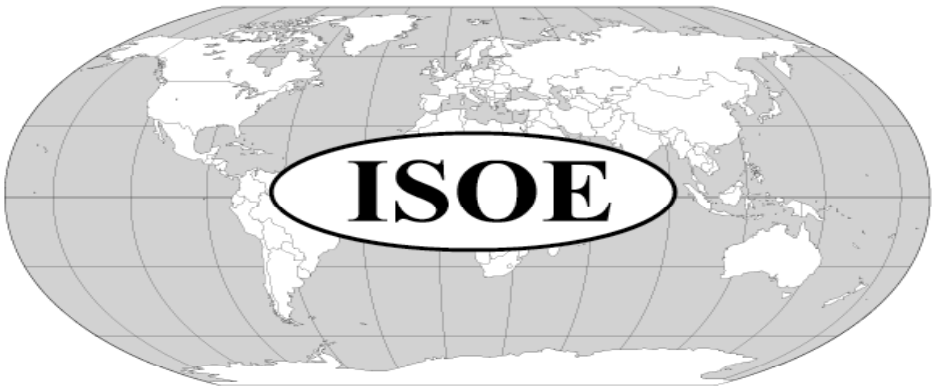
OECD Nuclear Energy Agency
International Atomic Energy Agency



INFORMATION SYSTEM ON OCCUPATIONAL EXPOSURE

General Distribution **November 2001**

ISOE INFORMATION SHEET

North American Technical Center
Information System on Occupational Exposure
US PWR 5 Year Dose Reduction Plan:
Donald C. Cook Nuclear Power Plant

NATC ISOE Information Sheet No. 01-7

NATC ISOE Information Sheet No. 01-7 presents a **good example** of a U.S. Pressurized Water Reactor 5 year dose reduction plan prepared by the D.C. Cook ALARA Group (Michigan,USA). The Institute of Nuclear Power Operations (**INPO**) has provided the US PWR collective radiation exposure goal for 2005 as **0.65 person Sv (65 person Rem) per unit** (median value). The 2000 INPO PWR collective radiation exposure goal was 1.1 person Sv (110 person Rem) per unit. The actual US PWR collective dose in recent years was as follows:

1997	1.24 person Sv
1998	0.82 person Sv
1999	0.98 person Sv
2000	0.82 person Sv

Remote monitoring, cobalt-60 source term reduction, permanent work platforms, hot spot reduction & worker training are key initiatives for dose reduction at US PWRs. For comparison, the 1999 & 2000 worldwide average annual dose per reactor unit is provided in the table below:

Country/Region (# units)	**Collective dose per Reactor (person-Sv)** **1999**	**2000**
Finland (2)	0.68	1.13
France (54)	1.17	1.08
Germany (14)	1.23	1.13
Japan (23)	1.02	1.03
Spain (7)	0.71	0.59
Sweden (3)	0.43	0.43
United Kingdom (2)	0.66	0.46

DC COOK Nuclear Power Plant
2001 Dose Reduction 5 Year Plan

Date: June 28, 2001
Originator: Scott M. Griffin

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1. Executive Summary

This 5-year plan summarizes the existing programs for dose reduction. It also outlines exposure reduction activities to be implemented. Significant components among these activities are: installation of permanent shielding on the NRV/QRV walls, the removal of RTD lines, and the incorporation of PEX Resin into the CVCS beds. This document provides a vehicle to prioritize and direct these initiatives.

2. Introduction

DC Cook Nuclear Power Plant is committed to minimizing radiation exposure to meet PWR INPO first quartile performance and to be recognized as one of the superior radiation protection programs in the nuclear power industry.

The vision: DC Cook becomes a world class performer in nuclear power generation.

This vision will be realized through low collective dose to the workforce, low dose to the general public due to plant operations, low generation of radioactive waste, and a high degree of regulatory performance.

The 5-year dose reduction plan is the road map to superior ALARA performance. It will be periodically reviewed and revised as the station and industry demands change. On an annual basis, the ALARA Committee will review the results of the plan and recommend changes as warranted based on conditions and requirements present during that time period. This should occur prior to the start of the next calendar year.

