Publication of New Atomic Bomb Radiation Dosimetry System

On February 27, 2006, the Radiation Effects Research Foundation (RERF) announced the publication of a 2-volume book commonly known as "DS02," with the official title of "Reassessment of the Atomic Bomb Radiation Dosimetry for Hiroshima and Nagasaki – Dosimetry System 2002, after more than five years of research and writing and many months of editorial work and document preparation. Dr. Toshiteru Okubo took the opportunity at the publication press conference to express deep respect and heartfelt appreciation to all people involved in the reassessment work as well as to the U.S. Department of Energy and the Ministry of Health, Labour, and Welfare of Japan, both of which supported the work.

RERF has been conducting studies of long-term health effects on A-bomb survivors. To determine whether health effects are caused by radiation exposure, first it is necessary to determine the radiation dose to the various organs of each survivor. The dosimetry system provides information on the dose. The radiation protection community throughout the world depends on the estimates of risk from exposure to radiation defined by the epidemiological studies conducted at RERF, and those estimates of risk depend on the accuracy with which the radiation doses are determined.

After the previous dosimetry system (DS86) began to be used at RERF, it was pointed out that some of the calculations did not match the neutron activation measured in samples of materials in Hiroshima, especially beyond 1.5 km from the hypocenter. In an effort to resolve this discrepancy, various studies were initiated both in the United States and Japan. In December 2000, the U.S. and Japanese governments convened a meeting of experts to discuss a unified approach to resolve the neutron discrepancy. At that meeting it was decided to establish a Joint U.S.-Japan Working Group to reassess the A-bomb dosimetry. The Japanese chair of this Working Group was Dr. Hiromi Hasai and the U.S. chair was Dr. Robert W. Young. The independent working group was extremely active, holding eight meetings until January 2003, during which the Joint Working Group reached specific conclusions. Then, in January 2003, the U.S. and Japanese governments established a Joint Senior Review Group, composed of four members from each country (Japanese chair: Dr. Wataru Mori, U.S. chair: Dr. Warren K. Sinclair), which approved the findings and recommendations of the Joint Working Group. On 15 March 2003, DS02 was established as a new dosimetry system to replace DS86. DS02: A New Dosimetry System for A-Bomb Survivor Studies (36KB)

The new DS02 dosimetry system was approved after a 3-year investigation by experts based on voluminous data. Since then, the many scientists who contributed to DS02 have finished the documentation of their work for this report; the Working Group has examined several issues to insure that there were no outstanding problems with the DS02 dosimetry; the chairmen have summarized the history and basis of the DS02 dosimetry system reassessment for the general public; and the entire report has been edited for technical accuracy and consistency.

The years of work of the Joint Working Groups ended with the completion of the DS02 Report written by the members of the Joint Working Group and edited by Dr. Robert Young and Dr. George Kerr. Then, RERF carried out the formidable task of formatting, assembling, and publishing the report. The complete DS02 report is available on the RERF website at http://www.rerf.or.jp/shared/ds02/index.htm.

The DOE Office of Environment, Safety and Health has recognized the outstanding work of the editors, Dr. Young and Dr. Kerr, and the other members of the U.S. Working Group (Robert Christy, Harry Cullings, Stephen Egbert, Alexandra Heath, Dean Kaul, Tore Straume, Paul Whalen, Stephen White, and Robert Santoro (posthumously) with Special Achievement Awards. DOE is grateful to all who have contributed to this endeavor.

Comparison between DS86 and DS02 does reveal many small improvements. Generally speaking, however, DS86 estimates are not very different from DS02 estimates and have proved to be mostly correct.

Due to recent advances in computer technology, DS02 allows more complicated and detailed calculations than DS86 did, as well as detailed simulations of the atomic bomb explosions and of the radiation's release and dispersal. Many improvements have been made, including dose estimates, with consideration paid to the more detailed shielding conditions of individual survivors, which has resulted in greatly improved accuracy of the radiation dose estimates.

The discrepancies between neutron calculations and actual measurements beyond 1.5 km from the hypocenter in Hiroshima, the circumstance that triggered the review of DS86, have been resolved. The discrepancies between neutron calculations and activation measurements at less than 0.5 km from the hypocenter in Hiroshima were resolved when the burst height was raised by 20 m. Thanks to significant improvements in accuracy of the measurements, neutron measurements up to 1.5 km from the hypocenter closely correspond with DS02 calculations. Beyond 1.5 km from the hypocenter, measurements become too uncertain to be used to verify the radiation calculations. Because the calculations are carried out in exactly the same manner at all distances and those calculations now match the measurements at all distances where the measurements are considered reliable, there is confidence that the DS02 calculations accurately compute the dose to survivors at all distances from the detonations.

Specific changes arising from use of the new system for Hiroshima and Nagasaki include:

1. Yield of the bombs and height of burst: In Hiroshima, the yield of the bomb was increased by 1 kiloton. The estimate of burst height in Hiroshima was raised from 580 m to 600 m above the ground.
2. Hypocenters: In previous studies, hypocenter locations were determined on maps created by the U.S. Army based on aerial photos. Hypocenter locations used for DS86 were determined by transfer from the old maps to

new maps created in Japan based on certain landmarks on the ground. More detailed reviews based on DS02 indicated the need for a revision of hypocenter location. The hypocenters were therefore moved 15 m (14.7 m) to the west in Hiroshima and 2 m (2.5 m) to the west in Nagasaki.

3. Radiation doses: In Hiroshima, gamma doses increased by as much as 10% beyond 500 m. Neutron doses increased 15% at 1 km, then decreased slightly beyond 2 km. In Nagasaki, gamma doses increased by about 10%. Neutron doses were slightly reduced beginning at the hypocenter, and were continually reduced with distance, so that the neutron doses are decreased by 30% at 2 km from the hypocenter.
4. Shielding: Improvements concerning shielding in DS02 include: 1) Improvements in shielding calculation by incorporating terrain features (Hijiyama in Hiroshima and Konpirasan in Nagasaki) that were not adequately considered in DS86; 2) Subdivision of a category of frontal shielding that was not adequately taken into consideration in the evaluation of shielding by wooden houses; and 3) Buildings with large rooms, like schools, have much less shielding and are now calculated with a 30% increased dose; 4) Buildings using a “globe” shielding which had very large uncertainties in DS86 are now more accurately calculated; and 5) More detailed calculation of shielding in factories in Nagasaki. Due to these improvements, the reliability of shielding calculations has increased.