

# LOW LEVEL INTERNAL DOSE SCREEN—CONUS TESTS

## Nuclear Test Personnel Review

Science Applications International Corporation  
P.O. Box 1303  
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22 December 1986

Technical Report

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| <p>A methodology is developed whereby DoD participants in the atmospheric nuclear tests program are screened to determine whether they received an internal radiation dose commitment less than a selected threshold. The methodology is based on the external gamma dose that the participant received from the source that concurrently provided the radioactive material to be inhaled. Algorithms are developed to relate the internal dose commitment to external dose parameters. The methodology is used to identify those participants by unit or project number who received a 50-year bone dose commitment of less than 150 millirem. Most participants in the continental testing received less than this screen threshold.</p> |       |   |   |   |
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## **SECTION 1**

### **INTRODUCTION AND SUMMARY**

From 1945 through 1962, the Atomic Energy Commission tested more than 250 nuclear weapons/devices primarily at sites in Nevada and in the Pacific Ocean. Over 200,000 Department of Defense (DoD) personnel were involved in these tests. As a result of concern over alleged adverse health effects resulting from exposure to ionizing radiation among these participants, the DoD initiated the Nuclear Test Personnel Review (NTPR) program in 1977. One of the objectives of this program is to compile a roster of all DoD personnel involved in these tests and to ascertain the radiation doses they received.

Considerable progress has been made in the effort to identify the test participants and determine their doses; however, data gaps still exist. It was standard practice to issue film badges to all test participants or representative members of groups to measure their "external" radiation (primarily gamma) doses. Much film badge dosimetry data has been located and entered into the NTPR data base. Only a few assessments (e.g. Reference 7) have been made to determine "internal" doses resulting from intake of radioactive material. Therefore, such doses must be calculated to supplement external dose information in the data base.

Detailed calculation of the internal dose for each test participant would be an overwhelming task; therefore, a method is needed to quickly screen groups of participants who were exposed to similar radiological conditions and eliminate those who most likely did not receive a significant internal dose. This report describes such a method for the pertinent exposure pathways and lists those participants (by project or unit) who did not receive a dose greater than a specified screen threshold. This method allows for rapid reassessment of internal dose level should additional information surface as to participant activities.

For purposes of this report, a committed dose equivalent (50-year) of 150 millirem to the bone is used for the screen threshold. This dose is 1 percent of radiation protection guideline (annual limit) for occupational exposure currently

recommended by the National Council on Radiation Protection and Measurements (NCRP). The choice of bone as the indicator organ is reasonable because, according to NCRP Report 39, "bone has a unique position as a limiting organ because of the experience with radium depositions and the fact that many radionuclides give a much higher dose to the skeleton than to other body parts." Radium is the longest studied of the "bone-seekers," which include many nuclear fuel and fission product radionuclides. Had red bone marrow, the critical organ for leukemia induction, been selected as the indicator organ, the results would be essentially the same. The composite bone dose conversion factor (rem per microcurie inhaled) based on data presented in Reference 1 is slightly higher than the composite red marrow factor based on Reference 2.

This report addresses DoD participation in the atmospheric nuclear tests conducted within the continental United States (CONUS) at the Nevada Test Site (NTS), and in New Mexico. The oceanic tests that occurred principally at the Pacific Proving Ground (PPG) will be covered in a subsequent report. A distinction between the continental and oceanic tests is that residence ships and islands in the PPG were sometimes subjected to fallout. Therefore, the PPG assessments consider the "chronic" exposures due to residence in contaminated areas as well as the "acute" exposures that resulted from activities on contaminated shot islands and target ships. Since foodstuffs could be contaminated from fallout on the residence islands/ships, both ingestion and inhalation pathways must be considered in the oceanic internal dose assessments. In contrast, the residence areas of the NTS were virtually free of contamination, and eating was prohibited in contaminated test areas; therefore, this report considers only the inhalation pathway. If exceptions to the eating prohibition are noted, the analysis must be augmented.

The results contained in this report are summarized as follows:

- Most DoD participants in continental nuclear testing received a 50-year bone dose commitment less than the screen threshold of 150 mrem.
- Airbursts provided the least potential for internal dose, followed by tower shots.



- Participants at near-surface and shallow underground bursts who encountered the high concentration of contaminants in the shot area may have received bone dose commitments greater than the screen threshold.
- Almost all activities conducted in the radiation fields of very low yield bursts resulted in a potential for internal dose in excess of the screen threshold.

## SECTION 2

### METHODOLOGY

#### 2.1 INTRODUCTION.

Few body burden measurements, bioassays, or air sampling data are available to calculate the committed dose equivalent (hereafter termed "dose commitment") to specific body organs resulting from inhaled radioactive material. Therefore, an indirect approach is necessary. Usually, the only indicators of the radiological environment to which test participants were exposed are gamma radiation intensities as measured by a survey meter or integrated external doses determined from film badges. Fortunately, such measurements can be related to an airborne activity concentration of radioactive material that can be used to calculate an internal organ dose commitment using the following equation:

$$D = AA \times BR \times T \times DF \quad (1)$$

where:

|    |   |  |
|----|---|--|
| D  | = | 50-year internal dose commitment (rem) to the organ                          |
| AA | = | Airborne activity concentration (Ci/m <sup>3</sup> ) of radioactive material |
| BR | = | Breathing rate (m <sup>3</sup> /hr)  |
| T  | = | Duration of exposure (hr)  |
| DF | = | Inhalation Dose Conversion Factor* (rem/Ci) for the organ.                   |

There are three basic scenarios for the inhalation of radioactive material by nuclear test personnel:

- Inhalation of fallout particles that were deposited on the ground or other surfaces and resuspended by mechanical or natural disturbances.
- Inhalation of neutron-induced radioactivity in the soil (or other material) that had been lofted into the air by mechanical or natural disturbances.

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\*Dose conversion factors have been published to convert the intake of various radionuclides to a 50-year dose commitment to specific body organs. The particle size and the chemical and metabolic properties of the specific radionuclide are considered in the calculation of inhalation dose factors (References 1 and 2).

- Inhalation of radioactive material contained in the nuclear cloud or descending fallout. Obviously the former case would be limited to aircrews who flew through the cloud.

## 2.2 INHALATION OF RESUSPENDED FALLOUT.

In the case of inhalation of resuspended fallout, the airborne concentration of radioactive material is calculated through the application of a resuspension factor,  $K(m^{-1})$  which correlates the airborne activity concentration,  $AA (Ci/m^3)$ , to the amount of radioactive material on the ground or other surface,  $SA (Ci/m^2)$ , under a given set of conditions. The surface activity (SA) is not directly measured; however, it can be related to a gamma radiation intensity,  $I (R/hr)$ , measured at a given distance (1 meter) above the surface. The ratio  $SA/I (Ci/m^2 \text{ per } R/hr)$  is a function of the gamma energy spectrum of the time-dependent mixture of radionuclides on the surface. Substituting these relationships into the basic equation (Equation 1) for calculating organ dose commitments and generalizing to mixed nuclear debris yields the following equation:

$$D = I \times \frac{SA}{I}(t) \times K \times BR \times T \times DF(t) \quad (2)$$

where:

|                   |   |  |
|-------------------|---|--|
| D                 | = | Fifty-year dose commitment to the organ (rem)  |
| I                 | = | Gamma radiation intensity (R/hr)   |
| $\frac{SA}{I}(t)$ | = | Surface activity--intensity ratio ( $Ci/m^2 \text{ per } R/hr$ )*  |
| K                 | = | Resuspension factor ( $Ci/m^3 \text{ per } Ci/m^2$ , or $m^{-1}$ )   |
| BR                | = | Breathing rate ( $m^3/hr$ )  |
| T                 | = | Duration of exposure (hr)  |
| DF(t)             | = | Activity-weighted average (composite) dose conversion factor for the organ for the mixture of radionuclides in the fallout (rem/Ci)* |
| t                 | = | Time after detonation of exposure (hr).  |

Equation (3) relates the product of the free-field gamma radiation intensity (I) and the duration of exposure (T) to a time integrated dose ( $D_{FB}$ ) in roentgens (or rem)

---

\*Note that, while the quantities  $SA/I$  and  $DF$  are independent of radiation levels, they are functions of time after detonation because of the changing radionuclide inventory due to radiological decay.

that should be indicated by a film badge worn by a person standing in a uniform fallout field (Reference 3).

$$D_{FB} = 0.7 \times I \times T \quad (3)$$

Therefore, the internal dose commitment to a particular organ can be related to the external film badge dose an individual receives at the same time from the same source.

Equations (2) and (3) are combined to calculate the external film badge dose that is equivalent to an internal bone dose commitment of 150 millirem as follows:

$$D_{FB} = \frac{0.150 \times 0.7}{\frac{SA}{I}(t) \times K \times BR \times DF(t)} \quad (4)$$

If the film badge dose, calculated using values for breathing rate, resuspension factor, and time after the detonation that can be related to the various activities performed by nuclear test participant, is more than the known or upper limit external dose received by a category of participants, the corresponding internal bone dose commitment is less than 150 millirem.

Due to the complexity of the calculation, in particular the determination of values for the time dependent parameters SA/I and DF, the computer code FIIDOS (Reference 4) is used for this task. The code considers the production and radiological decay of all radionuclides (fission products, neutron activation products, and actinide elements including unfissioned nuclear fuel) present in unfractionated fallout. Values of SA/I\* and DF\*\* are shown in table 1 for the three principal fission reactions--fast\*\*\* neutron fission of U-235 and Pu-239, and 14 MeV neutron fission of U-238. The tabulated values pertain only to the fission product radionuclides. Contributions of other radionuclides vary with the design and efficiency of individual nuclear devices and surrounding materials (such as shot tower cabs). If the activities of non-fission

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\*Surface is modeled to approximate empirical ground roughness factor of 0.7 for desert terrain.

\*\*Composite bone dose conversion factor for aerosol (oxide clearance classification) having an Activity Median Aerodynamic Diameter (AMAD) of 1.0  $\mu$ m.

\*\*\*Unmoderated fission neutron spectrum.

product radionuclides are known or estimable, these may be used to augment the fission product information below. Only if present in great activity could other radionuclides significantly perturb the tabulated values of SA/I. However, certain radionuclides may influence the aggregate DF far out of proportion to their activity.

Table 1. Surface activity to radiation intensity ratios and composite bone dose factors for fission products from selected fission reactions.

| TIME AFTER<br>DETONATION | SA/I (Ci/m <sup>2</sup> per R/hr) |         |         | DF (rem/Ci) |         |         |
|--------------------------|-----------------------------------|---------|---------|-------------|---------|---------|
|                          | U-235                             | U-238   | Pu-239  | U-235       | U-238   | Pu-239  |
|                          | FAST                              | 14MeV   | FAST    | FAST        | 14MeV   | FAST    |
|                          | NEUTRON                           | NEUTRON | NEUTRON | NEUTRON     | NEUTRON | NEUTRON |
| 3 Min                    | 0.100                             | 0.100   | 0.117   | 3.86        | 3.20    | 3.20    |
| 9 Min                    | 0.095                             | 0.089   | 0.095   | 8.22        | 7.18    | 6.91    |
| 30 Min                   | 0.083                             | 0.078   | 0.081   | 18.4        | 16.3    | 14.6    |
| 1 Hr                     | 0.069                             | 0.067   | 0.067   | 34.6        | 30.8    | 27.8    |
| 2 Hr                     | 0.065                             | 0.063   | 0.064   | 68.6        | 62.0    | 56.2    |
| 4 Hr                     | 0.085                             | 0.082   | 0.085   | 125         | 113     | 101     |
| 6 Hr                     | 0.112                             | 0.109   | 0.113   | 169         | 148     | 133     |
| 9 Hr                     | 0.139                             | 0.137   | 0.139   | 222         | 189     | 170     |
| 12 Hr                    | 0.150                             | 0.149   | 0.151   | 269         | 226     | 201     |
| 18 Hr                    | 0.154                             | 0.157   | 0.160   | 367         | 301     | 263     |
| 1 Day                    | 0.155                             | 0.161   | 0.164   | 471         | 375     | 323     |
| 2 Day                    | 0.158                             | 0.166   | 0.169   | 907         | 669     | 556     |
| 3 Day                    | 0.155                             | 0.162   | 0.163   | 1350        | 963     | 785     |
| 4 Day                    | 0.151                             | 0.157   | 0.156   | 1770        | 1250    | 1020    |
| 5 Day                    | 0.147                             | 0.153   | 0.152   | 2170        | 1530    | 1240    |
| 6 Day                    | 0.145                             | 0.151   | 0.147   | 2540        | 1790    | 1450    |
| 7 Day                    | 0.143                             | 0.148   | 0.145   | 2910        | 2050    | 1650    |
| 10 Day                   | 0.142                             | 0.148   | 0.141   | 3890        | 2810    | 2240    |
| 14 Day                   | 0.147                             | 0.154   | 0.146   | 5050        | 3740    | 2890    |
| 21 Day                   | 0.161                             | 0.168   | 0.159   | 6640        | 5090    | 3750    |
| 1 Mon                    | 0.179                             | 0.185   | 0.176   | 8250        | 6430    | 4540    |
| 2 Mon                    | 0.225                             | 0.227   | 0.221   | 12500       | 9700    | 6620    |
| 3 Mon                    | 0.240                             | 0.243   | 0.241   | 15800       | 12000   | 8290    |
| 4 Mon                    | 0.240                             | 0.244   | 0.245   | 18600       | 14000   | 9810    |
| 1 Yr                     | 0.415                             | 0.422   | 0.459   | 62200       | 39600   | 25400   |
| 2 Yr                     | 1.18                              | 0.775   | 0.840   | 150000      | 83700   | 49400   |

Table 2 presents the calculated external film badge doses that are equivalent to a bone dose commitment of 150 millirem for exposures received at various times after most\* CONUS nuclear detonations resulting in significant on-site fallout. A resuspension factor of  $1 \times 10^{-5} \text{ m}^{-1}$ , a breathing rate of  $1.2 \text{ m}^3/\text{hr}$ , and dose conversion

\*BUSTER-JANGLE Shot Able and HARDTACK II Shots Tamalpais and Blanca are excluded due to insufficient radiochemistry data.

Table 2. External film badge dose (rem) equivalent to internal bone dose commitment of 150 millirem.