3. Statement of Purpose

One of the fundamental principles of radiation protection is that radiation exposures be kept as low as reasonable achievable (ALARA). Furthermore, the Nuclear Regulatory Commission, the Institute of Nuclear Power Operations, American Nuclear Insurers, and others use cumulative radiation exposure as an indicator of nuclear plant performance. DC Cook is committed to maintaining collective radiation exposure among the lowest in the country.

The primary purpose of the DC Cook 5-year Dose Reduction Plan is to establish exposure reduction activities to be implemented which will help achieve dose reductions; projecting us into the first quartile of dose performers.

This will be accomplished through an aggressive approach to ALARA. Radiation sources will be reduced through filtration, flushing, system chemistry controls, decontamination, cobalt reduction, and eliminating certain high dose components. Where the source cannot be removed, temporary and permanent shielding will be used when dose effective. Reductions in collective outage dose will be realized through shorter and

more efficient outages. A highly trained and motivated work force, utilizing the latest technology, will make a significant contribution to lowering personnel radiation exposure during both outages and non-outage times.

This report also serves as a status report for on-going exposure reduction actions and as a summary of exposure reduction activities.

4. Plant Dose History and Projection (in person-rem)

Year	Cook Annual	Cook 3 year ave.	Cook delta to median	Industry Median	Cook delta To 1st Quartile	1st Quartile
1999	171	141/unit	+43	98	+63	78
2000	338	105/unit	+23	82	+56	49
2001	110	103/unit	+20	83	+56	47
2002	105	92/unit	+15	77	+47	45
2003	228	74/unit	+1	73	+30	44
2004	84	70/unit	+1	69	+28	42
2005	80	65/unit	0	65	+24	41

Shaded areas are forecasted numbers. 2003 Cook Annual dose includes refuel outages for both units and removal of RTD lines in both units.

The above table shows DC Cook's dose history and projections, and shows the gap we must bridge to reach median and upper quartile collective radiation dose values.

5. Administrative ALARA Program

ALARA Procedures

The two governing ALARA procedures, PMP 6010.ALA.001, ALARA Program – Review of Plant Work Activities, and PMP 6010.ALA.002, ALARA Committees were recently revised to increase their effectiveness. Enhancements included clarification of responsibilities, lowering the dose thresholds for reviews and the creation of three data sheets that strengthen our review of Design Change Packages, ALARA In-Progress reviews, and ALARA Suggestions. It also clarified management ownership of dose budgets and dose reduction, and included a section for source term reduction.

Exposure Limits

Minimizing exposure at the individual level is an essential part of reducing the collective site radiation exposure. It is our policy to not just maintain personnel exposures below regulatory and administrative limits, but to keep individual exposure ALARA. In an effort to maintain individual occupational exposures as low as reasonably achievable, a site administrative limit has been established to maintain personnel radiation exposure to <2000 mrem during any year. This limit also helps to encourage departments to equalize dose among their work force.

Training

Initial Radworker Training, and the annual Radworker requalification, stress ALARA awareness and the potential for changing or abnormal radiological conditions; including the actions required when these conditions occur. This training not only increases worker awareness of radiological conditions; it also reduces their dependence upon the radiation protection technicians in the field. Radiation Protection Department staff attend on and offsite training, seminars, and perform industry benchmarking to keep abreast of new developments in the industry and their impact on our site.

ALARA Committees

DC Cook has 2 ALARA Committees, the ALARA Committee and the ALARA Sub-Committee. The ALARA Committee is chaired by the Plant Manager and is composed of departmental Directors, Managers, and Superintendents. The ALARA Sub-Committee is chaired by the RP Supervisor – ALARA and has representatives from the different departments.

Cook Plant procedure PMP-6010.ALA.001, ALARA Program – Review of Plant Work Activities, requires jobs estimated at ≥1 person-rem TEDE to receive an ALARA Review by the ALARA Sub-Committee for establishment of techniques and requirements to maintain exposure ALARA. The ALARA Committee reviews all jobs estimated to be ≥5 person-rem TEDE.

Departmental Dose Reduction Plans

Departments that expect to receive greater than 100 mrem in any year are required to prepare a Dose Reduction Plan outlining the actions they intend to implement during that year to reduce the dose received by personnel in their department. The requirements for these plans are in the ALARA Procedure PMP-6010.ALA.001.

