Title: Health Effects and Life-Shortening from the Uranium and Coal Fuel Cycles, Task B

Lead Responsibility: Division of Site Safety and Environmental Analysis

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1. Problem Description

Current practice in health impact assessments is to convert radiation exposure estimates into estimates of health effects, such as cancer deaths, illness, and life-shortening. However, the models presently being used, such as those in WASH-1400, GESMO, current NRC case related testimony, and EPA assessments, all suffer from similar weaknesses. A major common weakness, which appears amenable to solution, is related to the correct treatment of competing risks among populations with life expectancies, age, and sex distributions that vary with time. Since the staff is currently attempting to assess health effects in the future (e.g., Year 2000 and beyond), it is reasonable to expect significant changes in current population statistics. To make such an assessment, a demographic model is required which extrapolates the current population into the future, correctly allowing for competing risks of mortality from various causes (e.g., accidents, heart disease, and cancer). Failure to do so results, for example, in hypothetical cancer deaths for people who would statistically die from other causes. In the absence of better predictive models, it is not possible to even evaluate the uncertainty associated with the use of the current simplified methods for estimating health effects and consequent life-shortening. Uncertainties in the use of current models are greatly magnified when attempting to make comparisons of health effects for the coal and nuclear fuel cycles.

Current health effects models generally are used for estimating long-term impacts. Chronic exposure may be the primary determinant of the number of deaths for a given period for a given pollutant. However, in the case of non-radiological pollutants from the coal fuel cycle, short-term fluctuations leading to acute exposures may determine the time of death and consequent life-shortening. Current evaluations of the coal fuel cycle generally fail to account for short-term mortality, disease and illness. In addition, short-term effects from chemical pollutants are generally dependent on the prior history of chronic (long-term) exposure.

Current models generally assume linear dose-response relationships even when evidence exists for real or practical thresholds, or where experimental data support a non-linear dose response relationship.

2. Plan for Problem Resolution

a. Currently, Argonne National Laboratory is developing a preliminary model for estimating radiological effects using NRR Technical Assistance Contract funding. This model will permit estimates of health effects and life-shortening for facilities of the uranium fuel cycle. It will combine basic dose-effect models (e.g., the recommendations of the NAS Committee on the Biological Effects of Ionizing Radiation--BEIR) with demographic models which will correctly allow for competing risks in the exposed population.

The staff plans on funding ANL to extend this work and that already completed by ANL on health effects of the coal fuel cycle (NUREG-0252, "The Environmental Effects of Using Coal for Generating Electricity," June, 1977). ANL has also done some preliminary work in certain areas related to projecting health effects from coal combustion for ERDA/AES.

The major steps in this plan are outlined below:

Stage 1

Resolution of problems related to demography (FY 78). Specifically, outputs of the model at this stage would include: a) a life table analysis of mortality needed to derive the statistics necessary to calculate risks to specific age groups and individuals; b) a projection of the living population exposed to the pollutant considered with no migration from the area considered; c) a projection of the deaths, by age and sex, which can be expected in each 5-year interval during the time span covered by the projection.

Stage 2

Definition and development of dose-response functions for both the coal and nuclear fuel cycle (FY 78).

Stage 3

Time-dependent dose-response functions will be developed, and linear dose-response functions developed in Stages 1 and 2 will be modified as appropriate to make the functions dependent on the time elapsed since first exposure (FY 78).

Stage 4

Development of non-linear dose response function (FY 78 and FY 79); primarily for coal fuel cycle pollutants, but also non-linear radiation dose-response function.

Stage 5

Development of morbidity models to account for the fact that protracted periods of illness normally are followed by recovery or death. This will permit estimates of man-days of work lost, and associated medical expenses (FY 78 and FY 79).

Stage 6

Superposition of short-term effect models on long-term effect models (FY 79). This final effort will fuse models for short-term and long-term health effects. This model will appropriately consider the prevalence and mean severity of illness in the population including those induced by long-term exposure to specific environmental pollutants.

b. End Products of the Task:

A comprehensive, technically defensible package of computer codes which will enable more precise estimates of health risks from the nuclear and coal fuel cycles than has heretofore been possible. It will permit estimates for individuals (as a member of specific age groups, sex, etc.) and populations with acute or chronic exposure conditions, following pre-existing exposures to various pollutants, including radiation.

3. NRR Technical Organizations Involved:

a. Radiological Assessment Branch, DSE

Task Manager will serve in the principal technical management function for the task. The Task Manager will have the primary responsibility for maintaining coordination, assuring task

coordination, assuring task progress and general monitoring of the task effort at Argonne National Laboratory and within NRR.

	FY 78	FY 79
Estimated manpower:	3 man-months	2 man-months

b. Environmental Projects Branch 1, DSE

Will provide technical review of ANL work.

	FY 78	FY 79
Estimated manpower:	0.5 man-months	0.5 man-months

c. Cost Benefit Analysis Branch, DSE

Will provide technical review of ANL work.

	FY 78	FY 79
Estimated manpower:	0.5 man-months	0.5 man-months

d. Environmental Evaluation Branch, DOR

Will provide technical review of ANL work.

	FY 78	FY 79
Estimated manpower:	0.5 man-months	0.5 man-months

4. Technical Assistance Requirements

Research funds were originally requested for the FY 78 and FY 79 ANL effort as part of TAP A-20, Impacts of the Coal Fuel Cycle (see SAFER letter from E. G. Case to S. Levine, dated August 4, 1977).

The funding level and man-power requirements supported by RE will be:

FY 78		FY 79	
man-months	$K	man-months	$K
18	100	18	100

5. Interactions with Outside Organizations:

Interactions with outside organizations will be primarily with the Department of Energy, and the Environmental Protection Agency. This stems from a common need for assessing health risks from the coal and nuclear fuel cycles. These agencies will be kept informed of the ANL progress and be asked to provide technical comments as the work progresses.

6. Assistance Requirements from Other NRC Offices:

Technical assistance outside NRR will be supplied by:

a. Health and Environmental Research Branch, Office of Nuclear Regulatory Research

Will direct work at Argonne National Laboratory in conjunction with NRR Task Manager. This effort is expected to involve approximately 2 man-months of contract administrator time and 36 man-months of laboratory effort (18 per year) over a period of 2 years.

b. Environmental Standards Branch, Office of Standards Development

Will provide technical assistance and review of ANL work.

	FY 78	FY 79
Estimated manpower:	1.0 man-month	0.5 man-months

c. Occupational Health Standards Branch, Office of Standards Development

Will provide technical assistance and review of ANL work.

	FY 78	FY 79
Estimated manpower:	1.0 man-months	0.5 man-months

7. Schedule for Problem Resolution:

Major milestones and approximate times for completion of the described work are shown below following approval by the Technical Activities Steering Committee.

Task Description:	Time in Months
a. Committee approval of TAP	0
b. Stage 1 - demographic model	2-3
c. Stage 2 - dose-response functions	10-12
d. Stage 3 - time dependent functions	12-15
e. Stage 4 - non-linear dose response	12-18
f. Stage 5 - morbidity models	15-20
g. Stage 6 - short-term effects models	24

8. Potential Problems

Since some of the development of models and functions represents new concepts and applications, it is possible some of the stages may take longer to accomplish than envisioned. In addition, it is possible that a few aspects of the study may prove intractable to satisfactory technical solutions, such as development of non-linear dose response functions for all types of pollutants in both fuel cycles.