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FOREIGN TRIP REPORT

ORNL/FTR-3567

DATE: April 6, 1990

SUBJECT: Report of Foreign Travel of George Kerr of the Health and Safety Research Division

TO: Alvin W. Trivelpiece

FROM: George Kerr

PURPOSE: To visit the Radiation Effects Research Foundation in Hiroshima, Japan, to begin work on a manual for the new dosimetry system (DS86).

SITES VISITED: 3/9-28/90 RERF, Hiroshima, Japan J.W. Thiessen

ABSTRACT: The traveler visited the Radiation Effects Research Foundation (RERF) from March 9 to March 28, 1990. The purpose of this visit was to begin preparation of a report that describes the application of a new dosimetry system (DS86) to individual A-bomb survivors. Such a report is vital to future work of both national and international committees dealing with the health risks of radiation exposure. The traveler, who recently spent a year working at RERF in Hiroshima, will prepare this report in collaboration with the RERF staff. The funding for preparation of this report is being provided by RERF through contract ERD-88-813 with Martin Marietta Energy Systems, Inc.

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VISIT TO RADIATION EFFECTS RESEARCH FOUNDATION (RERF) HIROSHIMA, JAPAN

The traveler visited the RERF, Hiroshima, Japan, from March 9 through March 28, 1990 (see Appendix A). The purpose of this visit was to establish a format for an implementation manual on the Dosimetry System 1986 (DS86) and to obtain updated data on the DS86 assignments for populations of survivors in major study samples of RERF (Kerr 1988). The funding for preparation of the manual is being provided by RERF through contract ERD-88-813 with Martin Marietta Energy Systems, Inc.

A final two-volume report has been published that discusses the physical basis for the DS86 system (RERF 1987, 1988). To be useful in risk assessment, however, the DS86 system must be individualized (i.e., applied to the assertions of particular survivors as to their whereabouts at the time of bombing). The newer DS86 estimates replace the so-called Tentative 1965 Dose (or T65D) estimates for individual survivors which served as a basis for risk assessment throughout the 1970s (Kato *et al.* 1988, Shimizu *et al.* 1987, Preston and Pierce 1987).

DS86 MASTER TAPE

The DS86 Master Tape includes information on 141,635 persons who have a T65D estimate and are either members or parents of offspring of major study samples at RERF (Thiessen 1988). Currently, there are three DS86 Master Tapes -- Version 1 dated March 25, 1987, Version 2 dated April 15, 1988, and Version 3 dated July 3, 1989 (Thiessen 1989). Version 1 of the DS86 Master has been discussed by Preston and Pierce (1987) and Kerr (1989), and Version 2 has been discussed by Shimizu *et al.* (1987) and Kato *et al.* (1989). The latest DS86 estimates from Version 3 of this tape will be used in the preparation of the *DS86 Implementation Manual.*

The modifications incorporated in Version 2 pertained only to DS86 organ-dose estimates and affect the following (Kerr 1987):

1. Breast, ovary, and uterus for female adults (over age 11 years at time of bombing and only those in a standing or prone position).

2. All organ doses for infants (those whose ages were coded as 0 at the time of bombing were assigned adult organ doses by mistake).

Due to the above modifications, it was also necessary to recalculate organ doses for those survivors with indirect DS86 estimates based on average organ-dose factors (and average house-transmission factors).

Version 3 provides DS86 estimates (kerma and organ doses) for an additional 11,120 survivors. The DS86 cohorts for the two cities are now comparable and the changes are as follows:

1. New estimates for 10,034 survivors who were in the open at more than 2500 m from the hypocenters (7452 survivors in Hiroshima and 2582 survivors in Nagasaki).

2. New estimates for 361 Nagasaki survivors who were shielded by hills or other terrain features.

3. New estimates for 815 Nagasaki survivors who were shielded in factory buildings.

Thus, Version 3 reduces significantly the number of unknown DS86 cases in both cities (Kerr 1987), and the newer DS86 estimates for Nagasaki factory workers are in higher dose ranges that are extremely important in risk assessment (Kerr 1989).