| OPERATION - SHOT         | 1<br>HOUR | 4<br>HOURS | 9<br>HOURS | 1<br>DAY | 2<br>DAYS | 4<br>DAYS | 1<br>WEEK | 2<br>WEEKS | 1<br>MONTH | 2<br>MONTHS | 4<br>MONTHS | 1<br>YEAR |
|--------------------------|-----------|------------|------------|----------|-----------|-----------|-----------|------------|------------|-------------|-------------|-----------|
| TRINITY                  | 2900      | 520        | 170        | 63       | 32        | 17        | 10        | 4.1        | 1.6        | 0.64        | 0.26        | 0.028     |
| BJ - Sugar               | 2800      | 610        | 230        | 120      | 77        | 45        | 24        | 7.3        | 2.4        | 0.96        | 0.43        | 0.044     |
| BJ - Uncle               | 2600      | 540        | 210        | 120      | 79        | 47        | 24        | 6.6        | 1.9        | 0.74        | 0.32        | 0.033     |
| TS - Easy                | 3100      | 640        | 200        | 74       | 35        | 18        | 11        | 5.5        | 2.3        | 0.94        | 0.41        | 0.042     |
| TS - Fox                 | 3400      | 720        | 240        | 96       | 50        | 27        | 16        | 7.4        | 3.1        | 1.3         | 0.58        | 0.063     |
| TS - George              | 3600      | 760        | 260        | 110      | 55        | 30        | 18        | 8.5        | 3.7        | 1.6         | 0.73        | 0.081     |
| TS - How                 | 3200      | 670        | 210        | 77       | 36        | 19        | 11        | 5.9        | 2.6        | 1.1         | 0.46        | 0.048     |
| UK - Annie               | 3600      | 780        | 260        | 110      | 56        | 31        | 18        | 8.8        | 2.9        | 1.7         | 0.78        | 0.090     |
| UK - Nancy               | 3500      | 750        | 250        | 100      | 53        | 29        | 17        | 8.2        | 3.5        | 1.5         | 0.69        | 0.078     |
| UK - Ruth                | 3600      | 780        | 270        | 120      | 70        | 40        | 23        | 9.9        | 4.2        | 1.9         | 0.93        | 0.11      |
| UK - Ray                 | 3600      | 780        | 270        | 120      | 70        | 40        | 23        | 9.9        | 4.2        | 1.9         | 0.91        | 0.10      |
| UK - Badger              | 3600      | 780        | 270        | 120      | 66        | 37        | 22        | 9.9        | 4.1        | 1.8         | 0.82        | 0.097     |
| UK - Simon               | 3600      | 790        | 270        | 110      | 57        | 31        | 19        | 9.2        | 4.1        | 1.8         | 0.88        | 0.10      |
| UK - Harry               | 3700      | 820        | 280        | 120      | 64        | 35        | 21        | 10         | 4.5        | 2.0         | 1.0         | 0.12      |
| T - Moth                 | 1800      | 320        | 94         | 31       | 14        | 6.7       | 4.0       | 1.9        | 0.75       | 0.28        | 0.11        | 0.011     |
| T - Tesla                | 1200      | 200        | 57         | 19       | 8.5       | 4.3       | 2.4       | 1.1        | 0.40       | 0.15        | 0.057       | 0.0057    |
| T - Turk                 | 3700      | 800        | 270        | 110      | 53        | 28        | 18        | 9.2        | 4.2        | 1.8         | 0.89        | 0.11      |
| T - Hornet               | 2900      | 590        | 200        | 74       | 34        | 16        | 9.7       | 4.8        | 2.0        | 0.78        | 0.33        | 0.035     |
| T - Bee                  | 2800      | 550        | 170        | 61       | 28        | 14        | 8.3       | 4.1        | 1.7        | 0.68        | 0.28        | 0.029     |
| T - Ess                  | 2600      | 540        | 220        | 120      | 80        | 47        | 24        | 6.6        | 1.9        | 0.74        | 0.32        | 0.034     |
| T - Apple I              | 3000      | 610        | 190        | 71       | 34        | 17        | 10        | 5.1        | 2.1        | 0.86        | 0.38        | 0.039     |
| T - MET                  | 3900      | 880        | 300        | 130      | 66        | 36        | 23        | 12         | 5.9        | 2.9         | 1.7         | 0.26      |
| T - Apple II             | 3400      | 720        | 240        | 91       | 45        | 23        | 14        | 7.2        | 3.1        | 1.3         | 0.61        | 0.067     |
| T - Zucchini             | 3500      | 730        | 240        | 91       | 44        | 23        | 14        | 7.2        | 3.2        | 1.4         | 0.62        | 0.068     |
| P - Boltzmann            | 3200      | 670        | 220        | 81       | 38        | 19        | 11        | 5.8        | 2.5        | 1.0         | 0.45        | 0.048     |
| P - Franklin             | 3600      | 770        | 260        | 99       | 47        | 24        | 15        | 8.2        | 3.9        | 1.8         | 1.0         | 0.19      |
| P - Wilson               | 2900      | 580        | 180        | 64       | 29        | 15        | 8.9       | 4.5        | 1.9        | 0.77        | 0.33        | 0.034     |
| P - Priscilla            | 3900      | 890        | 310        | 130      | 67        | 35        | 23        | 12         | 6.1        | 3.1         | 1.8         | 0.30      |
| P - Diablo               | 3200      | 650        | 210        | 82       | 41        | 21        | 13        | 5.9        | 2.5        | 1.0         | 0.44        | 0.047     |
| P - Kepler               | 2300      | 430        | 130        | 44       | 20        | 10        | 5.9       | 2.8        | 1.1        | 0.42        | 0.17        | 0.019     |
| P - Shasta               | 3200      | 650        | 210        | 81       | 40        | 21        | 12        | 5.8        | 2.4        | 0.98        | 0.43        | 0.046     |
| P - Smoky                | 3900      | 870        | 310        | 130      | 67        | 36        | 22        | 12         | 5.8        | 2.8         | 1.6         | 0.24      |
| P - Galileo              | 2300      | 420        | 130        | 50       | 25        | 13        | 7.2       | 3.0        | 1.1        | 0.43        | 0.18        | 0.028     |
| P - Fizeau               | 2900      | 570        | 180        | 65       | 30        | 15        | 8.8       | 4.4        | 1.9        | 0.73        | 0.31        | 0.032     |
| P - Whitney              | 3200      | 650        | 210        | 82       | 42        | 22        | 13        | 5.8        | 2.4        | 0.96        | 0.41        | 0.045     |
| HII - Quay               | 160       | 23         | 6.2        | 1.8      | 0.77      | 0.37      | 0.21      | 0.1        | 0.04       | 0.015       | 0.006       | <0.001    |
| HII - Hamilton           | 0.84      | 0.12       | 0.032      | 0.01     | 0.004     | 0.002     | 0.001     | <0.001     | <0.001     | <0.001      | <0.001      | <0.001    |
| HII - Rio Arriba         | 3600      | 790        | 280        | 120      | 69        | 39        | 23        | 10         | 4.4        | 2.0         | 1.0         | 0.12      |
| HII - Humboldt           | 5.7       | 0.79       | 0.22       | 0.064    | 0.029     | 0.014     | 0.008     | 0.004      | 0.001      | <0.001      | <0.001      | <0.001    |
| DII - Johnnie Boy        | 3700      | 890        | 380        | 190      | 95        | 39        | 23        | 13         | 6.2        | 3.1         | 1.9         | 0.032     |
| DII - Small Boy          | 790       | 120        | 33         | 11       | 4.7       | 2.3       | 1.3       | 0.6        | 0.23       | 0.086       | 0.033       | 0.003     |
| DII - Little Feller I,II | 18        | 2.5        | 0.69       | 0.21     | 0.09      | 0.043     | 0.025     | 0.012      | 0.004      | 0.002       | <0.001      | <0.001    |

factors for aerosols (oxide clearance classification) with an Activity Median Aerodynamic Diameter (AMAD) of  $1.0\text{ }\mu\text{m}$  are used in the calculations. The breathing rate ( $1.2\text{ m}^3/\text{hr}$ ) corresponds to that of a typical adult male during light activity (Reference 5). For strenuous activities, the external doses corresponding to a 150 millirem bone dose commitment are approximately two-thirds of those indicated in the table. Table 2 shows that the relationship between the external dose and the internal bone dose commitment changes rapidly with time after the detonation and varies from shot to shot. These variations result from radiological decay and shot specific differences in the mixture of radionuclides in the fallout, in particular the amount of long-lived radionuclides generated and/or left over (unfissioned) from the detonation. Several radionuclides that contribute to the bone dose commitment have half-lives well in excess of the human life span, and thus are not radiologically depleted in the environment or the body. Because these nuclides are principally beta and alpha particle emitters, they contribute little to the external dose; however, they increasingly dominate the relationship between bone dose commitment and external doses as most of the short half life gamma emitters decay away.

For utility, table 3 presents a "worst-case composite" of information for a large number of NTS shots. (TEAPOT Shots Moth and Tesla, all HARDTACK II Shots except Rio Arriba, and DOMINIC II Shots Small Boy, Little Feller I and II are excluded; discussion will follow.) Information is presented for three values of the resuspension factor ( $K = 1 \times 10^{-3}$ ,  $10^{-4}$ , and  $10^{-5}\text{ m}^{-1}$ ) for selected times after the detonation.

Table 3 is used to determine whether or not a participant in any of the shots covered (see exceptions mentioned above) received a bone dose commitment of less than 150 millirem as follows:

- Step 1: Select an appropriate resuspension factor. The scientific literature provides a basis for selecting resuspension factors that are applicable to various activities performed by DoD participants in the nuclear test program. For example, table 4 is a summary of experimentally determined resuspension factors for a variety of activities and environmental settings (Reference 6). Using this information, the resus-

Table 3. Composite\* external film badge dose (rem) equivalent to internal (bone) dose commitment of 150 millirem.

| K ( $m^{-1}$ )     | Time After Detonation |         |                  |                   |                   |                    |                     |                     |                       |
|--------------------|-----------------------|---------|------------------|-------------------|-------------------|--------------------|---------------------|---------------------|-----------------------|
|                    | H+4 hrs               | H+9 hrs | H+24 hrs (1 day) | H+48 hrs (2 days) | H+96 hrs (4 days) | H+168 hrs (1 week) | H+336 hrs (2 weeks) | H+720 hrs (1 month) | H+1440 hrs (2 months) |
| $1 \times 10^{-3}$ | 4.2                   | 1.3     | 0.44             | 0.20              | 0.10              | 0.059              | 0.028               | 0.011               | 0.0042                |
| $1 \times 10^{-4}$ | 42                    | 13      | 4.4              | 2.0               | 1.0               | 0.59               | 0.28                | 0.11                | 0.042                 |
| $1 \times 10^{-5}$ | 420                   | 130     | 44               | 20                | 10                | 5.9                | 2.8                 | 1.1                 | 0.42                  |

\*Composite NTS shots minus BUSTER-JANGLE Shot Able, TEAPOT Shots Moth and Tesla, and most HARDTACK II and DOMINIC II shots.



Table 4. Resuspension factors\* reported in reactor safety study.

| Arid/Desert  | Seniarid/Grassland  | Urban/Suburban   | Interiors   |
|--|---|--|---|
| $4 \times 10^{-7}$ near road graded in fallout field(a)<br>$5 \times 10^{-5}$ in Land Rover during travel to work site and outside during work; fission products (5-18 hr)(a)<br>$3$ to $10 \times 10^{-4}$ downwind of crater(a)<br>$1 \times 10^{-3}$ mechanical disturbance(a)<br>$5 \times 10^{-4}$ dust from vehicles<br>$10^{-4}$ to $10^{-6}$ dust from pedestrians(a)<br>$3 \times 10^{-7}$ particles of 7 $\mu$ m MMD on 6-m circles (sandy) furrowed and rocky with sand base (dry)(b)<br>$1 \times 10^{-7}$ to $3 \times 10^{-7}$ (wet)(b)<br>$1.2 \times 10^{-7}$ in 1000- $\mu$ g/m <sup>2</sup> isopleth<br>$1.4 \times 10^{-7}$ in 100- $\mu$ g/m <sup>2</sup> isopleth<br>$1.6 \times 10^{-6}$ in 10- $\mu$ g/m <sup>2</sup> isopleth<br>-35 day half-time air concentration decay<br>1 to 3- $\mu$ m median aerosol size<br>38-day half-time for resuspension of fission products from Schooner(d)<br>76-day half-time for resuspension of fission products from Baneberry(d)<br>$3 \times 10^{-10}$ for 8- to 10- year Pu aged deposit (e)<br>$2 \times 10^{-9}$ for direction of strongest wind (e) | $5 \times 10^{-6}$ (ZnS) walking and loading boxes (f)<br>$1 \times 10^{-5}$ ( $\pm 0.5 \times 10^{-5}$ ) limestone, rock, sand, grass, bushes; fission products(a)<br>$0.8$ to $2 \times 10^{-7}$ crater of tower shot; fission products; road graded from soil disturbance(a)<br>$2 \times 10^{-5}$ to $4 \times 10^{-6}$ in vehicle on road graded through fallout(a)<br>$8 \times 10^{-6}$ 0 to 4 $\mu$ m U <sub>3</sub> O <sub>8</sub><br>$5 \times 10^{-7}$ 0 to 12 $\mu$ m U <sub>3</sub> O <sub>8</sub><br>$8 \times 10^{-9}$ to $10^{-11}$ Y-91 aqueous solution on sandy soil-rain weathering small plot(a)<br>$1 \times 10^{-7}$ for particles of 7 $\mu$ m MMD on 6-m circles, grass plot (dry)(b)<br>$4 \times 10^{-8}$ for particles of 7 $\mu$ m MMD on 6-m circles, grass plot protected by snow fence (dry)(b)<br>$2 \times 10^{-7}$ both cases, above, wet(b) | $2.5 \times 10^{-6}$ sandblasting for I-131 removal(k)<br>$2 \times 10^{-6}$ 0- to 4- $\mu$ m U <sub>3</sub> O <sub>8</sub> particles on concrete slabs(a)<br>$1.5 \times 10^{-7}$ 0- to 12- $\mu$ m U <sub>3</sub> O <sub>8</sub> particles on concrete(a)<br>$10^{-4}$ to $10^{-2}$ fraction resuspended per pass through particles(h)<br>$2 \times 10^{-2}$ to $2 \times 10^{-4}$ ; initially very rapid half-time of a few days<br>$-2 \times 10^{-5}$ to $2 \times 10^{-3}$ at 4 days | $1 \times 10^{-5}$ heavy work(i) ZnS (3.1 $\mu$ m)<br>$7 \times 10^{-4}$ light work(l) CuO (2 $\mu$ m)<br>$2 \times 10^{-3}$ operations(j)<br>$0.4$ to $7 \times 10^{-3}$ clothes change and other activity(k)<br>$1.2 \times 10^{-4}$ people walking in change room(k)<br>$5 \times 10^{-5}$ PuO <sub>2</sub> , many steps (l)<br>$3 \times 10^{-6}$ PuO <sub>3</sub> , many steps (l)<br>$2 \times 10^{-4}$ to $4 \times 10^{-5}$ in enclosed space, I-131 in brick dust(a,2) |

For references, see continuation.

\*Reciprocal meters (m<sup>-1</sup>)

Table 4. Resuspension factors reported in reactor safety study -  
References (Concluded).

- (a) Stewart, K., 1964, "The Resuspension of Particulate Material from Surfaces," in Proc. Symp. Surface Contamination, Gatlinburg, Tenn. 1964, Pergamon Press.
- (b) Healy, J. W., and J. J. Fuguoy, 1959, "Wind Pickup of Radioactive Particles from the Ground," Progress in Nuclear Energy, Series 12, Vol. 1, pp. 427-436.
- (c) Wilson, R. H., R. G. Thomas, and J. N. Stannard, 1960, Biomedical and Aerosol Studies Associated with a Field Release of Plutonium, WT-1511.
- (d) Anspaugh, L. R., P. L. Phelps, N. C. Kennedy, and H. G. Booth, "Wind-Driven Redistribution of Surface-Deposited Radioactivity," in Proc. IAEA Symp. Environmental Behavior of Radionuclides Released In the Nuclear Industry, Aix-en-Provence, May 14-18, 1973.
- (e) Anspaugh, L. R., 1973, Relationship Between Resuspended Plutonium in Air and Soil, NVO-140.
- (f) Schwendiman, L., 1958, Health Physics, 1, p. 352.
- (g) Chamberlain, A. C., and R. C. Chadwick, 1951, Transport of Iodine from Atmosphere to Ground, United Kingdom Atomic Energy Authority, Report AERE-R 4870.
- (h) Anspaugh, L. R., J. H. Shinn, and D. W. Wilson, 1974a, "Evaluation of the Resuspension Pathway Towards Protective Guidelines for Soil Contamination with Radioactivity," in Proc. IAEA/WHO Symp. on Radiological Safety Evaluation of Population Doses and Application of Radiological Safety Standards to Man and the Environment, Portorez, Yugoslavia, May 20-24, 1974.
- (i) Fish, B. R., et al., 1965, Redispersal of Settled Particulates, Oak Ridge National Laboratory Report ORNL-TM-1049.
- (j) Bailey, J. C., and R. C. Rohr, 1953, Airborne Contamination, Oak Ridge National Laboratory Report K-1088.
- (k) Brunskill, 1964, "The Relationship Between Surface and Airborne Contamination," in Proc. Symp. Surface Contamination, Gatlinburg, Tenn. 1964, Pergamon Press, Oxford.
- (l) Jones, I. S., and S. F. Pond, 1964, "Some Experiments to Determine the Resuspension Factor of Plutonium from Various Surfaces," in Proc. Symp. Surface Contamination, Gatlinburg, Tenn. 1964, Pergamon Press.

pension factors shown in table 5 are selected for typical activities involving DoD test participants. Note that the resuspension factor could change during an activity; for example, radioactive fallout material is resuspended only when the surface is disturbed during digging operations.

- Step 2: Determine period of exposure. From appropriate references, the approximate time that the activity in question occurred is determined. For example, many exposures received by scientific project personnel were incurred by H+4 hours. Most observer and maneuver troop activities took place on shot day and were completed by at least H+9 hours, however, in some cases these troops visited contaminated display areas on subsequent days or may have rehearsed in an "old" fallout field.
- Step 3: Estimate breathing rate of test participants. For most activities, a breathing rate of  $1.2 \text{ m}^3/\text{hr}$  is assumed. This breathing rate is used in the calculations for the preparation of tables 2 and 3. For strenuous activities, the calculated external doses are reduced by one-third.
- Step 4: Compare "actual" external film badge doses with table 3. The maximum external film badge dose received by the category of test participants in question is determined from appropriate references. This dose is then compared with the dose indicated in table 3 for the appropriate value of the resuspension factor and time after the detonation as determined in Steps 1 and 2. If the actual dose is less than that indicated in table 3, the internal bone dose commitment is less than 150 millirem. For example, according to Reference 7, the upper limit external film badge dose received by the service observers at Shot Nancy (Operation UPSHOT-KNOTHOLE) was 0.32 rem. The observer activities were completed on shot day (prior to H+9 hrs); therefore, assuming that the resuspension factor associated with their activities was  $10^{-5}$ , their external dose could have been as high as 130 rem before an internal bone dose commitment of 150 millirem would have resulted. Even if the resuspension factor had been as high as  $10^{-4}$ , the 13 rem external dose corresponding to a 150 millirem

Table 5. Resuspension factors for typical DoD participant activities in contaminated areas.

| <u>Participant Category</u> | <u>Activity</u>  | <u>Resuspension Factor (m<sup>-1</sup>)</u> |
|-----------------------------|--|---|
| Observers & Maneuver Troops | Touring display area after shot (on foot, or inside vehicle) | 10 <sup>-5</sup>                            |
| Maneuver Troops             | Maneuvers involving helicopter landings/take off             | 10 <sup>-3</sup>                            |
|                             | Assaults or marches behind armored vehicles or marches       | 10 <sup>-3</sup>                            |
|                             | Crawl through open terrain                                   | 10 <sup>-4</sup>                            |
|                             | Dig foxholes, etc.   | 10 <sup>-4</sup>                            |
|                             | Ground assaults (no vehicle)                                 | 10 <sup>-5</sup>                            |
|                             | Trucking   | 10 <sup>-5</sup>                            |
| Project Troops              | Dig out buried instrumentation/equipment                     | 10 <sup>-4</sup> - 10 <sup>-5</sup>         |
|                             | Equipment/data recovery                                      | 10 <sup>-4</sup> - 10 <sup>-5</sup>         |
|                             | Decontamination projects (Bulldozing, etc.)                  | 10 <sup>-4</sup>                            |
|                             | Visit project area (on foot or vehicle)                      | 10 <sup>-5</sup>                            |
| Support Troops              |  |   |
| - Engineers/Ordinance       | Dig trenches, install/dismantle displays                     | 10 <sup>-4</sup>                            |
| - Communications            | Lay wire (communications network)                            | 10 <sup>-4</sup>                            |
| - Decontamination           | Equipment/personnel decontamination                          | 10 <sup>-4</sup>                            |
| - Transportation            | Trucking   | 10 <sup>-5</sup>                            |
| - MP's                      | Traffic control, security sweep                              | 10 <sup>-5</sup>                            |
| - Rad-Safe                  | Survey area on foot or from vehicle                          | 10 <sup>-5</sup>                            |

bone dose commitment still greatly exceeds their actual dose of 0.32 rem; therefore, it is highly unlikely that these observers received a bone dose commitment in excess of 150 millirem.