Shielding

To reduce personnel exposure, we install approximately 49,000 pounds of shielding (~25 shielding packages) during a typical refueling outage. The ALARA review/job planning process assesses the use of shielding for jobs during outage and nonoutage. Shielding materials include lead blankets, lead bricks, and water shields.

Hot Spot Tracking

Hot Spots are defined in the Hot Spot procedure, 12-THP-6010.RPP.013, as an accessible component having a contact dose rate ≥ 100 mr/hr and five times the general area dose rate at 30 cm.

Each identified Hot Spot is entered and tracked in the Hot Spot Tracking Log. The Hot Spot is assigned a survey frequency to monitor for changes in location or activity. A Cost/Benefit Work Sheet is also completed for every Hot Spot. If the work sheet shows that removal or flushing is cost beneficial, then a Work Order request is generated for its removal.

ALARA Cost Benefit Analysis

The current value associated to 1 person-rem of exposure is $18,154. This value is used to aid in justifying design changes, modifications, and other major expenditures. This figure was established in 1989 and was reevaluated again in 1995.

Benchmarking

Radiation Protection personnel maintain contact with their counterparts at other nuclear utilities to exchange information and ideas. Efforts are made to attend regular meetings such as the Region III Radiation Protection Managers, ISOE International ALARA Symposia, PWR/RP ALARA Committee, Health Physics Society, EPRI, INPO, NEI, and others. Information exchanged is used to continually improve and maintain knowledge of industry changes and innovations related to exposure reduction. Evaluation of new products such as robotic technology, computer surveys and remote monitoring are essential for continuing improvement in radiation protection.

eCAP Actions are used to track good practices from Benchmarking which merit evaluation for implementation. Some of the items implemented from past benchmarking include:

- The new ALARA Suggestion cards.
- Formalized guide for ALARA reviews of procedures and design changes.
- Radiological Risk Significance categories (A, B, or C) for RWPs.
- Changes to the ALARA procedure to perform "in-process" ALARA reviews for high dose / high risk significance jobs or projects.
- RP Turnover Sheet to use for days to gives to nights (front side) then nights gives back to days (back side of paper). Sections include: Posting Changes, Condition Reports Written, work summary, look ahead, relief required, and expectations for nightshift/dayshift.
- Radiological Pre-job plans (i.e. cavity decon)
- Re-established area supervisors and leads with adequate staffing.
- DOP testing of HEPA ventilation units and HEPA vacuums.
- Changes to High Radiation and Locked High Radiation area signs (new signs have a visual and dynamic difference).
- Reinstatement of outage handbooks (U2C13).

6. Source Term Reduction (STR)

Source Term refers to activity in piping or other plant components which, through various processes, can be removed. The removal of this source term results in lower exposure rates to radiation workers and to reduced "Dose to the Public."

STR to be implemented prior to U2C13:

1) Flushing of the RHR System – the RHR water will be flushed to the CVCS HUT using RCS pressure, prior to placing the RHR into service. This will reduce the increase in RCS activity normally seen during shutdown, because the RHR system will be at the same temperature and oxygen content as the RCS prior to being placed into service.

2) Reduced activity in the reactor cavity - Filling the reactor cavity using the RHR's Hot Leg injection point instead of the Cold Leg injection point will reduce the activity in the reactor cavity because the fill will not flow through the reactor core.
3) RCS Vacuum Fill and Vent – Reduces the RCS fill time by 6 hours and eliminates RCP sweeps which will reduce RCP seal wear and associated maintenance resulting in reduced dose.

Source Term Reduction Team

We have assembled a Source Term Reduction Team with members from RP, ALARA, Operations, Maintenance, Environmental, Chemistry, and Engineering to evaluate and prioritize source term reduction processes. Processes include hot spot removal, flushing, cobalt reduction and shutdown chemistry.

Cobalt Reduction

Particulate cobalt entering the RCS is activated as it passes through the reactor. Cobalt isotopes are the major contributors of exposure at the Cook Plant. Reduction of radioactive cobalt precursors, such stellite, in the primary system will result in decreased dose. As a matter of perspective, one gram of Co^{60} has a specific activity of >1000 curies.

