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RADIOLOGICAL CONTROLS INTEGRATED INTO DESIGN

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ABSTRACT

Radiological controls are required by law in the design of commercial nuclear power reactor facilities. These controls can be relatively minor or significant, relative to cost. To ensure that radiological controls are designed into a project, the health physicist (radiological engineer) must be involved from the beginning. This is especially true regarding keeping costs down.

For every radiological engineer at a nuclear power plant there must be fifty engineers of other disciplines. The radiological engineer cannot be an expert on every discipline of engineering. However, he must be knowledgeable to the degree of how a design will impact the facility from a radiological perspective. This paper will address how to effectively perform radiological analyses with the goal of radiological controls integrated into the design package.

INTRODUCTION

Every health physicist, radiological engineer, ALARA coordinator, or whatever title one may hold, has a primary objective to maintain exposure to ionizing radiation As Low As Reasonably Achievable. Many hours have been focused on achieving reduction of radiation exposure in the commercial nuclear power industry. Why is this? Regulatory Guide 8.10[1] says it well:

> "Even though current occupational exposure limits provide a very low risk to injury, it is prudent to avoid unnecessary exposure to radiation. The objective is thus to reduce occupational exposures as far below the specified limits as is reasonably achievable by means of good radiation protection planning and practice..."

NUREG-1272[2] says:

> "Because the economics of operating a plant creates a strong impetus to lower exposures and achieve ALARA (As Low As Reasonably Achievable) objectives.. the vast majority of nuclear power plant personnel have annual exposures far below NRC regulatory limits ..."

NUREG-1272[2] further brought out that the average radiation worker received 1.9 rem twenty years ago compared to 0.4 rem in 1991.[3] Between 1983 and 1992, the average collective dose per U.S. reactor dropped by 65%. The report concludes that the reduction is believed to be primarily the result of the licensees' extensive dose-reduction efforts.

Many good practices that reduce dose have been implemented and communicated throughout the industry. Data collected by INPO (the Institute of Nuclear Power Operations) clearly indicates a strong commitment to achieving lower doses. One extremely important area that can be tapped to further reduce dose is the design change process. Granted, our plants have been built and all have some inherent designs that have proven to have not been in the best interest of ALARA. However, all power plants are getting older, new technology is constantly being developed, and changes are being made. The time for improvements is now. The health physicist must take advantage of the opportunities to include ALARA principles. However, one must not overlook the R, which stands for "reasonably," in the acronym ALARA. The purpose of this presentation is not to define reasonably, but to clearly present a methodology of obtaining dose reduction at a reasonable cost from a design change perspective.

CONCEPTUAL DESIGN INPUT

The design engineer must meet with the radiological engineer during the conceptual phase of the project. The initial communication should include basic information to enable the radiological engineer to determine the frequency of interface. The following three designations are recommended:

- **Category:** Insignificant/Low Risk

  Example: An emergency service water flow indicator is being replaced with a different more reliable type. Work is to be performed within the radiologically restricted area; however, dose-rates are only <0.5 mrem/hr (0.005 mSv/hr).

  Frequency: The need for radiological interface subsequent to the conceptual review is infrequent. Certainly, the radiological engineering group should review the final package as part of the approval process; however, there is no need for a periodic interface during the interim.

  Reason: The radiation levels in the area are very low, the proposed activity has no potential to cause a change in radiological conditions, and there is no change to the operability of the system from a radiological perspective.

- **Category:** Periodic/Moderate Risk

  Example: A design change is determined to be necessary regarding the installation of several temperature detectors on the residual heat removal system. Radiation levels are 100 - 300 mrem/hr (1 - 3 mSv/hr) and the work is expected to require 25 person-hours in the work area.

  Frequency: The need for interface for a job such as this would be periodic. The radiological engineer would determine exactly the frequency period. It may be weekly, monthly, or whatever he should feel appropriate.

  Reason: There is typically a degree of latitude when installing temperature detectors. A distance of a few feet may be quite substantial regarding dose rates. The radiological engineer could provide guidance. Additionally, conduit has to be installed for the wiring. Selection of where the conduit traverses is also important. Another consideration should be to compare the dose required for permanent installation and subsequent upkeep compared to temporary installation.