As stated earlier, table 3 is based on a worst-case composite of a large number of CONUS detonations. The same methodology can be applied to the shots not covered by the table (see exceptions) by using the shot-specific values in table 2 with appropriate adjustments for the value of the resuspension factor (K). For example, the H+4 hour, external film badge dose values for Shot Small Boy (DOMINIC II) would be 120 rem, 12.0 rem, and 1.2 rem for  $K = 1 \times 10^{-5}$ ,  $10^{-4}$ , and  $10^{-3}$ , respectively. The equivalent film badge doses for DOMINIC II Shots Little Feller I and II and most HARDTACK II shots with significant on-site fallout are considerably less. The fallout from these low-yield nuclear shots tended to be rich in unfissioned nuclear material, which leads to a high potential for internal bone dose.

In many cases, specific information regarding categories of troop participants is not available; however, the information in table 3 allows certain conclusions to be drawn. For example, it is evident that any activity that would result in an internal bone dose commitment of 150 millirem on the day of most shots would also be accompanied by an extremely high external dose (over 130 rem during activities where a resuspension factor of  $1 \times 10^{-5}$  is applicable; 13 rem where moderately high levels,  $K = 1 \times 10^{-4}$ , of resuspended material are encountered). For activities that are completed by H+4 hours, the corresponding external doses are more than three times higher. Since few external doses of this magnitude were recorded during any operation, most participants who were involved in activities on shot day only, can be assigned an internal bone dose commitment of less than 150 millirem unless they were involved in activities where unusually high ( $K \geq 1 \times 10^{-3}$ ) levels of resuspended material were present.

External (film badge) dose limits for most DoD participants ranged from 3.0 to 6.0 rem, depending on the operation. Taking the higher value (6.0 rem), table 3 shows that an internal bone dose commitment of less than 150 millirem could be assigned to any person exposed to resuspended fallout material, ( $K = 1 \times 10^{-5}$ ) up to almost 1 week

after most shots, provided that he did not receive an external dose over-exposure during that period. Obviously, the exposure period is shorter for higher values of the resuspension factor. Nevertheless, since test participant external doses were controlled and over-exposures documented, exposure limits can be used as worst case values of the external dose when specific information is not available.

Variants of the methodology are required when information is lacking for one or more of the scenario-related parameters in Equations 2 and 3. In order to make any internal dose evaluation for personnel in a fallout field, the resuspension factor must be estimable; this is accomplished from qualitative project descriptions that are generally available. Film badge dose, especially on a project basis, is typically unavailable. While a high-sided value of the operation dose limit is useful as a constraint on early time exposures, it aids late-time determinations only rarely, as attaining the dose limit would require unrealistic exposure durations at late times. Also, the time after burst of exposure, the implicit but important parameter of Equation 2, is often unspecified. This is particularly problematic when the poorly documented removal of test equipment well after the shot requires more time or involves greater resuspension than the better documented, early-time data recoveries.

When external dose and time-after-burst information are lacking, the internal dose can be evaluated if the innermost location (to GZ, or nearest the fallout hotline) of the participant is identified. For a given exposure duration at a specific location, the bone dose commitment is high-sided by the earliest possible exposure; the early fission product contribution decays, leaving long-lived weapon debris to dominate the internal dose from late-time exposures. Exposure durations, where not stated, are estimable with reasonable accuracy; normally, the order of 1 hour or 10 hours is appropriate to cleanup activities. For the high-sided weapon debris content represented by the composite shot described above, there is a time-dependent relation to radiation intensity. Radiation survey measurements have been used to determine the gamma intensity fields associated with nuclear fallout. These, as reported in Reference 8 (with many refinements in other DNA documents) were usually normalized with the  $t^{-1.2}$  decay rule to one hour after burst. Thus, the H+1 hour intensity, as read from published contour plots for a known location, provides a useful measure for internal dose evaluation when other data are lacking.

For a known location or where the radiation intensity can be upper-limited, the bone dose commitment is directly proportional to resuspension factor, exposure time, and H+1 hour intensity; it declines weakly with time after burst and thus correlates poorly with film badge dose or intensity measured during the exposure. In terms of Equation 2, variation in intensity with time after burst is largely compensated by the time-dependence of the composite dose conversion factor. In order to implement a procedure using H+1 hour intensities, the external-internal dose relationship depicted in table 3 is adapted. For each pair of resuspension factor and exposure duration values, the earliest possible exposure time after burst, consistent with operational film badge dose limits, is chosen. The film badge dose is used to calculate (Equation 3) an intensity, which is normalized to H+1 hour ( $t^{-1.2}$  decay). For example, with  $K = 10^{-4} \text{ m}^{-1}$  and  $T = 10 \text{ hr}$ , the 4.4 rem value in the table for D+1 is used as an approximate value for the various operational dose limits. The corresponding intensity is 0.63 R/hr, which implies 29 R/hr at H+1. With the same resuspension factor but a one-hour exposure duration, 290 R/hr at H+1 would have been permissible. Other resuspension factors permit attainment of the operational external dose limit at different times: for  $10^{-3} \text{ m}^{-1}$ , at about H+4 hours; for  $10^{-5} \text{ m}^{-1}$ , at about 1 to 2 weeks. (Note that at later exposure times in each case, the external dose limits would not have been reached.) This procedure results in the following results for limiting intensities (R/hr) at H+1:

| $K(\text{m}^{-1})$ | Exposure Duration (T in hours) |     |     |      |
|--------------------|--------------------------------|-----|-----|------|
|                    | 1                              | 10  | 100 | 1000 |
| $10^{-3}$          | 32                             | 3.2 | N/A | N/A  |
| $10^{-4}$          | 290                            | 29  | 2.9 | N/A  |
| $10^{-5}$          | 4000                           | 400 | 40  | 4    |

The last two columns apply primarily to personnel resident in contaminated areas, where chronic, low-level exposure resulted from routine activities over periods as long as several months. This situation occurred during oceanic, but not continental testing. Only realistic combinations of T and K are tabulated.

These values do not account for the decay that actually occurs during extended exposures; they are high-sided by this consideration. The small variation in the lead

digits (as opposed to order of magnitude) is solely the result of the variation in earliest reasonable reentry time; all entries would start with 29 if reentry were on D+1. It would be expected that D-day reentry would have the lowest lead digits because of the greater fission product activity then present; it is the composite-shot origin of table 3 that happens to perturb the values pertinent to a single shot.

Both military rehearsals and technical project fielding were often conducted in fallout fields remnant from earlier shots. The above limiting H+1 hour intensities are also useful for assessing these situations. Personnel activities in old high-intensity (H+1 hour) areas were limited because of shot positioning and timing practices. Tower and surface/underground shots, which accounted for almost all significant fallout, were conducted at distinct GZs during an operation. The heavily contaminated areas around such GZs were not used in preparations for subsequent shot activities. When tower GZs were reused during later operations, one or two years later, the resuspension factor would have diminished by at least an order of magnitude through weathering (Reference 6) and the potential for internal dose thus would have greatly diminished.

All CONUS fallout fields are examined to determine their potential impact on internal dose for activities during subsequent shots. The shots impacting other shot areas with H+1 intensities exceeding each major threshold tabulated above are indicated as follows. Through Operation PLUMBBOB, no tower shot had associated H+1 intensities as great as 4000 R/hr anywhere in the field; consequently, no activity characterized by  $K = 10^{-5} \text{ m}^{-1}$  and  $T = 1 \text{ hr}$  results in a 150 mrem dose commitment to bone. Only the cratering shots (BUSTER-JANGLE Sugar and Uncle, and TEAPOT Ess in the period of significant DoD participation at NTS) exceeded 4000 R/hr, and then not distant from the crater; no other shot areas were impacted at this level. Even at the 290 R/hr level, no shot impacted another with the exception of TEAPOT Tesla. Tesla has an internal dose potential considerably above that of the composite shot; therefore, part of its fallout field about 1 km northwest of Shot Post "effectively" exceeds 290 and 400 R/hr.

The shots impacting other areas at 29 R/hr or above are as follows:



|                     | <u>1st Shot</u> | <u>2nd Shot</u> | <u>H+1 Hour<br/>Intensity (R/hr)</u> | <u>Location from 2nd Shot</u>         |
|---------------------|-----------------|-----------------|--------------------------------------|---------------------------------------|
| BUSTER-<br>JANGLE   | Sugar           | Uncle           | 30<br>> 100                          | GZ<br>Several hundred meters S and SE |
| TUMBLER-<br>SNAPPER | Easy            | Fox             | 50                                   | 2+ km S                               |
| UPSHOT-<br>KNOTHOLE | Nancy           | Ray             | 100                                  | 500 m WSW                             |
|                     | Nancy           | Badger          | 75                                   | Widespread                            |
|                     | Badger          | Harry           | 50                                   | 2 km N; narrow strip                  |
|                     | Badger          | Climax          | 50                                   | 2 km W to S; narrow strip             |
|                     | Simon           | Harry           | 200                                  | Widespread                            |
| TEAPOT              | Moth            | Hornet          | 40*                                  | 1 km NE                               |
|                     | Tesla           | Post            | 290-400*                             | 1 km NW                               |
| PLUMBBOB            | Diablo          | Smoky           | 50                                   | Widespread                            |

Only a few additional shots impacted other areas at 3.2 R/hr or above:

|          |           |            |           |            |
|----------|-----------|------------|-----------|------------|
| TEAPOT   | Turk      | Apple I    | 10        | 3 km NW    |
| PLUMBBOB | Boltzmann | Smoky      | 10        | Widespread |
|          | Boltzmann | Lassen     | 20        | Widespread |
|          | Boltzmann | Wilson     | 20        | Widespread |
|          | Boltzmann | Owens      | 20        | Widespread |
|          | Boltzmann | Wheeler    | 20        | Widespread |
|          | Boltzmann | Charleston | 20        | Widespread |
|          | Shasta    | Smoky      | 15        | Widespread |
|          | Smoky     | Wheeler    | } 6<br>20 | GZ         |
|          | Smoky     | Charleston |           | 1 km N     |
|          | Smoky     | Morgan     |           |            |

The only case in which a shot in a previous operation moderately impacted an area is TEAPOT Tesla on the colocated PLUMBBOB balloon Shots Lassen, Wilson, Hood, Owens, Wheeler, Charleston, and Morgan. The "effective" Tesla intensity, corrected for reduced resuspension factor after 2 years, is about 10 R/hr (H+1 hour) at the balloon GZ; it rises to about 30 R/hr within 1 km to the southwest, before the immediate vicinity of the Tesla GZ is reached.

While several of the HARDTACK II shots were also impacted by earlier shots, consideration of their radiation levels was not required for the screening. Since many

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\*"Effective" intensity.

of the HARDTACK II shots had an internal dose potential much greater than the composite shot, non-remote participants fail to pass the screen regardless. None of the DOMINIC II shots significantly impacted subsequent shots during the operation or were meaningfully impacted by shots from previous operations.

The above shot-specific information is considered in estimating internal dose levels but, for simplicity, no designation regarding previous shots is shown on the lists of projects/units identified as receiving bone dose commitments of less than 150 millirem presented in Section 3. Those projects or units failing to qualify for the list on this account do not appear. Where qualification is marginal on one account and multiple exposures or sources of internal dose exist, the sum is considered. Even if there is qualification on all separate accounts, the sum must qualify for the unit to make the list. For a given shot, only the qualification based on the leading contributing exposure is displayed; this may well involve a late cleanup activity rather than a documented data recovery.

No ground maneuver troops or observers fail to qualify for the list (under 150 mrem bone dose) based on activities (e.g., rehearsals) in old radiation areas. In fact, almost every such unit also qualifies when post-shot activities are also included. The reasons revolve around the pertinent resuspension factors, exposure times and durations, and distances from GZs. The great majority of maneuver troops and observers were operating at  $K = 10^{-5} \text{ m}^{-1}$  by virtue of walking or being trucked. Most of their post-shot activities were accomplished on D-day, exposure durations were 10 hours or less, and no part of a fallout field with H+1 intensity as great as 400 R/hr was entered. Therefore, all walking and riding maneuver and observer troops qualify. Most instances of higher resuspension factors are considered in dose reconstruction reports. Task Force BIG BANG (DNA 4772F) crawling in fallout, Task Force RAZOR (DNA-TR-83-07) resuspending fallout with tanks, and marines breathing helicopter-lofted contamination (4th MCPAEB--DNA 5774F) all qualify. However, certain activities of Task Force WARRIOR (Reference 3), for which internal dose has not previously been analyzed, do not clearly qualify; therefore, TF WARRIOR does not appear on the list.

### **2.3 INHALATION OF LOFTED NEUTRON-ACTIVATED MATERIAL.**

Numerous nuclear test devices were detonated sufficiently high above the ground so that minimal on-site fallout occurred. However, in many cases, the neutrons

emitted from these detonations produced considerable radioactivity in the soil through activation by neutron capture. Any lofting or suspension of this activated soil by mechanical or natural means creates a potential inhalation hazard to those who enter the area.

The methodology for calculating internal organ dose commitments resulting from the inhalation of neutron-induced activity is basically the same as that for resuspended fallout as presented in Section 2.2. Again, the airborne concentration is determined by the application of a (re)suspension factor that relates the surface activity to that in the air above. The surface activity is determined from gamma radiation intensities measured above the surface.

As described in Reference 7, the relationship between activity in soils and gamma intensity is developed from field data on known activation products, generalized to other soil constituents through theoretical considerations of neutron capture. All reported constituents in NTS soil have been analyzed to determine relative contributions to both gamma intensity and internal bone dose commitment at relevant times of exposure. As shown in Reference 7, Na-24 dominates both the gamma intensity and bone dose commitment in the first few days after detonation. After Na-24 decays (half-life of 15 hours), Ca-45 (half-life of 163 days) is left as the dominant contributor to bone dose commitment.

Results in Reference 7 are expressed for time zero in terms of a unit radiation intensity (R/hr) from Na-24, a unit (re)suspension factor ( $m^{-1}$ ), a unit breathing rate ( $m^3/hr$ ), and a unit exposure duration (hr): 2.2 rem to the bone from Na-24 and 0.2 rem from Ca-45. The top centimeter of soil is considered to be available for suspension, and a suspension factor of  $1 \times 10^{-3} m^{-1}$  demonstrates the implications of severe surface disturbances. Internal doses from Na-24 are directly proportional to external dose accrued during the interval that Na-24 dominates the radiation intensity. With a breathing rate of  $1.2 m^3/hr$  and use of Equation (2), a bone dose commitment of 0.15 rem from Na-24 corresponds to a film badge dose of 40 rem. Thus, adherence to external dose limits in early days after the detonation would preclude a significant bone dose commitment from inhalation of activated soil.

At late times, it is theoretically possible to accrue a bone dose commitment from Ca-45 in excess of 0.15 rem without exceeding operational limits on film badge dose; however, this could be accomplished in extremely limited areas only, consistent with a reasonable exposure time. From the previous paragraph it is seen that Na-24, before decay, leads to 11 times the internal bone dose commitment from Ca-45. Thus, for 0.15 rem from Ca-45, the corresponding film badge dose based on undecayed Na-24 is >440 rem. Radiation intensities at H+1 in excess of 100 R/hr, coupled with a several-hour exposure and the extreme suspension factor of  $1 \times 10^{-3} \text{ m}^{-1}$  throughout, would lead to values of this magnitude. Reference 8 indicates that such H+1 intensities did exist from induced activity, for a few shots, within a few hundred meters of ground zero. However, no military activities are known to have occurred under the combined set of circumstances that would lead to a bone dose commitment exceeding 0.15 rem from inhalation of suspended, activated soil. Consequently, a shot having a radiation field from neutron-induced activity is taken to imply, without further analysis, bone dose commitments of less than 0.15 rem for all participants at that shot.

## 2.4 INHALATION OF CLOUD DEBRIS.

A limited number of nuclear test personnel had the potential for exposure to internal dose while performing missions in aircraft or helicopters. Exposure to airborne nuclear debris was either planned, as in the case of cloud samplers, or inadvertent, as in the case of Marine helicopter exercises in Operation UPSHOT-KNOTHOLE. As in the case of ground personnel, radiation exposure was usually indicated by film badge dose or meter readings of gamma intensity.