The ALARA Group using the Data Sheet 3, ALARA Review form found in the ALARA procedure (PMP-6010.ALA.001), reviews plant modifications, including all Design Change Packages. Data Sheet 3 guides the reviewer to look for and eliminate stellite. Plant Engineering procedures and training also discuss reduction of cobalt bearing materials.

Some important contributions to cobalt reduction have already been accomplished. The steam generators in both units have been replaced with generators having lower cobalt content than the original design. Inconel fuel assembly grid spacers were replaced with zircaloy spacers in both units during refueling outages in 1990. A cobalt reduction program database that identifies cobalt-bearing valves in communication with the primary system was developed in 1992. Since the development of this database, valve replacements and valve replacement parts have been ordered cobalt free by the warehouse.

Chemistry Program Enhancements

Power Operations - Moving from a 'modified' RCS lithium program to a 'coordinated' program. The Chemistry Department is funding a system materials evaluation by Westinghouse that will allow higher coolant lithium concentrations at the beginning of each cycle. This change will allow lithium concentrations to be controlled at levels high enough to produce a constant pH throughout the cycle, minimizing early cycle corrosion product deposition on fuel surfaces and subsequent transport out of the reactor core.

Startup Chemistry - Continuing to follow a strategy to minimize time spent with acid reducing condition during RCS heatup. The aim of this strategy is to avoid creating a chemistry regimen that would de-stabilize core deposits and promote transport around the reactor coolant system.

Shutdown Chemistry - Revising reactor coolant de-lithiation practices to achieve acid conditions early in cooldown process. The coolant will be de-lithiated during the downpower at a rate that will result in an at-temperature pH of 6.5 at entry into Mode 3. Also, revising the RCS degas process to ensure that sufficient dissolved hydrogen is retained in the coolant to provide an adequate margin for maintaining corrosion products in a soluble form.

Foreign Material Exclusion Program

The Plant Manager Procedure for FME contains guidance on cleanliness when working on valve internals with emphasis on thorough cleaning to ensure no loose cobalt/stellite is left inside the valve that could later get into the reactor. The FME program also controls debris/foreign materials from entering plant system, which prevents that material from damaging the fuel, or other components.

7. Worker Productivity Enhancements

ALARA Work Planning

ALARA Job packages are used in pre-job planning and include lessons learned from past work. By reviewing past experiences, we can usually find ways to do the work more efficiently, reducing the overall personnel dose. The ALARA group breaks jobs into smaller activities to see where additional dose can be saved, if a mock-up would increase efficiency, or if other facilities have something helpful to share. ALARA dose goals and incentives are also used to motivate workers to work more efficiently.

ALARA In-progress and Post Job Reviews

The ALARA group performs in-progress reviews, at 50% and 80% of the estimated dose, of all jobs with an estimated dose budget greater than 1 Person-rem. Post-work reviews are also performed after these jobs are complete. These reviews are placed into the ALARA Job package for review and incorporation of lessons learned prior to performing the work again.

ALARA Suggestion Program

An individual or work group may submit suggestions to improve how a job is performed. Since the rebirth of the Suggestion/Incentive program, in early 2000, an average of 10 suggestions have been received per month. The estimated dose savings from these suggestions is 5 person-Rem, or ~$90,000 ($18k/person-Rem).

Initiation of an ALARA parking spot has helped to increase interest in the ALARA Suggestion Program. The parking spot is used to reward personnel who submit suggestions resulting in large dose savings.

Mock-ups

Mock-up activities are performed to help personnel become more efficient in their task and to identify areas needing improvement, especially new technologies or first time evolutions. By performing the task in a non-radiological environment, we can experiment with new ideas while becoming proficient with the job at hand. Examples of mock-ups which have aided in dose reduction include: RCP work, S/G activities, Reactor Vessel Support work/cleaning, filter change-outs, non-routine valve work, cutting and machining of RCS piping (SGRP), RCS pipe end decon (SGRP), Steam Generator girth cut (SGRP), moisture carry over testing, and many other new or unfamiliar tools, processes, and technologies.

Exposure Trending

Comparison of dose received for prior evolutions allows for challenging dose goals to be established. When the ALARA dose goal are met, ALARA incentives awards are often given in recognition of good ALARA work practices.