- **Category:** High Risk/Impact

  Example: The reactor water clean-up line in the drywell has sustained significant erosion/corrosion wear and is in need of replacement. Radiation levels in the work areas range from 20 - 2500 mrem/hr (0.2 - 25 mSv/hr).

Frequency: Radiological engineering would want to work every step of the way with the design engineer on a project such as this. Design changes in this category have a high risk of dose from the implementation and/or as a result of the implementation.

Reason: Many facets of the job have the potential to have a significant radiological impact. This includes not only the methodology of removing the old pipe and installing the new, but also includes material selection, and processes such as electropolishing and passivation. Additionally, other support activities, such as chemical decontamination prior to removal of the old line, or determination of permanent shielding as part of the design change, need to be considered.

Why break down the frequency of radiological engineering interface into three categories? Early, clear definition of radiological engineering involvement will help to ensure the modification is designed correctly from an ALARA perspective the first time. The identified frequency will ensure the proper emphasis is directed to design changes as appropriate, resulting in more bang for the buck. Thus, resources can be spent more efficiently.

INTERFACE OBJECTIVES

What are the objectives of the radiological engineer when interfacing with the design engineer? Simply, the radiological engineer would want to clearly communicate with the design engineer the radiological risk, impact, and benefit from the proposed change, along with potential dose reduction opportunities. By doing so, proper input can be provided at the appropriate time.

The radiological engineer should include the appropriate dose reduction methods relative to the cost/benefit. For example, a new type of gauge is being installed in the reactor water cleanup (RWCU) system. There are two options presented for review. 1) the first gauge cost $10,000, has a service life of 10 years, and requires calibration once every 12 months, and 2) the other gauge cost $14,000, has a service life of 12 years, requires calibration once every 18 months. The dose rate in the area is 50 mrem/hr (0.5 mSv/hr), calibration requires 2 person-hours in the area, entrance to the area requires a dress-out for contamination control.

Additional facets with replacing the gauge, regardless of which model, are; plant operations takes reading from this gauge shiftly (2 minutes), surveillances are performed quarterly (1 person-hour in the area), and two feet of tubing will be replaced.

Considering the given information, one can perform a comparison to determine which gauge is the best from a dollar versus dose perspective. However, the radiological engineer should not stop there. Since the RWCU system is a highly contaminated system that has the potential to cause a CRUD build-up within the tubing which could result in an increase in area radiation levels, one must take into consideration the selection of materials.

Consideration should be given to whether the gauge can be relocated. Perhaps by moving the gauge only a few feet radiation levels may be significantly lower. Possibly, by moving the gauge only a few feet dress-out for contamination control may be avoided.

Granted the additional cost of relocating will have to be weighed against the benefit. But the point is, DO NOT STOP AT THE SURFACE! Do some digging, be creative.

BENEFIT FROM INTERFACING

What is the benefit of integrating radiological controls in the design change package, especially from the conceptual stage?

Less cost, less dose.

How? If a design engineer spends time to formulate an idea and does not involve the radiological engineer, ALARA principles may not be included. When the radiological engineer does review the package, he may feel it appropriate to request (require) the design engineer to "go back to the drawing board." Thus a portion of the time (money) spent on the project would be lost.

Furthermore, additional ALARA benefit can be realized by the opportunity afforded during some design changes. For example, let us use the example of the gauge replacement discussed earlier. Relocating the gauge just for ALARA reasons in this case would not be an option. However, since the gauge is being replaced along with some tubing, the extra work might be acceptable. Along with the lower dose rates at the proposed location, time and cost savings associated with not having to dress-out should be factored in.

CONCLUSION

In conclusion, integration of radiological controls into design is an opportunity to further reduce radiation exposures now. ALARA actions can be implemented as part of a design change that would not have been an option otherwise. Collective dose is trending downward; use this viable resource to reduceccupational exposures as far below the specified limits as is reasonably achievable.

REFERENCES

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Author Biography

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