The analysis of exposure to nuclear cloud debris differs from that of grounded debris through the variation in radiation source geometry. The volumetric radiation source geometry relates differently to gamma intensity than does a planar source. No consideration analogous to a resuspension factor is required; worst-case analysis takes the ambient airborne activity concentration without reduction. The other condition required for simple analysis is that the exposure and associated meter readings and film badge readings are from immersion in a cloud of uniform activity concentration over the range of gamma radiation. Equation (1) is applied as follows:

$$D = I \times \frac{AA}{I}(t) \times BR \times T \times DF, \quad (5)$$

where the new quantity AA/I is the ratio of airborne activity concentration to gamma intensity (Ci/m<sup>3</sup> per R/hr). Derived from an energy balance in Reference 7, AA/I is only weakly time-dependent from the small variation in average gamma emissions energy, E (MeV per disintegration):

$$\frac{AA}{I} = 5 \times 10^{-4}/E \quad (6)$$

This expression is based on sea level air density; AA/I is directly proportional to air density at altitude. However, the breathing rate tends to vary inversely with air density; consequently, no overall corrections for altitude are made in Equation (5).

The overall expression for worst-case exposure to nuclear cloud debris aloft is obtained from substitution of Equations (6) and (3) into Equation (5). Because of the intensity variations encountered in flight, the condition stated above is imperfectly met; however, deviations almost invariably high-side the internal dose. With Equation (3) used in its time-integral form, the following result is obtained:

$$D = 7 \times 10^{-4} \times D_{FB} \times BR \times DF/E \quad (7)$$

For the 0.15 rem bone dose commitment, the limiting film badge dose is:

$$D_{FB} = 210 \times E/(BR \times DF) \quad (8)$$

At early times after detonation,  $t \sim 1$  hr,  $E = 0.8$  MeV is approximately correct for all fission types. With the usual breathing rate of 1.2 m<sup>3</sup>/hr,

$$D_{FB} = 140/DF \quad (9)$$

At early times, fission products dominate the dose conversion factor for many shots; thus, values of DF (the largest, from fission of U-235) from Section 2.2 are used to determine the following limiting film badge doses:

| t(hr)                 | 0.5 | 1   | 2   | 4   |
|-----------------------|-----|-----|-----|-----|
| D <sub>FB</sub> (rem) | 7.6 | 4.0 | 2.0 | 1.1 |

Worst-shot values of  $D_{FB}$ , in the manner of (and excluding the same shots as in) table 3, are obtained by multiplying the above  $D_{FB}$  by worst-shot to best-shot ratios from table 2. Approximate results are:

| t(hr)          | 0.5 | 1   | 2   | 4   |
|----------------|-----|-----|-----|-----|
| $D_{FB}$ (rem) | 5.0 | 2.4 | 1.1 | 0.5 |

The limiting film badge doses given above apply in the absence of protective devices. They do not apply, for example, to aircrews breathing 100 percent oxygen. However, they are appropriate, at least as a reasonable upper limit, where the activity concentration within an aircraft does not correspond to ambient values. Even the slow infiltration of outside air and contaminants does not necessarily reduce the potential for internal dose; long after departure from the nuclear cloud, an aircraft may retain contamination within. In fact, the internal dose commitment is independent of infiltration rate under the following conditions: the rate is constant, exposure continues until the contamination has effectively exited the aircraft, particles are of inhalable sizes and remain in suspension within the aircraft, personnel negligibly deplete the contaminants, and radiological decay may be neglected during the period of exposure. In practice, only rapid infiltration permits these conditions to be met; otherwise, incomplete exposure to or degradation of the radioactive source occurs.

Film badge doses as used above tend to yield a conservatively high internal dose commitment because badge readings typically overrepresent the immediate radiation environment aloft; aircraft avoid the regions of highest activity concentration that nevertheless contribute to the gamma intensity at a distance. This phenomenon is most familiar when no local contamination is present; a gamma reading from distant contamination is referred to as cloud "shine."

## 2.5 INHALATION OF DESCENDING FALLOUT.

The inhalation of descending fallout can be considered the ground-based analog of the inhalation of cloud debris. However, the analysis of internal dose from this pathway develops quite differently because the common type of radiation measurement has a different interpretation. Except for the onset of fallout or for very fine

particles, the radiation intensity is dominated by fallout already deposited. This follows from the deposition velocities of fallout particles, the range of gamma radiation, and the duration of fallout deposition at a given position.

The airborne activity concentration must be represented in terms of the gamma intensity. This is accomplished through the following product:  $I \times (SA/I) \times (AA/SA)$ , in which  $SA/I$  is obtained from Section 2.2 for the time after detonation of exposure,  $t$ . For an airborne activity concentration  $AA$  that persists for a duration  $T$ , during which a deposition velocity  $V$  applies, the resulting surface activity  $SA = AA \times V \times T$ . In effect, a column of height  $V \times T$  is deposited on the surface. Clearly, the corresponding radiation intensity is that at the termination of fallout deposition.

The above analysis is equally valid where  $AA$  and  $V$  are time-dependent, as realistically occurs; the integral representation obtains equivalent results. Because  $AA/SA = 1/(V \times T)$ , substitution into Equation (1) eliminates  $T$ . However,  $T$  has an impact when radiological decay is considered. If  $T \ll t$ , the above analysis is rigorous; otherwise, internal dose is high-sided by determining the largest time-normalized value of  $I$  and taking the exposure to have occurred at time  $t$  corresponding to the end of fallout deposition. In practice, the peak reported intensity and associated time adequately correspond to this limiting case, as  $t$  is typically a small multiple of  $T$ . Where multiple fallout episodes occur, the internal dose is readily high-sided by conversion of the combined late intensity to an H+1 hour value.

The deposition velocity is not commonly reported, but is simply estimated as follows. In order to reach the surface at time  $t$  from the nuclear cloud, the average fall speed is the stabilized altitude divided by  $t$ . For most nuclear tests, fallout particles descended on the order of 10 km. As the deposition velocity at the surface approximates the average fall speed,  $V \sim 10 \text{ km}/t$ . Thus,  $AA/SA = t/(T \times 10^4 \text{ m})$ . Substitution into Equation (1) in consistent units yields:

$$D = I \times \frac{SA}{I} \times 10^{-4} \times t \times BR \times DF \quad (10)$$

Further simplifications of this equation are possible. Most exposures involving particles small enough to be fully inhalable were from about H+10 hours onward. At

such times, Reference 4 indicates that SA/I has a nearly constant value of 0.16 Ci/m<sup>2</sup> per R/hr. For the typical breathing rate of 1.2 m<sup>3</sup>/hr, Equation (10) reduces to:

$$D = 2.0 \times 10^{-5} \times I \times t \times DF \quad (11)$$

To obtain the peak intensity that for any time  $t$  corresponds to a bone dose commitment of 150 mrem requires knowledge of the composite dose factor. The analysis of Section 2.2 using H+1 hour intensities provides a means of limiting the bone dose commitments. A comparison of Equation (10) with Equation (2) shows that the coefficient  $10^{-4}$  is formally equivalent to a resuspension factor, and that time after detonation  $t$  replaces exposure duration  $T$ . Interpolating from the limiting values of H+1 intensity displayed in Section 2.2 for various combinations of  $K$  and  $T$  yields approximately 30 R/hr for  $t=10$  hr and 3 R/hr for  $t=100$  hr. Fallout arriving at earlier times was either not of inhalable size or fell out from lower altitudes in the cloud stem. Without special knowledge of particle size, the limiting H+1 intensity is reasonably held at 30 R/hr, rather than increased, for  $t < 10$  hr.

In order for the internal dose evaluation from descending fallout to be accurate, the measured intensities must correspond to the deposited fallout, and personnel exposure must correspond to the full period of deposition. The presumption of full exposure when not otherwise known reasonably high-sides the internal dose, but the use of film badge readings would lead to inappropriate high-siding; exposure to external radiation continued long after fallout deposition ceased.

Few nuclear test participants received a bone dose commitment in excess of 150 mrem from the inhalation of descending fallout; most at NTS received far less.



### SECTION 3

#### UNITS/PROJECTS WITH BONE DOSE COMMITMENT LESS THAN 150 MILLIREM

Based on a review of the activities performed by DoD participants in the atmospheric nuclear weapons tests program as presented in DNA reports\* and application of the methodologies presented in Section 2, the project/unit personnel listed in the following tables received an internal bone dose commitment of less than 150 millirem. The codes listed below are used to explain the rationale for the inclusion of a project/unit on these tables; operation and shot abbreviations are defined in the Appendix.

| <u>CODE</u> | <u>RATIONALE</u>   |     |      |      |      |       |       |       |        |
|-------------|--|-----|------|------|------|-------|-------|-------|--------|
| Blank       | Stated participation does not apply to given shot, or non-participant in (and not impacted by) shot.   |     |      |      |      |       |       |       |        |
| IA          | Participated in shot activities before, during, or after shot, but not exposed to airborne radioactivity.  |     |      |      |      |       |       |       |        |
| IB          | Exposed or potentially exposed to airborne activity but provided absolute respiratory protection.  |     |      |      |      |       |       |       |        |
| II          | Exposed to resuspended fallout but received an external film badge dose (rem) less than that indicated for the conditions characterized by the matrix below: |     |      |      |      |       |       |       |        |
|             | 1  | 2   | 3    | 4    | 5    | 6     | 7     | 8     | 9      |
| A           | 4.2  | 1.3 | 0.44 | 0.20 | 0.10 | 0.059 | 0.028 | 0.011 | 0.0042 |
| B           | 42   | 13  | 4.4  | 2.0  | 1.0  | 0.59  | 0.28  | 0.11  | 0.042  |
| C           | 420  | 130 | 44   | 20   | 10   | 5.9   | 2.8   | 1.1   | 0.42   |

Where: A = Resuspension Factor (K) of  $1 \times 10^{-3} \text{m}^{-1}$   
 B = Resuspension Factor (K) of  $1 \times 10^{-4} \text{m}^{-1}$   
 C = Resuspension Factor (K) of  $1 \times 10^{-5} \text{m}^{-1}$   
 1 = Up to 4 hours after the detonation  
 2 = Up to 9 hours after the detonation

\* DNA-6001F through DNA-6028F and DNA-6032F through DNA-6040F.

- 3 = Up to 1 day after the detonation
- 4 = Up to 2 days after the detonation
- 5 = Up to 4 days after the detonation
- 6 = Up to 1 week after the detonation
- 7 = Up to 2 weeks after the detonation
- 8 = Up to 1 month after the detonation
- 9 = Up to 2 months after the detonation

For example, Code IIB2 indicates that the unit was exposed to moderately high levels of resuspended fallout ( $K = 1 \times 10^{-4} \text{m}^{-1}$ ) during the period up to 9 hours after the detonation and received an external film badge dose of 13 rem or less. Table 3 equates such an external dose to an internal bone dose commitment of less than 150 mrem. Note that when this code is applied, the actual or reconstructed film badge dose from residual radiation received by the project/unit is entered under " $D_{FB}$ " in the table. For some cases where the actual external dose is unknown but the other parameters are known, the maximum permissible dose limit for the operation is applied. If further research indicates that external doses exceeded the limits, the corresponding bone dose commitment must be reconsidered.

II Exposed to resuspended fallout in areas where the H+1 hour gamma radiation intensity (R/hr) was less than that indicated for the exposure parameters listed below:

|   | a    | b   | c   | d   |
|---|------|-----|-----|-----|
| A | 32   | 3.2 | N/A | N/A |
| B | 290  | 29  | 2.9 | N/A |
| C | 4000 | 400 | 40  | 4   |

Where:

- A = Resuspension factor (K) of  $1 \times 10^{-3} \text{m}^{-1}$
- B = Resuspension factor (K) of  $1 \times 10^{-4} \text{m}^{-1}$
- C = Resuspension factor (K) of  $1 \times 10^{-5} \text{m}^{-1}$
- a = Exposure duration of up to 1 hour
- b = Exposure duration of up to 10 hours
- c = Exposure duration of up to 100 hours
- d = Exposure duration of up to 1000 hours

For example, Code IIAb indicates that the unit operated up to 10 hours in an area where the H+1 hour intensity was 3.2 R/hr or less and the level of resuspended material was extremely high ( $K = 1 \times 10^{-3} \text{m}^{-1}$ ). According to Section 2.2, such exposure conditions would result in an internal bone dose commitment of less than 150 mrem. Note that film badge information is not required for assignment of these codes.

III Exposed to suspended neutron-activated material in the absence of a fallout field. According to Section 2.3, it is virtually impossible to obtain an internal bone dose commitment in excess of 150 mrem from exposures in an induced activity field. Some shots had induced activity fields supplemented by on-site fallout deposition, restricted to the downwind direction. Of the shots listed in table 2, Annie, Harry, Bee, Apple I, Wilson, and Priscilla are of this type. Where participants are known to have operated only in the induced activity portion of the field, Code III is assigned.

IV Exposed to nuclear cloud debris while in flight but received an external film badge dose (rem) less than that indicated for the conditions characterized by the matrix below:

| 1   | 2   | 3   | 4   |
|-----|-----|-----|-----|
| 5.0 | 2.4 | 1.1 | 0.5 |

Where: 1 = Up to 0.5 hours after the detonation  
 2 = Up to 1 hour after the detonation  
 3 = Up to 2 hours after the detonation  
 4 = Up to 4 hours after the detonation

For example, Code IV2 indicates that the participant flew through the nuclear cloud or fallout within the first hour after the detonation and received an external film badge dose of 2.4 rem or less for the duration of his immersion in the cloud. His exposure to airborne

contaminants may have persisted until he exited the aircraft. No personal protective gear is assumed. According to Section 2.4, such exposure conditions would result in an internal bone dose commitment of less than 150 mrem.

V Exposed to descending fallout from a nuclear cloud where the H+1 hour radiation intensity (R/hr) corresponding to completed fallout deposition on the surface was less than that indicated for the conditions listed below:

| 1  | 2  | 3   | 4 |
|----|----|-----|---|
| 30 | 15 | 7.5 | 3 |

Where: 1 = Up to 10 hours after the detonation  
 2 = Up to 20 hours after the detonation  
 3 = Up to 40 hours after the detonation  
 4 = Up to 100 hours after the detonation

For example, Code V2 indicates that fallout from the nuclear cloud reached the participant's site and attained a peak radiation intensity within 20 hours after the detonation. Negligible fallout deposition occurred after that time. The peak intensity, adjusted to H+1 hour according to  $t^{-1.2}$ , was less than 15 R/hr. According to Section 2.5, the participant, even if unprotected, would have received an internal bone dose commitment of less than 150 mrem.

A few of the code entries in the tables are asterisked because the shot involved was an exception to the conditions of code derivation (Section 2). Based on shot-specific information (table 2), effective values of film badge dose or radiation intensity are determined prior to application of codes.

For projects/units with multiple activities, the rules regarding inclusion in the list are according to the differentiability of project participants.

- Numbered subprojects are considered separately.
- If all project personnel were rotated at known intervals, each interval is considered separately.

- Air and ground participants are considered separately.
- If an individual could have performed all activities, the aggregate exposure is considered.
- For concurrent activities, activity sets are determined, each to be considered in the aggregate. Any set not satisfying code criteria excludes the entire project/unit from the list, except as noted above.

It must be emphasized that the assessments are based on the conditions reflected by the codes and stated activity. If additional information surfaces to indicate that the code does not accurately portray the exposure conditions (e.g., if the unit was exposed at a later time than that indicated or an individual participated in multiple activity sets), the dose must be re-evaluated. It should also be noted that unlisted project/unit personnel did not necessarily receive a bone dose commitment greater than 150 millirem. In many cases, units are excluded from the list because uncertainties in scenario or exposure conditions allow the possibility of the dose exceeding the threshold, pending further research. Also, the upper-limiting inherent in the generalized code definitions affects some cases. More detailed analyses of these cases may indicate that they qualify for inclusion in these tables.