Contaminated Square Footage

Many areas of the plant that were once posted as contaminated areas have been decontaminated and are maintained as clean areas. This enhances access while reducing contaminated clothing and DAW generation. The plant enforces a clean as you go policy for all workers. Contaminated area square footage is tracked by the RP Department and is an indicator of radiological performance.

8. Effective Exposure Reduction Practices

Design Changes/System Enhancements

Design Change Packages are reviewed by the ALARA group, using the Data Sheet 3, DCP ALARA Review form in the ALARA Program procedure (PMP-6010.ALA.001). The Data Sheet 3 is a check-off list with 117 questions prompting the reviewer to look for exposure savings design criteria. The questions are divided into 12 sections, including shielding, source term reduction, contamination control, and system layout.

Remote monitoring

Remote monitoring is used to reduce the exposure of personnel performing inspections or walk-downs, and for RP technicians providing job coverage. The individual is able to remain in a low dose area while work is being performed in an area of greater radiological significance. Remote monitoring is used for various refueling, RCP, and Steam Generator activities. Radiation Protection also uses robotics (e.g. under water subs, and the scavenger) to save personnel dose.

Remote technology is an important tool for reducing personnel dose. Use of remote monitoring and robotics has greatly increased throughout the nuclear industry. Several actions to evaluate and implement additional remote technologies are listed in this 5 year plan.

9. Exposure Reduction Techniques being investigated for implementation 2001 – 2006 (within the next five years)

Project	Benefit	Owner	Due Date
Hot Spots			
Develop a matrix of current hot spots	Aid in identification of significant dose contribution due to hot spot(s)	S. Griffin	09/2001
Prioritized list of hot spots for removal	Aid in driving removal of hot spots	STR Team	10/2001
Flushing of hot spots (U2C13)	Reduces plant collective dose	S. Griffin Water HIT	10/2001
Shielding			
Installation of permanent shielding @ NRV/QRV walls	Save exposure from installation and removal in future outages.	L. Green ALARA	05/2003
Establish storage containers for shielding inside containment during power	Saves time and dose during temporary shielding installation and removal	L. Green ALARA	11/2003
Pre-approved installation specifications for temporary shielding	Save engineering time and decrease the time for installation – simplify the use of shielding	L. Green ALARA	11/2003
Installation of permanent shielding in the Regen and Excess Letdown Hx rooms	Saves exposure from installation and removal in future outages.	L. Green ALARA	12/2004

Source Term Reduction (STR)			
STR Team meetings	Members from RP, Maintenance, Operations, Chemistry, & Engineering help drive exposure reduction issues and take ownership of actions	S. Griffin	10/2001 & quarterly
Evaluation of new methods of chemistry control & shutdown, including Zinc addition and PRC-01 Resin	PRC-01 resin is reported to improve the RCS particulate removal and reduce loose contamination levels within the reactor coolant system.	D. Kozin Chem. HIT	10/2001 & as needed
Evaluate the 1992 Cobalt Reduction Program for replacement of valves with high cobalt content	Reduce the cobalt in the RCS	S. Griffin	01/2002
Reduced filter size to 0.2 micron in RCS filters during power operations	Reduces the amount of crud in the RCS, reducing the material available to become activated	D. Luther Chem. HIT	12/2001
DCP- Removal of RTD Lines	Reduce exposure for future outages	B. Story	10/2001
Others			
Storage of scaffolding in containment during power operations	Reduced time and exposure for scaffold installation and removal	T.Tillstrom	2003
Remote dose rate monitoring program for shutdown (w/reproducible monitoring locations)	Monitoring dose rates during shutdown to measure effects of RCS shutdown chemistry	S. Griffin	TBD
Develop remote video monitoring program	Save dose for operations and fire watch tours	S. Griffin	10/2001
DCP – 4 Bolt modification for Blind Flange	Save time and dose in lower Cavity	TBD	08/2002
Mock-up facility in the Training building	Increase worker efficiency, reducing dose	TBD	TBD
Continue to reduce the contaminated square footage	Reduces contaminated clothing and DAW generation	RP Production	TBD
Permanent primary S/G platforms	Eliminate the time and dose associated with scaffold erection @ the S/G platforms	K.Worthington	2003