose target for the fourth and last installation (Unit 3) was set at 7.0 rem and our latest dose statistics indicated that the actual dose was 6.9 rem. It is worth noting that the dose savings were achieved with a corresponding reduction in the total person hours required for the job.

This clearly demonstrates that excellence in productivity is complementary rather than in conflict with radiation protection goals.