Table 6. Project TRINITY participants with bone dose commitment less than 150 millirem.

| <u>PROJECT/UNIT</u>                            | <u>ACTIVITY</u>  | <u>D<sub>FB</sub></u> | <u>CODE (See Section 3 text)</u> |
|--|--|-----------------------|----------------------------------|
| Official Observers                             | Observed detonation from Base Camp or Compana Hills.   |                       | IA                               |
| Military Intelligence                          | Performed intelligence functions and measurements with recording barographs in towns and cities up to 100 miles from site.                     |                       | IA                               |
| Evacuation Detachment<br>(-Reinforced Platoon) | Observed detonation from bivouac area approximately 14 km NW of GZ. Evacuation contingency not exercised.                                      |                       | IA                               |
| Reinforced Platoon,<br>Evac. Detachment        | Observed detonation from bivouac area approximately 14 km NW of GZ. Deployed to Bingham (H+1.5 to H+7.5) Evacuation contingency not exercised. | 4.0                   | IIC2                             |
| TR-1B Timing and<br>Remote Control             | Manned N, W, and S 10,000 yd shelters on shot day.   |                       | IA                               |
|  | Visited W 800 yd station on D+1.   | 0.1                   | IIC3                             |
| TR-1C Stock                                    | Miscellaneous activities at Base Camp.   |                       | IA                               |
| TR-1E Radio-<br>communications                 | Operated radiocommunication equipment in 10,000 yd shelters.   |                       | IA                               |
| TR-2A Piezo Gauges                             | Retrieved gauges from shot area on D+1.  | 0.1                   | IIB3                             |
| TR-2C Excess Velocity<br>Measurements          | Conducted measurements at N and W 10,000 yd shelters on shot day.  |                       | IA                               |
|  | Visited N and W 800 yd stations on D+1.  | 0.15                  | IIC3                             |
| TR-2D Impulse Gauges                           | Manned W 10,000 yd shelter on shot day. One member made re-entry to W-800 yd station on D+1.   | 1.38                  | IIC3                             |
| TR-2E Maximum Pres-<br>sure Gauges             | Recovered instruments as close as W 300 yd station on D+1. Involved digging.   | 2.8                   | IIB3                             |
| TR-2H Displacement<br>Seismographs             | Manned N 10,000 yd shelter and several off-site stations on shot day.  |                       | IA                               |
| TR-4 and 4D<br>Meteorology                     | Gathered weather data at Base Camp.  |                       | IA                               |
| TR-6 Airborne Con-<br>denser Gauges            | Project to drop canisters from B-29 over GZ cancelled at last minute due to weather.   |                       | IA                               |
| TR-7B Searchlight<br>Crews                     | Tracked cloud with searchlights from N and W 10,000 yd shelters (L-2 and L-3).   |                       | IA                               |
|  | Tracked cloud with searchlights and made radiation measurements at stations (L-7 and L-8) approximately 20 miles NE of GZ.                     |                       | V1                               |

Table 7. Operation RANGER, scientific project participants with bone dose commitment less than 150 millirem.

| <u>PROJECT/ UNIT</u>                        | <u>ACTIVITY</u>  | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |           |            |           |
|---|--|-----------------------|--|-----------|-----------|------------|-----------|
|   |  |                       | <u>A*</u>                              | <u>B*</u> | <u>E*</u> | <u>B2*</u> | <u>F*</u> |
| Field Fortifications                        | Inspected field fortifications (trenches foxholes, etc.) and retrieved film badges from GZ area. |                       | III                                    | III       | III       | III        | III       |
| Thermal Effects Program                     | Retrieved test samples from GZ area.   |                       | III                                    | III       | III       | III        | III       |
| Thermal and Ionizing Radiation Measurements | Retrieved test samples (fabrics) from GZ area.   |                       | III                                    |           |           |            |           |
| Radiation Measurements                      | Retrieved ion chambers and test samples from GZ area.  |                       |  |           | III       | III        | III       |
| Fireball Growth                             | Retrieved film from camera stations 3.2 km NE and SE of GZ on shot day.                          |                       | IA                                     | IA        | IA        | IA         | IA        |
| Gamma Radiation as Function of Distance     | Retrieved film badges from GZ area on shot day.  |                       | III                                    | III       | III       | III        | III       |

\* See Appendix for shot abbreviation.

Table 8. Operation RANGER, Air Force support participants with bone dose commitment less than 150 millirem.

| <u>PROJECT/ UNIT</u>                                 | <u>ACTIVITY</u>  | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |           |            |           |
|--|--|-----------------------|--|-----------|-----------|------------|-----------|
|  |  |                       | <u>A*</u>                              | <u>B*</u> | <u>E*</u> | <u>B2*</u> | <u>F*</u> |
| 4925th Special Weapons Group                         | Dropped nuclear device from B-50.  |                       | IA                                     | IA        | IA        | IA         | IA        |
| 4925th Special Weapons Group                         | Conducted aerial radiation survey of GZ area from helicopters.                         |                       | IA                                     | IA        | IA        | IA         | IA        |
| 4925th Special Weapons Group                         | Flew disaster assistance missions in C-47 and provided general support (except decon). |                       | IA                                     | IA        | IA        | IA         | IA        |
| Strategic Air Command                                | Photographed mission from B-50 trailing drop aircraft.                                 |                       | IA                                     | IA        | IA        |            | IA        |
| 374th Recon Sq.                                      | Flew cloud sampling missions in B-29s (Aircrews breathed 100% oxygen).                 |                       | IB                                     | IB        | IB        | IB         | IB        |
| 374th Recon Sq.                                      | Flew cloud tracking mission in B-29s (Did not penetrate cloud).                        |                       | IA                                     | IA        | IA        | IA         | IA        |
| Cambridge Research Lab and Air Force Weather Service | Flew aerial radiation survey missions in B-17 and C-47 aircraft.                       |                       | IA                                     | IA        | IA        | IA         | IA        |
| 4901st Support Wing (Atomic)                         | Flew courier missions in B-25 aircraft.  |                       | IA                                     | IA        | IA        | IA         | IA        |
| 1009th Special Weapons Squadron                      | Manned off-site control center.  |                       | IA                                     | IA        | IA        | IA         | IA        |

\* See Appendix for shot abbreviations.

Table 9. Operation BUSTER, Desert Rock support participants with bone dose commitment less than 150 millirem.

| <u>PROJECT/UNIT</u>                    | <u>ACTIVITY</u>  | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |           |           |           |
|--|--|-----------------------|--|-----------|-----------|-----------|-----------|
|  |  |                       | <u>A*</u>                              | <u>B*</u> | <u>C*</u> | <u>D*</u> | <u>E*</u> |
| AFSWP Advisory Group                   | Provided advice to Desert Rock personnel. Accompanied observers and maneuver troops in forward area. |                       |  |           |           | III       |           |
| III Corps Hqs and Hqs Co               | Command functions.   |                       |  |           |           | III       |           |
| III Corps Arty, Hqs and Hqs Bty        | Command functions.   |                       |  |           |           | III       |           |
| Control Group                          | Supervised troop operations in forward area.   |                       |  |           |           | III       |           |
| 806th Army Postal Unit                 | General support at CDR.  |                       |  |           |           |           |           |
| 90th Engr Water Supply Co              | General support at CDR.  |                       |  |           |           |           |           |
| 231st Engr Cbt Bn                      | Recovered equipment and materials from display area.   |                       |  |           |           | III       |           |
| 359th Engr Util Det                    | General support at CDR.  |                       |  |           |           |           |           |
| 597th Engr Lt Equip Co, Det            | Forward area support to troop units.   |                       |  |           |           | III       |           |
| 705th Engr FM Co, Det Med              | General support at CDR.  |                       |  |           |           |           |           |
| 94th Vet Food Ins Det                  | General support at CDR.  |                       |  |           |           |           |           |
| 374th Conv Cen Dets A&B                | Established medical aid station and provided ambulances at forward parking area.                     |                       |  |           |           |           |           |
| 161st Ord Depot Co (-)                 | General support at CDR.  |                       |  |           |           |           |           |
| 393d Ord Bn                            | General support at CDR.  |                       |  |           |           |           |           |
| 3623d Ord Co                           | Forward area support.  |                       |  |           |           | III       |           |
| 505th MP Bn                            | Controlled traffic to shot area, accompanied troops into forward areas as part of Control Group.     |                       |  |           |           | III       |           |
| 53d QM Base Depot Co Hqs & Hqs Co, Det | General support at CDR.  |                       |  |           |           |           |           |

\* See Appendix for shot abbreviations.



Table 9. Operation BUSTER, Desert Rock support participants with bone dose commitment less than 150 millirem (Concluded).

| <u>PROJECT/UNIT</u>                 | <u>ACTIVITY</u>  | <u>DFB</u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |           |           |           |
|-------------------------------------|--|------------|--|-----------|-----------|-----------|-----------|
|                                     |  |            | <u>A*</u>                              | <u>B*</u> | <u>C*</u> | <u>D*</u> | <u>E*</u> |
| 523d QM Subs Co (-)<br>Det          | General support at CDR.  |            |  |           |           |           |           |
| 539th QM Ldry Co                    | General support at CDR.  |            |  |           |           |           |           |
| 621st QM Svc Co                     | General support at CDR.  |            |  |           |           |           |           |
| 303d Sig Svc Bn<br>Hqs & Hqs Co Det | General support at CDR.  |            |  |           |           |           |           |
| 314th Sig Svc Bn,<br>Co B, Det      | Forward area support.  |            |  |           |           |           | III       |
| 504th Sig Base Maint<br>Co Det      | General support to CDR.  |            |  |           |           |           |           |
| 4th Trans Trk Co                    | Transported observers, maneuver troops<br>and evaluation teams to forward area.                    |            |  |           |           |           | IA        |
| 92d Trans Trk Co                    | Transported observers, maneuver troops<br>and evaluation teams to forward area.                    |            |  |           |           |           | IA        |
| 562d Trans Staging<br>Area Co       | Transported observers, maneuver troops<br>and evaluation teams to forward area.                    |            |  |           |           |           | IA        |
| Chemical Corps<br>School            | Provided rad-safe support (radiological<br>surveys, accompanied observer and<br>evaluation teams). |            |  |           |           |           | III       |
| Hqs Sixth Army<br>Chem Section      | Provided rad-safe support (radiological<br>surveys, accompanied observer and<br>evaluation teams). |            |  |           |           |           | III       |
| Evaluation Teams                    | Evaluated damage to equipment in display<br>area; teams included Desert Rock support<br>troops.    |            |  |           |           |           | III       |

\* See Appendix for shot abbreviations.

Table 10. Operation BUSTER, Air Force support participants with bone dose commitment less than 150 millirem.

| <u>PROJECT/UNIT</u>                  | <u>ACTIVITY</u>   | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |           |           |           |
|--------------------------------------|---|-----------------------|--|-----------|-----------|-----------|-----------|
|                                      |   |                       | <u>A*</u>                              | <u>B*</u> | <u>C*</u> | <u>D*</u> | <u>E*</u> |
| 4925th Test 6p<br>(Atomic)           | Dropped nuclear device from aircraft.   |                       |  | IA        | IA        | IA        | IA        |
| 57th Strategic Recon<br>Sq (B-29)    | Flew cloud sampling missions in support of Projects 7.3 and 10.4 (Crew breathed 100% oxygen). |                       | IB                                     | IB        | IB        | IB        | IB        |
| APG, Eglin (T-33)                    | Flew cloud sampling missions in support of Projects 7.3 and 10.4 (Crew breathed 100% oxygen). |                       | IB                                     | IB        | IB        | IB        | IB        |
| 4901st Support Wing<br>(Atomic)      | Flew disaster control mission in C-47.  |                       | IA                                     | IA        | IA        | IA        | IA        |
| 57th Strategic Recon<br>Sq (weather) | Flew cloud tracking missions (did not penetrate cloud).                                       |                       |  | IA        | IA        | IA        | IA        |
| 4901st Support<br>Wing               | Flew aerial radiation survey missions in C-47s.   |                       |  | IA        | IA        | IA        | IA        |
| 1009th Support<br>Weapons Sq         | Flew aerial radiation survey missions in C-47s.   |                       |  | IA        | IA        | IA        | IA        |
| 57th Strategic Recon<br>Sq           | Flew aerial radiation survey missions in C-47s.   |                       |  | IA        | IA        | IA        | IA        |
| 4901st Support Wing<br>(Atomic)      | General support at ISAFB (except decontamination).  |                       |  |           |           |           |           |

\* See Appendix for shot abbreviations.

Table 11. Operation BUSTER, maneuver troops and observers with bone dose commitment less than 150 millirem.

| <u>PROJECT/UNIT</u>                  | <u>ACTIVITY</u>   | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |           |           |           |
|--------------------------------------|---|-----------------------|--|-----------|-----------|-----------|-----------|
|                                      |   |                       | <u>A*</u>                              | <u>B*</u> | <u>C*</u> | <u>D*</u> | <u>E*</u> |
| Maneuver Troops<br>(Desert Rock I)   | Observed shot from point 11 km south of GZ. Advanced on foot to objective near GZ; toured display area on shot day. |                       |  |           |           | III       |           |
| Service Observers<br>(Desert Rock I) | Observed shot from point 11 km south of GZ. Toured 4 of 5 display areas on shot day.                                |                       |  |           |           | III       |           |
|                                      | Observed shot from observation area more than 10 km S of GZ.  |                       |  |           | IA        |           | IA        |

\* See Appendix for shot abbreviations.

Table 12. Operation BUSTER, AFWSP project participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT   | ACTIVITY  | DFB | SHOTS/CODE (See Section 3 text) |     |     |     |     |
|--|---|-----|---------------------------------|-----|-----|-----|-----|
|  |   |     | A*                              | B*  | C*  | D*  | E*  |
| 2.3 Effects of Geometry on Flush Thermal Damage                        | Inspected test samples (wood) in GZ area on shot day. Recovery on D+1.                      |     |                                 | III |     | III |     |
| 2.4a Protective Value and Ignition of Textile Materials                | Inspected test fabrics in GZ area on shot day.  |     |                                 | III |     | III |     |
| 2.4b Thermal Effects on Paints, Plastics, and Coated Fabrics           | Inspected, photographed and recovered samples on shot day.                                  |     |                                 | III |     | III |     |
| 2.4-1 Basic Thermal Measurements                                       | Retrieved thermal detectors and samples of cloth, wood, and paint from GZ area on shot day. |     |                                 | III | III | III | III |
| 2.4.2 Effects of Thermal Radiation on Materials                        | Inspected and recovered samples from GZ area on shot day.                                   |     |                                 | III |     | III |     |
| 2.6 Field Fortification Protection against Gamma and Neutron Radiation | Recovered dosimeters from foxholes in GZ area on shot day.                                  |     |                                 | III | III | III |     |
| 3.5 Minefield Clearance  | Inspected minefield in GZ area. Recovered some fuses and replaced others.                   |     |                                 | III | III | III | III |
| 3.8 Vulnerability of Parked Aircraft                                   | Inspected and recovered instruments from test A/C parked in GZ area.                        |     |                                 |     |     | III | III |
| 3.9 Effects on Water Supply Equipment                                  | Inspected and photographed water tanks in GZ area on shot day.                              |     |                                 |     |     |     | III |
| 4.1 Radiation Dosimetry  | Recovered radiation detectors (some buried) from GZ area on shot day.                       |     |                                 | III | III | III | III |
| 4.2 Thermal Effects on Animals   | Recovered test animals (dogs) from GZ area on shot day.                                     |     |                                 | III |     | III |     |
| 4.2a Thermal Effects on Animals  | Recovered test animals (rats) from GZ area on shot day.                                     |     |                                 | III |     | III |     |
| 4.3 Flash Blindness  | Observed shot from C-54, at 15,000 ft altitude, 15 km south of GZ.                          |     |                                 | IA  | IA  | IA  |     |
| 6.1b Dosimetric Materials  | Recovered dosimeters from shelters in GZ area on shot day.                                  |     |                                 | III | III | III |     |
| 6.4 Airborne Radiac Evaluation   | Conducted radiation measurements from aircraft.   |     |                                 | IA  | IA  | IA  | IA  |

\* See Appendix for shot abbreviations.

Table 12. Operation BUSTER, AFWSP project participants with bone dose commitment less than 150 millirem (Concluded).

| <u>PROJECT/UNIT</u>               | <u>ACTIVITY</u>   | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |           |           |           |
|-----------------------------------|---|-----------------------|--|-----------|-----------|-----------|-----------|
|                                   |   |                       | <u>A*</u>                              | <u>B*</u> | <u>C*</u> | <u>D*</u> | <u>E*</u> |
| 6.5 IBDA                          | Tested airborne radar for IBDA.                                       |                       |  |           |           | IA        | IA        |
| 6.9 Effects on Radio Propagation  | Tested radio communications at off-site locations.                    |                       |  |           |           | IA        | IA        |
| 7.1 Transport of Radiation Debris | Analyzed cloud tracking information. (See Air Force Support).         |                       |  | IA        | IA        | IA        | IA        |
| 7.2 Long Range Light Measurements | Operated cameras from off-site locations.                             |                       |  | IA        | IA        | IA        | IA        |
| 7.3 Radiochemical Analysis        | Analyzed samples obtained by cloud samplers. (See Air Force Support). |                       | IA                                     | IA        | IA        | IA        | IA        |
| 7.5 Seismic Waves                 | Recovered records from stations located 10-20 km south of GZ.         |                       | IA                                     | IA        | IA        | IA        | IA        |
| 7.6 Airborne Low Frequency Sound  | Operated remote stations.   |                       |  | IA        | IA        | IA        | IA        |
| 8.2 Air Weather Service           | Operated weather station at CP and several off-site locations.        |                       | IA                                     | IA        | IA        | IA        | IA        |
| 8.4 Technical Photography         | Photographed test from Project 6.5 aircraft.                          |                       |  |           |           | IA        | IA        |

\* See Appendix for shot abbreviations.

Table 13. Operation JANGLE, Desert Rock support participants with bone dose commitment less than 150 millirem.

| <u>PROJECT/ UNIT</u>                      | <u>ACTIVITY</u>   | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |
|---|---|-----------------------|--|-----------|
|   |   |                       | <u>S*</u>                              | <u>U*</u> |
| III Corps Arty, Hq and Hq Btry            | Command functions at CDR.   |                       |  |           |
| Control Group                             | Supervised troop operations in forward area.  | 0.195                 | IIC3                                   | IIC4      |
| 359th Engr Util Det                       | General support at CDR.   |                       |  |           |
| 90th Engr Water Sup Co                    | General support at CDR.   |                       |  |           |
| 705th Engr Fed Maint Co, Maint Plt        | General support at CDR.   |                       |  |           |
| 393rd Ord Bn, Hq and Hq Det               | General support at CDR.   |                       |  |           |
| 161st Ord Depot Co                        | General support at CDR.   |                       |  |           |
| 303rd Sig Svc Bn Hq and Hq Co, Det (1)    | General support at CDR.   |                       |  |           |
| 314th Sig Svc Br, Hq and Hq Co and Co "B" | General support at CDR.   |                       |  |           |
| 504th Sig Base Maint Co (Det)             | General support at CDR.   |                       |  |           |
| 505th MP Bn, Co "A"                       | Controlled traffic to shot area, accompanied troops to forward area.                                    | 0.053                 | IIC3                                   |           |
| 505th MP Bn, Co "C"                       | Controlled traffic to shot area, accompanied troops to forward area.                                    | 0.195                 | IIC3                                   | IIC4      |
| 621st QM Svc Co                           | General support at CDR.   |                       |  |           |
| 523rd QM Sub Dep Co, 1 Plt (-)            | General support at CDR.   |                       |  |           |
| 53rd QM Base Depot Co (Det)               | General support at CDR.   |                       |  |           |
| 539th QM Ldry Co, 1 Plt                   | General support at CDR.   |                       |  |           |
| 4th TC Trk Co                             | Transported observers and Evaluation Teams to forward area. Drove observers through Sugar display area. | 0.053                 | IIC3                                   |           |
| 92nd TC Car Co, 2 Plt                     | General support at CDR.   |                       |  |           |
| 806th APU                                 | General support at CDR.   |                       |  |           |
| 94th VFID                                 | General support at CDR.   |                       |  |           |
| 562nd Staging Area Co, 4 Sections         | General support at CDR.   |                       |  |           |
| Food Service Personnel                    | General support at CDR.   |                       |  |           |

\* See Appendix for shot abbreviations.