The data on Version 3 of the DS86 Master Tape are currently being analyzed as follows:

1. Study sample by city [Life Span Study (LSS), Adult Health Study, In-Utero Mortality Sample, and First-Generation Mortality Sample].

2. Shielding category by city (in open, shielded in house, outside shielded by house, shielded by terrain, and shielded in factory).

3. Availability of DS86 and T65D estimates and differences between these estimates by city, shielding category, and study sample.

The data will be summarized in the *DS86 Implementation Manual* using both tables and graphs.

RANDOM ERRORS

An analysis of the uncertainty and bias in the DS86 methodology of dose estimation for individual survivors was published recently by Kaul and Egbert (1989). The uncertainty in survivor locations and shielding histories were considered to be the greatest sources of random error in the dose assignments for either members or parents of offspring in the major study samples at RERF. The magnitude of the random errors in the DS86 estimates were estimated to range from about 20 to 40 percent (i.e., about 20 percent for exposure in the open, 30 percent for shielding in a house, and 40 percent for outside exposure shielded by a house).

Analyses of the random errors in the DS86 estimates also were made using data on chromosome aberrations (CA) and severe epilation (Sposto *et al.* 1990). These analyses have indicated random errors in the DS86 estimates of about 45 percent based on severe epilation and 45 to 55 percent based on the proportion of cells with CA in cultured blood lymphocytes from the populations of LSS survivors in Hiroshima and Nagasaki. Random errors of these magnitudes result only in an underestimation of about 10 to 15 percent in the dose response (or the risk coefficient) for cancer mortality (Pierce *et al.* 1989).

An analysis also has been made of the random errors in the DS86 estimates for Nagasaki factory workers using CA in cultured blood lymphocytes, severe epilation, and cancer mortality (Preston *et al.* 1989). With the exception of leukemia, which was not reliable because of the small number of cases, the findings were very consistent for nonleukemic cancer and other effects. The ratio of the dose response (or risk coefficients) for factory workers compared to that for other LSS survivors were 0.3, 0.6, and 0.5 for severe epilation, CA, and nonleukemic cancers, respectively (Preston *et al.* 1989).

The above results taken together suggest that there may be something wrong with the newer DS86 estimates for factory workers in Nagasaki. It can be concluded, for example, that either the DS86 dose estimates are too large for this group or the individual dose estimates have more variation than those for survivors in other shielding situations, particularly survivors inside houses. It is also possible that both factors are contributing to the differences. Hence, it has been suggested that additional shielding calculations are needed for Nagasaki factory buildings using ORNL's newly developed TORT computer code (Rhoades *et al.* 1989).

SUMMARY AND DISCUSSION

A study has also been completed of cobalt activation in samples from two new locations in Hiroshima (Kerr *et al.* 1990). The samples consisted of pieces of steel from a bridge at a distance of about 1300 m from the hypocenter and a building located at approximately 700 m. Close agreement was found between calculated and measured values for cobalt activation of the steel sample from the building at 700 m. It was found, however, that the measured values for the bridge sample at 1300 m were approximately twice the calculated values. Thus, the new results confirm the existence of a systematic error in the DS86 transport calculations for the neutrons from the Hiroshima bomb (Kaul and Egbert 1989).

It is obvious that much work remains to be done to resolve the above-mentioned systematic and random errors in DS86. Nevertheless, it is now possible to write a detailed report on the application of DS86 to almost all of the survivors in the major study samples of RERF. Such a report is vital to future work of both national and international committees and to users of the studies, e.g. the Department of Energy, dealing with the health risks of radiation exposure. The performance period for the preparation of the report will be one year. A draft of *DS86 Implementation Manual* will be submitted to RERF for review within the next six months. Time required for preparation of a final draft report will depend on the effort required to address reviewer's comments, but will not exceed an additional six months.

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APPENDIX A

Itinerary

March 7-8, 1990	Travel from Knoxville, Tennessee, to Hiroshima, Japan
March 9-28, 1990	RERF, Hiroshima, Japan
March 29, 1990	Travel from Hiroshima, Japan, to Knoxville, Tennessee

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