Table 14. Operation JANGLE, Air Force support participants with bone dose commitment less than 150 millirem.

| <u>PROJECT/ UNIT</u>    | <u>ACTIVITY</u>  | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |
|-------------------------|--|-----------------------|--|-----------|
|                         |  |                       | <u>S*</u>                              | <u>U*</u> |
| 4925th Test Gp (A)      | Flew cloud sampling mission in B-29s (breathed 100% oxygen).   |                       | IB                                     | IB        |
| 57th Strategic Recon Sq | Flew cloud tracking mission. Did not penetrate cloud.          |                       | IA                                     | IA        |
| 4901st Support Wing (A) | Flew Project 2.1c-1 missions and other aerial survey missions. |                       | IA                                     | IA        |
| 4901st Support Wing (A) | Flew courier mission from ISAFB.                               |                       | IA                                     | IA        |

Table 15. Operation JANGLE, Desert Rock observers with bone dose commitment less than 150 millirem.

| <u>PROJECT/ UNIT</u>       | <u>ACTIVITY</u>  | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |
|----------------------------|--|-----------------------|--|-----------|
|                            |  |                       | <u>S*</u>                              | <u>U*</u> |
| Service Observers (DR II)  | Observed shot from 9 km south of GZ. Toured display area in bus on D+1.                                    | 0.053                 | IIC3                                   |           |
| Service Observers (DR III) | Toured display area in bus on D-1. Observed shot from 9 km south of GZ. Toured display area in bus on D+2. | 0.142                 |  | IIC4      |

\* See Appendix for shot abbreviations.

Table 16. Operation JANGLE, AFSWP project participants with bone dose commitment less than 150 millirem.

| PROJECT/ UNIT  | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |        |
|--|--|-----------------|---------------------------------|--------|
|  |  |                 | S*                              | U*     |
| 1.3a Free Air Shock                                  | Suspended gauges from balloons in shot area prior to shot. Manned telemetry station approximately 13 km S of Sugar GZ.   |                 | IA                              | IA     |
| 1.3c Measurement of Free Air Blast Pressures         | Dropped canisters from B-29s. Recorded data from telemetry station 8 km SW of GZ.  |                 | IA                              |        |
| 1.5b Time of Arrival of Earth Movement               | Placed flash lamps at stations 30 to 180 m from GZ prior to shot. Photographed lamps from camera stations 2700 m E of GZ. Recovered film from cameras after R-hour.                    | 3.0             |                                 | IIC3   |
| 1.8b Air Weather Service Participation               | Operated weather station at CP and several off-site locations.   |                 | IA                              | IA     |
| 1.9b Base Surge Analysis                             | Analyzed photos of test.   |                 |                                 | IA     |
| 2.1c-1 Aerial Survey of Distant Contaminated Terrain | Tested airborne radiac for terrain surveys.  |                 | IA                              | IA     |
| 2.1c-2 Aerial Survey of Local Contaminated Terrain   | Tested airborne radiac for terrain surveys.  |                 | IA                              | IA     |
| 2.3-1 Total Gamma Radiation Dosage                   | Recovered dosimeters from stations 300 m to 15 km in various directions from GZ on D+2   | 3.0             | IIB4**                          | IIB4** |
| 2.3-2 Foxhole Shielding of Gamma Radiation           | Recovered dosimeter from foxholes, 610-1530 m NE of GZ on D+2.   | 3.0             | IIB4**                          | IIB4** |
| 2.4b Gamma Depth Dose in Unit Density Material       | Recovered instrumented phantoms from stations 690-1070 m SW of Sugar GZ and 460-910 m WSW of Uncle GZ on shot day.   | 3.0             | IIC2                            | IIC2   |
| 2.5a-2 Fallout Particle Studies                      | Recovered samples from fallout trays and air samples 610-6100 m NE of GZ.  | 3.0             | IIB3**                          | IIB3** |
|  | Recovered samples from GZ area using grappling hooks from helicopters.   | 3.0             | IIA1                            | IIA1   |
| 2.5a-3 Radiochemical Studies of Large Particles      | Analyzed Project 2.5a-1 samples.   |                 | IA                              | IA     |
| 2.6a Remotely Controlled. Sampling Techniques        | Collected soil samples from crater and lip area with weasel controlled remotely from station 1830 m from GZ. Removed samples from weasel at shield 4 miles upwind from GZ on shot day. | 3.0             | IIB2                            | IIB2   |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

Table 16. Operation JANGLE, AFSWP project participants with bone dose commitment less than 150 millirem (Concluded).

| PROJECT/ UNIT   | ACTIVITY  | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |      |
|---|---|-----------------|---------------------------------|------|
|   |   |                 | S*                              | U*   |
| 2.6c-2 Nature and Distribution of Residual Contamination II       | Analyzed samples collected by Project 2.6a.   |                 | IA                              | IA   |
| 2.7 Biological Injury from Particle Inhalation                    | Recovered dogs and sheep from stations 760, 1530, and 2440 m NE to NW of GZ at H+6.   | 3.0             | IIB2                            |      |
|   | Recovered dogs and sheep from stations 760, 1530, and 2440 m N to NW of GZ (some at H+6, rest at H+24).   | 3.0             |                                 | IIB3 |
| 4.1 Aerial Technical Photography                                  | Took photos from C-47 aircraft.   |                 | IA                              | IA   |
| 4.1a-1 Ground Technical Photography                               | Recovered film and cameras from the following stations beginning at H+3 and H+23.5: 4570 m SE, 3000 m NE, 2470 m E, 2440 m NW, and 1520 m SE.                     | 3.0             |                                 | IIC3 |
|   | Recovered film and cameras from the following stations beginning at H+3: 4570 m SW, 4270m SE, 3000 m NE, 2740 m SE, 1520 m SE, 1460 m SE, 1370 m SE, and 640m S.  | 3.0             | IIC3                            |      |
| 4.1a-2 Photographic Analysis                                      | Analyzed photos at remote location.   |                 | IA                              | IA   |
| 6.1 Evaluation of Military Radiac                                 | Evaluated various radiac equipment on shot day.   | 3.0             | IIC2                            | IIC2 |
| 6.4 Indirect Bomb Damage Assessment                               | Recorded data from aircraft over shot area.   |                 |                                 | IA   |
| 6.8 Evaluation of Field Water Supply                              | Retrieved water sample from open tank 460 m NE of Sugar GZ at H+6. Collected 70 pounds of dirt from crater lip at H+26 and used it to contaminate water for test. | 4.99            | IIB3**                          |      |
| 7.1a Transport of Radiation Debris                                | Tracked radioactive cloud using data received from B-29 cloud tracker (see Air Force Support).  |                 | IA                              | IA   |
| 7.1b Radiochemical Chemical, and Physical Analysis of Bomb Debris | Analyzed samples collected by cloud samplers (see Air Force Support).   |                 | IA                              | IA   |
| 7.3 Airborne Low-Frequency Sound                                  | Manned off-site stations.   |                 | IA                              | IA   |
| 8.4 Technical Photography for IBDA (Project 6.4)                  | Took photos from Project 6.4 aircraft.  |                 |                                 | IA   |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.



Table 17. Operation TUMBLER-SNAPPER, Desert Rock support personnel with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                                  | ACTIVITY  | DFB     | SHOTS/CODE (See Section 3 text) |    |     |     |    |      |      |    |
|---|---|---------|---------------------------------|----|-----|-----|----|------|------|----|
|   |   |         | A*                              | B* | C*  | D*  | E* | F*   | G*   | H* |
| CDR Headquarters                              | Command functions.  | 0.106** |                                 |    | III | III |    |      | IIA2 |    |
| Instructor Gp                                 | Presented orientation course.<br>Accompanied troops through display areas.  |         |                                 |    | III | III |    |      |      |    |
| AFSWP Instructor Gp                           | Presented orientation courses, accompanied observer and maneuver troops in trenches. Conducted tours of display area on shot day. | 3.0     |                                 |    |     |     |    | IIC2 | IIC2 |    |
| Hq & Hq Svc Co, 369th Engr Amph Spt Rgt***    | General support at CDR.   |         |                                 |    |     |     |    |      |      |    |
| Shore Bn, 369th Engr Amph Spt Rgt (Co D-F)*** | Construction of display areas (passed through fallout from Shot Easy).  | 0.056   |                                 |    | IA  | IA  |    | IA   | IA   |    |
| 562nd TSAC (-Plt)                             | Provided transportation for observers to and from forward area.   |         |                                 |    | IA  | IA  |    | IA   | IA   |    |
| 23rd Trans Trk Co                             | Provided transportation for maneuver troops and observers to and from forward area.   |         |                                 |    | IA  | IA  |    | IA   | IA   |    |
| 31st Trans Trk Co***                          | Provided transportation for maneuver troops and observers to and from forward area.   |         |                                 |    | IA  | IA  |    | IA   | IA   |    |
| 505th MP Bn, Co A                             | Controlled traffic on shot day.   |         |                                 |    | IA  | IA  |    | IA   | IA   |    |
| 314th Sig Constr Bn Det                       | Installed wire and radiocommunications system in trench area. (Exposed to Easy fallout during preparation for Shot Fox.)          | 0.056   |                                 |    | IA  | IA  |    | IA   | IA   |    |
| 504th Sig Base Maint Co Det                   | Operated PA systems in display area during tours on shot day.   | 3.0     |                                 |    | III | III |    | IIC2 | IIC2 |    |
| Med Det, Sixth Army                           | Established first aid station in forward area parking lot.  |         |                                 |    | IA  | IA  |    | IA   | IA   |    |
| 360th Army Band                               | General support at CDR.   |         |                                 |    |     |     |    |      |      |    |

\* See Appendix for shot abbreviations.

\*\* For Shot George.

\*\*\* Participated in Shot George troop maneuver.

Table 18. Operation TUMBLER-SNAPPER, Air Force support participants with bone dose commitment less than 150 millirem.

| <u>PROJECT/UNIT</u>   | <u>ACTIVITY</u>  | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |           |           |           |           |           |           |
|-----------------------|--|-----------------------|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|                       |  |                       | <u>A*</u>                              | <u>B*</u> | <u>C*</u> | <u>D*</u> | <u>E*</u> | <u>F*</u> | <u>G*</u> | <u>H*</u> |
| 4925th Test Gp (A)    | Dropped nuclear device from aircraft.  |                       | IA                                     | IA        | IA        | IA        |           |           |           |           |
| 4925th Test Gp (A)    | Flew cloud sampling missions (crews breathed 100% oxygen) in support of Program 13.        |                       | IB                                     | IB        | IB        | IB        | IB        | IB        | IB        | IB        |
| 4925st Test Gp (A)    | Flew aerial survey missions.   |                       | IA                                     | IA        | IA        | IA        | IA        | IA        | IA        | IA        |
| 4925th Test Gp (A)    | General support at ISAFB (except decon).   |                       | IA                                     | IA        | IA        | IA        | IA        | IA        | IA        | IA        |
| 4925th Test Gp (A)    | Trained Task Group 132.4 pilots in cloud sampling techniques (crews breathed 100% oxygen). |                       | IB                                     | IB        | IB        | IB        | IB        | IB        | IB        | IB        |
| 4901st Support Wg (A) | Flew cloud tracking missions. (Did not penetrate cloud.)                                   |                       | IA                                     | IA        | IA        | IA        | IA        | IA        | IA        | IA        |
| 55th Weather Recon Sq | Flew cloud tracking missions. (Did not penetrate cloud.)                                   |                       | IA                                     | IA        | IA        | IA        | IA        | IA        | IA        | IA        |
| 4901st Support Wg (A) | Flew courier missions.   |                       | IA                                     | IA        | IA        | IA        | IA        | IA        | IA        | IA        |
| 4901st Support Wg (A) | Flew disaster control missions in support of drop aircraft.                                |                       | IA                                     | IA        | IA        | IA        |           |           |           |           |
| 4901st Support Wg (A) | General support at Kirtland AFB (except decon).  |                       |  |           |           |           |           |           |           |           |

\* See Appendix for shot abbreviations.

Table 19. Operation TUMBLER-SNAPPER, maneuver troops and observers with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                           | ACTIVITY  | DFB   | SHOTS/CODE (See Section 3 text) |    |     |     |    |    |      |    |
|--|---|-------|---------------------------------|----|-----|-----|----|----|------|----|
|  |   |       | A*                              | B* | C*  | D*  | E* | F* | G*   | H* |
| Manuever Troops<br>(Shot Charlie)      | Observed shot from trenches 6400 m S of GZ. Advanced on foot to display area SW of GZ, then to paratroop drop area NNW of GZ.             |       |                                 |    | III |     |    |    |      |    |
| Paratroops (82d AB Div) (Shot Charlie) | Parachuted to area NNW of GZ. Advanced south on foot and joined BCT.  |       |                                 |    | III |     |    |    |      |    |
| Manuever Troops<br>(Shot Dog)          | Observed shot from trenches 6400 m S of GZ. Toured display areas 2 and 3. Maneuver cancelled due to high radiation levels.                |       |                                 |    |     | III |    |    |      |    |
| Manuever Troops<br>(Shot George)       | Observed shot from trenches 6400 m S of GZ. Advanced on foot behind tanks to 0.5 R/hr line S of GZ, then toured display area on shot day. | 0.106 |                                 |    |     |     |    |    | IIA2 |    |
| Service Observers<br>(Shot Charlie)**  | Observed shot from trenches 6400 m S of GZ. Toured display area on shot day.  |       |                                 |    | III |     |    |    |      |    |
| Service Observers<br>(Shot Dog)**      | Observed shot from trenches 6400 m S of GZ. Toured display areas 2 and 3 on shot day.   |       |                                 |    |     | III |    |    |      |    |
| Service Observers<br>(Shot Fox)**      | Observed shot from trenches 6400 m SE of GZ. Performed rifle tests and completed psychological tests and toured display area on shot day. | 0.126 |                                 |    |     |     |    |    | IIC2 |    |
| Service Observers<br>(Shot George)**   | Observed shot from trenches 3200 m SW of GZ and toured display area on shot day.  | 0.028 |                                 |    |     |     |    |    | IIC2 |    |
| CDR Observers                          | Observed shot from point near CP.   |       |                                 |    |     | IA  |    |    |      |    |
| Strategic Air<br>Command Observers     | Viewed shot from B-50 aircraft.   |       | IA                              | IA | IA  | IA  |    | IA | IA   | IA |

\* See Appendix for shot abbreviations.

\*\* Some CDR support troops also participated.

Table 20. Operation TUMBLER-SNAPPER, AFSWP project participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT  | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |     |     |     |      |      |      |      |
|---|--|-----------------|---------------------------------|-----|-----|-----|------|------|------|------|
|   |  |                 | A*                              | B*  | C*  | D*  | E*   | F*   | G*   | H*   |
| 1.1 Measurements of Free Air Blast Pressures        | Dropped instrumented canisters from B-29s over GZ.   |                 |                                 |     |     |     | IA   |      |      | IA   |
| 1.1 Measurements of Free Air Blast Pressures        | Manned telemetry/tracking stations least 11 km S, SE, and SW of GZ.  |                 |                                 |     |     |     | IA   |      |      | IA   |
| 1.1 Measurements of Free Air Blast Pressures        | Recovered instruments from underground station 1830 m E of GZ on D+1. (Retrieval of canisters not considered). |                 |                                 |     |     |     |      |      |      | IA   |
| 1.2 Air Pressure vs Time                            | Recovered blast gauges from blast line on shot day and D+1.  |                 | III                             | III | III | III |      |      |      |      |
| 1.3 Ground-level Pressure Measurements              | Recovered data from instrument trailer and blast gauges from blast line on shot day and D+1.                   |                 | III                             | III | III | III |      |      |      |      |
| 1.5 Free-Air Pressure Measurements                  | Photographed rocket trails from remote location, inspected, retrieved rocket launchers after shot.             |                 | III                             | III | III | III |      |      |      |      |
| 1.6 Ground Acceleration Measurements                | Recovered buried accelerometers from blast line on shot day and D+1.   |                 | III                             | III | III | III |      |      |      |      |
| 1.7 Earth Acceleration vs Time                      | Recovered buried accelerometers from blast line of shot day and D+1.   |                 | III                             | III | III | III |      |      |      |      |
| 1.9 Pre-Shock Dust                                  | Recovered air samplers from GZ area on shot day.   |                 | III                             | III | III | III |      |      |      |      |
| 1.13 Measurement of Air Blast Pressure vs Time      | Recovered gauges and film from GZ area.  |                 |                                 | III | III | III |      |      |      |      |
| 2.1 Total Gamma Exposure vs Distance                | Retrieved film packets from GZ area on shot day.   | 3.0             | III                             | III | III | III | IIC2 | IIC2 | IIC2 | IIC2 |
| 2.2 Gamma Energy Spectrum of Residual Contamination | Took measurements with radiac meters in radiation fields up to 1.3 R/hr on shot day, D+1 and D+2.              | 3.0             |                                 |     |     |     | IIC4 | IIC4 | IIC4 | IIC4 |

\* See Appendix for shot abbreviations.

Table 20. Operation TUMBLER-SNAPPER, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT   | ACTIVITY  | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |     |     |     |      |      |      |      |
|--|---|-----------------|---------------------------------|-----|-----|-----|------|------|------|------|
|  |   |                 | A*                              | B*  | C*  | D*  | E*   | F*   | G*   | H*   |
| 2.3 Neutron Flux and Energy Measurements                   | Retrieved neutron detectors from line 200-1830 m from GZ and assisted Project 17.1 personnel.       |                 |                                 |     | III | III |      |      |      | IICb |
| 3.1 Vulnerability of Parked Aircraft                       | Recovered film and instrument data and inspected damage to aircraft in test area.                   |                 | III                             | III | III | III |      |      |      |      |
| 3.3 Blast Damage to Trees                                  | Inspected damage to trees planted in GZ area.   |                 |                                 | III | III | III |      |      |      |      |
| 3.4 Minefield Clearance                                    | Inspected mine field in GZ area, emplaced mines for next shot. Removed undetonated mines after Dog. |                 |                                 | III | III | III |      |      |      |      |
| 4.2 Biomedical Exposure Equipment                          | Recovered film, test animals, and instruments from GZ area on shot day.                             |                 |                                 |     | III | III |      |      |      |      |
| 4.2 Biomedical Exposure Equipment                          | Recovered film from cameras in Easy GZ area and inspected cages 90-180 m from GZ on shot day.       | 3.0             |                                 |     |     |     |      | IIC2 |      |      |
| 4.2 Biomedical Exposure Equipment                          | Recovered film from stations 550, 640, and 790 m SE of GZ on shot day.                              | 3.0             |                                 |     |     |     |      |      |      | IIC2 |
| 4.3 Biological Effectiveness of Neutron Radiation          | Recovered mice from stations 90-1010 m from Charlie GZ and 780-1330 m from Dog GZ on shot day.      |                 |                                 |     | III | III |      |      |      |      |
| 4.3 Biological Effectiveness of Neutron Radiation          | Recovered mice and neutron detectors from station 870 m SE of GZ on shot day.                       | 3.0             |                                 |     |     |     |      |      |      | IIB2 |
| 4.4 Gamma Depth Dose Measurements in Unit Density Material | Recovered dosimeters placed in lucite spheres not less than 1 km from GZ on shot day.               | 3.0             |                                 |     | III | III | IIC2 |      |      | IIC2 |
| 4.5 Flash Blindness  | Witnessed detonation from trailer 15 km SW of GZ.   |                 |                                 |     | IA  | IA  |      |      |      |      |
| 6.1 Evaluation of Military Radiac                          | Recovered dosimeters from stations 910-2750 m from GZ on shot day.                                  | 3.0             | III                             |     | III |     | IIC2 | IIC2 | IIC2 | IIC2 |

\* See Appendix for shot abbreviations.

Table 20. Operation TUMBLER-SNAPPER, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT  | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |     |     |     |    |      |      |      |
|---|--|-----------------|---------------------------------|-----|-----|-----|----|------|------|------|
|   |  |                 | A*                              | B*  | C*  | D*  | E* | F*   | G*   | H*   |
| 6.1 Evaluation of Military Radiac                             | Took radiation measurements on D+1 in areas where intensity was 8.0 R/hr on shot day.  | 3.0             |                                 |     |     |     |    | IIC3 | IIC3 |      |
| 6.1 Evaluation of Military Radiac                             | Performed aerial survey of shot area from LC-126 about 30 minutes after the detonation.  |                 |                                 |     |     |     |    |      | IA   |      |
| 6.3 Evaluation of Filtration System for Pressurized Aircraft  | Flew through clouds in pressurized B-29s. (Removal of filters by ground crews not included).   |                 |                                 |     |     |     | IB | IB   | IB   |      |
| 6.4 IBDA  | Flew simulated bomb runs in formation with drop aircraft. One aircraft intentionally penetrated cloud at Shot Fox (crew breathed 100% oxygen). |                 | IA                              | IA  | IA  | IA  | IA | IB   |      |      |
| 6.7 Evaluation of Air Monitoring Instruments                  | Recovered air samplers from stations 8-10.5 km from GZ. Radiation intensities ranged from background to 5.0 R/hr during recovery at H+8 hr.    | 3.0             |                                 |     |     |     |    | IIC2 | IIC2 | IIC2 |
| 7.1a Electromagnetic Effects                                  | Manned on-site stations at Yucca Lake and off-site stations throughout world.  |                 |                                 |     | IA  | IA  | IA | IA   | IA   | IA   |
| 7.1b Long-range Light Measurements                            | Manned off-site stations throughout US.  |                 |                                 | IA  | IA  | IA  | IA | IA   | IA   | IA   |
| 7.2 Detection of Low Frequency Sound                          | Manned off-site stations throughout US.  |                 | IA                              | IA  | IA  | IA  | IA | IA   | IA   | IA   |
| 7.3 Radiochemical and Physical Analysis of Atomic Bomb Debris | Analyzed samples collected by cloud samplers (see Air Force Support).  |                 | IA                              | IA  | IA  | IA  | IA | IA   | IA   | IA   |
| 8.1 Effects on Forest Fuels                                   | Recovered samples from GZ area.  |                 |                                 |     | III | III |    |      |      |      |
| 8.2 Air Temperatures in Vicinity of Detonation                | Recovered thermal detectors from stations along blast line.  |                 | III                             | III | III | III |    |      |      |      |

\* See Appendix for shot abbreviations.

Table 20. Operation TUMBLER-SNAPPER, AFSWP project participants with bone dose commitment less than 150 millirem (Concluded).

| PROJECT/UNIT  | ACTIVITY  | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |     |     |     |      |      |      |      |
|---|---|-----------------|---------------------------------|-----|-----|-----|------|------|------|------|
|   |   |                 | A*                              | B*  | C*  | D*  | E*   | F*   | G*   | H*   |
| 8.3 Thermal Radiation from Nuclear Detonation               | Recovered instruments from stations along blast line.   |                 | III                             | III | III | III |      |      |      |      |
| 8.3a Thermal Radiation Measurements Using Passive Detectors | Recovered detectors from stations along blast line.   |                 |                                 |     | III |     |      |      |      |      |
| 8.4 Atmospheric Transmissions and Weather Measurements      | Collected meteorological data prior to shot. Collected data from receiving station at BJY after shot. Assisted Project 8.3a retrieve instruments. |                 |                                 | IA  | III | IA  |      |      |      |      |
| 8.5 Incendiary Effects on Building Sections                 | Inspected and recovered structures located in GZ area.  |                 |                                 |     | III | III |      |      |      |      |
| 8.6 Sound Velocity Changes Near Ground                      | Retrieved instruments from GZ area.   |                 | III                             | III | III | III |      |      |      |      |
| 8.7 Thermal Radiation Measurements                          | Trained UCLA personnel in use of thermal radiation measurement equipment and collected data recorded in Bldg. 400, near CP.                       |                 |                                 |     |     |     |      | IA   | IA   | IA   |
| 9.1 Technical and Training Photography                      | Provided photographic support to technical projects.  |                 | III                             | III | III | III | IICb | IICb | IICb | IICb |
| 9.2 Air Weather Service Participation                       | Operated on-site and off-site weather stations and compiled data for forecasts in support of operation.   |                 | IA                              | IA  | IA  | IA  | IA   | IA   | IA   | IA   |
| 9.2 Air Weather Service Participation                       | Recovered data from wind and humidity measurement stations on blast line on shot day. Recovered instruments on D+1.                               | 3.0             | III                             | III | III | III | IIB3 | IIB3 | IIB3 |      |
| 9.4 Effects on the Ionosphere                               | Operated on-site transmitter station 910 m N of CP and other transmitter/receiver stations off-site.  |                 | IA                              | IA  | IA  | IA  | IA   | IA   | IA   |      |
| 9.5 Electromagnetic Radiation Over the Radio Spectrum       | Operated two on-site stations 16-25 km from GZ and two off-site stations.   |                 | IA                              | IA  | IA  | IA  | IA   | IA   | IA   |      |

\* See Appendix for shot abbreviations.

Table 21. Operation TUMBLER-SNAPPER, other project participants with bone dose commitment less than 150 millirem.

| <u>PROJECT/UNIT</u>                                       | <u>ACTIVITY</u>                         | <u>DFB</u> | <u>SHOTS/CODE (See Section 3 text)</u> |           |           |           |           |           |           |           |
|---|---|------------|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|   |   |            | <u>A*</u>                              | <u>B*</u> | <u>C*</u> | <u>D*</u> | <u>E*</u> | <u>F*</u> | <u>G*</u> | <u>H*</u> |
| 10.2 Test of Scintillator Optical Path Technique          | Took measurements from remote location. |            |  |           |           |           |           | IA        | IA        |           |
| 18.1 Total Thermal Radiation and Atmospheric Transmission | Recovered brightness meter from Area 2. |            |  |           |           |           | IICa      | IICa      | IA        | IICa      |
| 18.3 Color Temperatures                                   | Took measurements at CP.                |            |  |           |           |           | IA        |           | IA        | IA        |
| 18.4 High-Resolution Spectroscopy                         | Took measurements at CP.                |            |  |           |           |           | IA        | IA        | IA        | IA        |
| 19.2a+b Blast-wave Material Velocity Measurements         | Recovered 90 mm gun from GZ area.       |            |  |           |           |           | IIBa      |           |           | IIBa      |

\* See Appendix for shot abbreviations.



Table 22. Operation UPSHOT-KNOTHOLE, Desert Rock support participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                          | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |      |     |    |     |      |      |     |     |     |   |  |
|---------------------------------------|--|-----------------|---------------------------------|------|-----|----|-----|------|------|-----|-----|-----|---|--|
|                                       |  |                 | A*                              | N*   | Ru* | D* | Ra* | B*   | S*   | E*  | H*  | G*  | C |  |
| CDR Headquarters                      | Command functions.   | 6.0             | III                             | IIC2 |     |    |     | IIC2 | IIC2 | III |     | III |   |  |
| Control Group                         | Supervised troop activities in forward area on shot day.   | 6.0             | III                             | IIC2 |     |    |     | IIC2 | IIC2 | III | III | III |   |  |
| Instructor Group                      | Accompanied observers in display area on shot day.   | 6.0             | III                             | IIC2 |     |    |     | IIC2 | IIC2 | III | III | III |   |  |
| 26th Trans Trk Br**<br>(Hq and Hq Co) | General support at CDR.  |                 |                                 |      |     |    |     |      |      |     |     |     |   |  |
| 23rd Trans Trk Co**                   | Transported observers, maneuver troops and control group to and from forward area on shot day.   | 6.0             | III                             | IA   |     |    |     | IIC2 | IIC2 | IA  | IA  | IA  |   |  |
| 31st Trans Trk Co**                   | Transported observers, maneuver troops and control group to and from forward area on shot day.   | 6.0             | III                             | IA   |     |    |     | IIC2 | IIC2 | IA  | IA  | IA  |   |  |
| 38th Trans Trk Co**<br>(Det)          | Transported observers, maneuver troops and control group to and from forward area on shot day.   | 6.0             | III                             | IA   |     |    |     | IIC2 | IIC2 | IA  | IA  | IA  |   |  |
| 53rd Trans Trk Co**<br>(Det)          | Transported observers, maneuver troops and control group to and from forward area on shot day.   | 6.0             | III                             | IA   |     |    |     | IIC2 | IIC2 | IA  | IA  | IA  |   |  |
| 50th Chem Serv Plt                    | Conducted radiological surveys and other rad-safe functions on shot day and subsequent re-entries into display areas no closer than 500 m from GZ. |                 | III                             | IICb |     |    |     | IICb | IICb | III | III | III |   |  |
| 77th Army Band**                      | General support at CDR.  |                 |                                 |      |     |    |     |      |      |     |     |     |   |  |
| 93rd Army Band                        | General support at CDR.  |                 |                                 |      |     |    |     |      |      |     |     |     |   |  |
| 94th Med Det<br>(Food Insp)           | General support at CDR.  |                 |                                 |      |     |    |     |      |      |     |     |     |   |  |
| 163rd QM Ldry Det**                   | General support at CDR.  |                 |                                 |      |     |    |     |      |      |     |     |     |   |  |

\* See Appendix for shot abbreviations.

\*\* Provided participants for troop maneuver at Shot Annie (see table 25).

NOTE: Some CDR Support troops observed Shots Encore and Harry (see table 24).

Table 22. Operation UPSHOT-KNOTHOLE, Desert Rock support participants with bone dose commitment less than 150 millirem (Concluded).

| PROJECT/UNIT                 | ACTIVITY  | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |      |     |    |     |    |      |      |     |     |     |  |
|------------------------------|---|-----------------|---------------------------------|------|-----|----|-----|----|------|------|-----|-----|-----|--|
|                              |   |                 | A*                              | N*   | Ru* | D* | Ra* | B* | S*   | E*   | H*  | G*  | C   |  |
| 371st Evac Hosp**<br>(SMBL)  | Established forward area aid station in parking area. Aidmen accompanied service observers.         | 6.0             | III                             | IIC2 |     |    |     |    | IIC2 | IIC2 | III | III | III |  |
| 505th MP Bn (Co C)**         | Controlled traffic to and from forward area on shot day. Accompanied Control Group in forward area. | 1.4             | III                             | IIC2 |     |    |     |    | IIC2 | IIC2 | III | III | III |  |
| 705th Engr Fld*<br>Maint Plt | General support at CDR.   |                 |                                 |      |     |    |     |    |      |      |     |     |     |  |
| 762nd QM Sub Sup*<br>Co      | General support at CDR.   |                 |                                 |      |     |    |     |    |      |      |     |     |     |  |

\* See Appendix for shot abbreviations.

\*\* Provided participants for troop maneuver at Shot Annie.

Table 23. Operation UPSHOT-KNOTHOLE, Air Force support participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT               | ACTIVITY   | D <b>F</b> B | SHOTS/CODE (See Section 3 text) |    |     |    |     |    |    |    |    |    |    |  |
|----------------------------|--|--------------|---------------------------------|----|-----|----|-----|----|----|----|----|----|----|--|
|                            |  |              | A*                              | N* | Ru* | D* | Ra* | B* | S* | E* | H* | G* | C  |  |
| 4925th Test Gp<br>(Atomic) | Dropped nuclear device from aircraft.  |              |                                 |    |     | IA |     |    |    | IA |    |    | IA |  |
| 4925th Test Gp<br>(Atomic) | Flew cloud sampling missions in support of Projects 7.5 and 13.1 (breathed 100% oxygen). |              | IB                              | IB | IB  | IB | IB  | IB | IB | IB | IB | IB | IB |  |
| 55th Weather Recon Sq      | Flew cloud tracking missions. Did not penetrate cloud.                                   |              | IA                              | IA | IA  | IA |     | IA | IA | IA | IA | IA | IA |  |
| 4901st Support Wing        | Flew courier and aerial survey missions.   |              | IA                              | IA | IA  | IA | IA  | IA | IA | IA | IA | IA | IA |  |
| 4935th Air Base Sq.        | General support at ISAFB (except decon).   |              |                                 |    |     |    |     |    |    |    |    |    |    |  |
| 4905th Maint and Sup Sq.   | Maintained UK project aircraft at Kirtland AFB (except sampler).                         |              |                                 |    |     |    |     |    |    |    |    |    |    |  |
| 4910th Air Base Gp         | General support at Kirtland AFB (except decon).  |              |                                 |    |     |    |     |    |    |    |    |    |    |  |

\* See Appendix for shot abbreviations.

Table 24. Operation UPSHOT-KNOTHOLE, observers with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                                  | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |      |     |    |     |      |      |     |     |     |   |
|---|--|-----------------|---------------------------------|------|-----|----|-----|------|------|-----|-----|-----|---|
|   |  |                 | A*                              | N*   | Ru* | D* | Ra* | B*   | S*   | E*  | H*  | G*  | C |
| Service Observers<br>(Shot Annie)             | Observed shot from trenches 3200 m SSW of GZ. Toured display area on shot day.     |                 | III                             |      |     |    |     |      |      |     |     |     |   |
| Service Observers<br>(Shot Nancy)             | Rehearsed and toured Annie display on D-2 (Annie + 5 days).                        |                 | III                             |      |     |    |     |      |      |     |     |     |   |
|   | Observed shot from trenches 3360 m SSW of GZ and toured Nancy display on shot day. | 0.32            |                                 | IIC2 |     |    |     |      |      |     |     |     |   |
| Volunteer Observers<br>(Shot Nancy)           | Observed shot from trenches 2290 m from GZ.  | 0.01            |                                 | IIC1 |     |    |     |      |      |     |     |     |   |
| Service Observers<br>(Shot Dixie)             | Observed shot from News Nob (10 miles S of GZ).                                    |                 |                                 |      |     |    | IA  |      |      |     |     |     |   |
| Service Observers<br>(Shot Ray)               | Observed shot from News Nob (11 miles S of GZ).                                    |                 |                                 |      |     |    | IA  |      |      |     |     |     |   |
| Service Observers<br>(Shot Badger)            | Rehearsed and toured Nancy display area on D-1 (Nancy + 23 days).                  | 0.04            |                                 | IIC8 |     |    |     |      |      |     |     |     |   |
|   | Observed shot from trenches 3660 m SSW of GZ. Toured Badger display on shot day.   | 1.4             |                                 |      |     |    |     | IIC2 |      |     |     |     |   |
| Volunteer Observers<br>(Shot Badger)          | Observed shot from trench 1830 m from GZ.  | 4.1             |                                 |      |     |    |     | IIC1 |      |     |     |     |   |
| Service Observers<br>(Shot Simon)             | Toured Badger display area on D-2 (Badger + 5 days).                               | 0.01            |                                 |      |     |    |     | IIC6 |      |     |     |     |   |
|   | Observed shot from trenches 3660 m S of GZ. Toured Simon display area on shot day. | 0.5             |                                 |      |     |    |     |      | IIC2 |     |     |     |   |
| Volunteer Observers<br>(Shot Simon)           | Observed shot from trench 1830 m from GZ.  | 3.8             |                                 |      |     |    |     |      | IIC1 |     |     |     |   |
| Service and CDR<br>Observers<br>(Shot Encore) | Observed shot from trenches 9420 m SSW of GZ. Toured display area on shot day.     |                 |                                 |      |     |    |     |      |      | III |     |     |   |
| Service and CDR<br>Observers<br>(Shot Harry)  | Observed shot from trenches 3660 m SSW of GZ. Toured display area on shot day.     |                 |                                 |      |     |    |     |      |      |     | III |     |   |
| Service Observers<br>(Shot Grable)            | Toured Harry display area on D-2 (Harry + 3 days).                                 |                 |                                 |      |     |    |     |      |      |     | III |     |   |
|   | Observed shot from trenches 4570 m WSW of GZ. Toured display area on shot day.     |                 |                                 |      |     |    |     |      |      |     |     | III |   |

\* See Appendix for shot abbreviations.

Table 25. Operation UPSHOT-KNOTHOLE, maneuver troops with bone dose commitment less than 150 millirem.

|  |  | SHOTS/CODE (See Section 3 text) |      |      |     |     |      |      |      |     |      |     |     |
|--|--|---------------------------------|------|------|-----|-----|------|------|------|-----|------|-----|-----|
| PROJECT/UNIT                                 | ACTIVITY   | D <sub>FB</sub>                 | A*   | N*   | Ru* | D*  | Ra*  | B*   | S*   | E*  | H*   | G*  | C   |
| Maneuver Troops<br>(Shot Annie)              | Observed shot from trenches 3200 m SSW of GZ. Advanced on foot to objective 1 km W of GZ and toured display area S of GZ on shot day.                                      | 0.8                             | III  |      |     |     |      |      |      |     |      |     |     |
| Maneuver Troops<br>(Shot Nancy)              | Observed shot from trenches 3660 m SSW of GZ. Advanced on foot toward objective 1-2 km W of GZ and toured display area SW of GZ on shot day.                               | 2.2                             |      | IIC2 |     |     |      |      |      |     |      |     |     |
| 1stBn, 8th Marines<br>(Shot Badger)          | Observed shot from trenches 3660 m SSW of GZ. Advanced toward objective until halted due to high radiation exposures shortly after detonation.                             | 4.7                             |      |      |     |     |      |      | IIC1 |     |      |     |     |
| 2dBn, 3rd Marines<br>(-"E" Co) (Shot Badger) | Observed shot from trenches 3660 m SSW of GZ. Advanced to objective 2000 yd N of trenches toured display area before H+4.  | 3.0                             |      |      |     |     |      |      | IIC1 |     |      |     |     |
| 2MCPAEB HQ<br>(Shot Badger)                  | Led troops through display area by H+2.25.   | 3.7                             |      |      |     | IA  | IA   |      | IIC1 |     |      |     |     |
| Maneuver Troops<br>(Shot Simon)              | Observed shot from trenches 3660 m S of GZ. Advanced on foot toward objectives 1-2 km W of GZ and toured display area S of GZ on shot day.                                 | 3.1                             |      |      |     |     |      |      | IIC2 |     |      |     |     |
| Maneuver Troops<br>(Shot Encore)             | Observed shot from trenches 9420 m SW of GZ. Advanced on foot and in helicopters to objective 1.5 km SE of GZ, advanced on foot to GZ and toured display area on shot day. |                                 |      |      |     |     |      |      |      | III |      |     |     |
| Maneuver Troops<br>(Shot Grable)             | Visited Harry display area on D-3 (Harry + 3 days).  |                                 |      |      |     |     |      |      |      |     |      | III |     |
|  | Observed shot from trenches 4570 m W of GZ. Advanced on foot toward objectives 2-3 km SE of GZ and toured portion of display area on shot day.                             |                                 |      |      |     |     |      |      |      |     |      |     | III |
| USMC Helicopter<br>Atomic Test Unit          | Observed detonation from locations 8.5 to 20 km from GZ. Flew to GZ area shortly after shot. Conducted radiological survey.  | 2.6                             | IIA1 | IIA1 |     | III | IIA1 | IIA1 | IIA1 | III | IIA1 |     |     |

\* See Appendix for shot abbreviations.

Table 26. Operation UPSHOT-KNOTHOLE, AFSWP project participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT  | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |      |      |     |     |      |      |        |      |     |     |
|---|--|-----------------|---------------------------------|------|------|-----|-----|------|------|--------|------|-----|-----|
|   |  |                 | A*                              | N*   | Ru*  | D*  | Ra* | B*   | S*   | E*     | H*   | G*  | C   |
| 1.1a/1.2 Air Blast Measurements   | Recovered data from underground recording stations 2130 + 3500 m from GZ on shot day. Recovered gauges later.        |                 |                                 |      |      |     |     |      |      | III    |      | III |     |
|   | Recovered rocket launchers from GZ area.   |                 | III                             |      |      | III |     |      |      | III    |      | III | III |
| 1.1a-1 Evaluation of Wiancko & Vibrotron Gauges                         | Recovered data from underground recording stations 2130 + 3500 m from GZ on shot day. Recovered gauges later.        |                 |                                 |      |      |     |     |      |      | III    |      | III |     |
| 1.1b Air Pressure & Ground Shock Measurements                           | Recovered records from instrument station on blast line on shot day. Recovered gauges on shot day.                   | 3.9             |                                 |      | IIB2 | III |     |      |      | III    |      | III | III |
| 1.1c-1 Air Shock Pressure/Time vs Distances                             | Recovered gauges/data from stations 210 to 2380 m NNW of Annie GZ and 500 and 700 m N, NE and E of Simon GZ.         |                 | III                             |      |      |     |     |      |      | IIBa** |      |     |     |
| 1.1c-2 Air Shock as Affected by Hills and Dales                         | Recovered data from instrument station 6 km west of GZ on shot day.  |                 |                                 |      |      |     |     |      |      | IA     |      |     |     |
| 1.1d Dynamic Pressure versus Time                                       | Retrieved records from recording stations on shot day.   |                 |                                 |      |      |     |     |      |      | III    |      | III | III |
| 1.3 Free-air Blast Measurements   | Dropped instrument canisters from B-29 aircraft upwind from shot.  |                 |                                 |      |      | IA  |     |      |      | IA     |      |     |     |
| 1.3 Free-air Blast Measurements   | Manned receiver stations east of Yucca Lake and north of CP during shot. Retrieved canister several days after shot. |                 |                                 |      |      | III |     |      |      | III    |      |     |     |
| 1.4 Free-field Measurements of Earth Stress/Motion                      | Retrieved data from recording station on blast line on shot day. Retrieved gauges later.                             |                 | III                             |      |      |     |     |      |      | III    |      | III |     |
| 2.2a Gamma Spectrum of Residual Contamination                           | Took measurements with radiac instruments in radiation field.  |                 |                                 | IICb | IICb |     |     | IICb | IICb | III    | IICb | III | III |
| 2.2b Residual Ionizing Depth Dose Measurements in Unit Density Material | Placed dosimeters in radiation field and retrieved them no later than D+2.   | 3.9             |                                 |      |      |     |     | IIC4 | IIC4 | III    | IIC4 | III |     |

\* See Appendix for shot abbreviations

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

Table 26. Operation UPSHOT-KNOTHOLE, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT   | ACTIVITY  | SHOTS/CODE (See Section 3 text) |           |           |            |           |            |           |           |           |           |           |          |
|--|---|---------------------------------|-----------|-----------|------------|-----------|------------|-----------|-----------|-----------|-----------|-----------|----------|
|  |   | <u>D<sub>FB</sub></u>           | <u>A*</u> | <u>N*</u> | <u>Ru*</u> | <u>D*</u> | <u>Ra*</u> | <u>B*</u> | <u>S*</u> | <u>E*</u> | <u>H*</u> | <u>G*</u> | <u>C</u> |
| 2.3 Neutron Flux Measurements  | Recovered neutron detectors from cable dragged from GZ area and from stakes at least 700 m from GZ on shot day. |                                 |           |           |            |           |            |           |           | III       | III       | III       |          |
| 3.1 Loading of Building and Equipment Shapes                             | Inspected structures and equipment in GZ area for damage and recovered instrument records.                      |                                 |           |           |            |           |            |           |           | III       |           | III       |          |
| 3.1a Shock Diffraction in Vicinity of Structures                         | Recovered instrument readings from GZ area.   |                                 |           |           |            |           |            |           |           | III       |           | III       |          |
| 3.3 Tests on Loading of Horizontal Cylinder Shapes                       | Inspected cylinders located at least 1460 m from GZ and recorded gauge data.                                    |                                 |           |           |            |           |            |           |           | III       |           | III       |          |
| 3.4 Tests on Loading of Truss Systems                                    | Inspected structures located at least 670 m from GZ and retrieved gauge data.                                   |                                 |           |           |            |           |            |           |           | III       |           | III       |          |
| 3.5 Tests on Response of Wall & Roof Panels                              | Inspected structures located at least 670 m from GZ and retrieved gauge data.                                   |                                 |           |           |            |           |            |           |           | III       |           |           |          |
| 3.6 Loading and Response of Railroad Equipment                           | Inspected railroad equipment (locomotive and cars) located 460-2010 m from GZ.                                  |                                 |           |           |            |           |            |           |           |           |           | III       |          |
| 3.7 Air Blast Effects on Entrances and Intakes on Underground Structures | Inspected entrances, intakes and filters in underground structure located 290 m from GZ.                        |                                 |           |           |            |           |            |           |           | III       |           | III       |          |
| 3.8 Air Blast Effects on Underground Structures                          | Inspected three underground structures located 280 m from GZ.   |                                 |           |           |            |           |            |           |           | III       |           | III       |          |
| 3.9 Field Fortification  | Inspected field fortifications and retrieved data from stations 150-2440 m from GZ.                             |                                 |           |           |            |           |            |           |           | III       |           | III       |          |
| 3.11-3.16 Navy Structures  | Inspected buildings and retrieved data 820-6100 m from GZ.  |                                 |           |           |            |           |            |           |           | III       |           | III       |          |

\* See Appendix for shot abbreviations.

Table 26. Operation UPSHOT-KNOTHOLE, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT   | ACTIVITY  | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |    |     |    |     |    |    |     |    |     |   |
|--|---|-----------------|---------------------------------|----|-----|----|-----|----|----|-----|----|-----|---|
|  |   |                 | A*                              | N* | Ru* | D* | Ra* | B* | S* | E*  | H* | G*  | C |
| 3.18 Minefield Clearance   | Inspected minefield 820 m from GZ. Detonated undetonated mines.                                       |                 |                                 |    |     |    |     |    |    |     |    | III |   |
| 3.19 Blast Damage to Tree Stands                                     | Inspected tree stand 2000 m from GZ and tree line 460-2440 m from GZ. Recovered gauge data.           |                 |                                 |    |     |    |     |    |    | III |    | III |   |
| 3.20 Blast and Thermal Effects on Tactical Communications Equip-ment | Inspected communications equipment (poles, lines, radios, etc) 90-4570 m from GZ.                     |                 |                                 |    |     |    |     |    |    | III |    | III |   |
| 3.21 Statistical Estimation of Damage to Ordnance Equipment          | Inspected tanks, trucks, jeeps and guns 270-2000 m from GZ. Recovered and uprighted equipment on D+2. |                 |                                 |    |     |    |     |    |    | III |    | III |   |
| 3.22 Effects on Engineer Bridging Equipment                          | Inspected bridge spans 320-1340 m from GZ. Retrieved gauge data.                                      |                 |                                 |    |     |    |     |    |    | III |    | III |   |
| 3.24 Effects on Tracked Landing Vehicles                             | Inspected and recovered film badges from vehicles 240-1370 m from GZ.                                 |                 |                                 |    |     |    |     |    |    | III |    | III |   |
| 3.26 Effects on POL Installations                                    | Inspected various POL equipment (drums, tanks, etc) 70-3110 m from GZ.                                |                 |                                 |    |     |    |     |    |    | III |    | III |   |
| 3.27 Effects on Field Medical Installations and Equipment            | Inspected medical installation and equipment located 1270-4570 m from GZ.                             |                 |                                 |    |     |    |     |    |    | III |    |     |   |
| 3.28.1 Structures Instrumentation                                    | Retrieved and reduced blast data from Program 3 projects.   |                 |                                 |    |     |    |     |    |    | III |    | III |   |
| 3.28.2 Pressure Measurements for Program 3 Projects                  | Retrieved and reduced pressure data for Program 3 projects.   |                 |                                 |    |     |    |     |    |    | III |    | III |   |
| 3.28.3 Pressure Measurements on Structures                           | Retrieved data from underground recording station (Project 3.1) 1500 m from GZ.                       |                 |                                 |    |     |    |     |    |    | III |    | III |   |

\* See Appendix for shot abbreviations.

Table 26. Operation UPSHOT-KNOTHOLE, AFSWP project participants with b  
commitment less than 150 millirem (Continued).

| PROJECT/UNIT  | ACTIVITY  | D <sub>FB</sub> | SHOTS/CODE (See Secti |      |      |     |      |        |
|---|---|-----------------|-----------------------|------|------|-----|------|--------|
|   |   |                 | A*                    | N*   | Ru*  | D*  | Ra*  | B*     |
| 3.29 Blast Effects<br>on Walls and<br>Partitions                | Inspected structures located 1340<br>and 2020 m from GZ.  |                 |                       |      |      |     |      |        |
| 4.2 Direct Air Blast<br>Exposure Effects in<br>Animals          | Recovered test animals and equipment<br>from GZ area (290-470 m) on shot<br>day.  | 3.9             |                       |      |      |     |      |        |
| 4.5 Ocular Effects<br>of Thermal Radiation                      | Viewed detonation from trailer at<br>least 10 km from GZ.   |                 | IA                    | IA   |      |     |      | IA 1   |
|   | Recovered test animals (rabbits)<br>from site at least 3 km from GZ on<br>shot day.   | 3.9             | IIB2                  | IIB2 |      |     |      | IIB2 1 |
| 4.7 Beta-Gamma Skin<br>Hazard in Post Shot<br>Contaminated Area | Took radiation measurements in GZ<br>area on shot day using thin-walled<br>ion chamber.   | 3.9             |                       |      |      |     |      | 1      |
| 4.8 Bio-effects of<br>Neutrons                                  | Recovered test animals (mice) from<br>14 stations 450-1800 m SSE of GZ on<br>shot day.  |                 |                       |      |      |     |      |        |
| 5.1 Effects on AD<br>Aircraft in Flight                         | Flew over detonation (did not pene-<br>trate cloud).  |                 | IA                    | IA   |      |     |      | IA 1   |
|   | Manned ground control station near<br>CP. Recovered test panels 1.2-2.2<br>km from GZ on shot day (Encore).                     |                 | IA                    | IA   |      |     |      | IA 1   |
| 5.2 Effects on B-50<br>Aircraft in Flight                       | Two B-50s flew in formation with<br>drop aircraft.  |                 |                       |      |      | IA  |      |        |
| 5.3 Blast Effects<br>on B-36 Aircraft in<br>Flight              | Flew B-36 in formation with drop<br>aircraft. Did not penetrate cloud.  |                 |                       |      |      |     |      |        |
| 6.2 Indirect Bomb<br>Damage Assessment<br>(IBDA)                | B-29 aircraft orbited at least 8 km<br>from GZ. Did not fly through or<br>under cloud.  |                 | IA                    | IA   | IA   | IA  | IA   | IA 1   |
|   | Manned radar transmitter/receiver<br>stations 9-11 km from GZ. Shut<br>down un-manned stations after shot<br>no later than D+1. | 3.9             | IA                    | IIC3 | IIC3 | III | IIC3 | IIC3 1 |
| 6.3 Interim IBDA<br>Capabilities of<br>SAC                      | Flew over test site (did not fly<br>through or under cloud).  |                 | IA                    | IA   | IA   | IA  | IA   | IA 1   |

\* See Appendix for shot abbreviations.



Table 26. Operation UPSHOT-KNOTHOLE, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT  | ACTIVITY  | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |      |      |     |      |      |      |     |      |     |    |  |
|---|---|-----------------|---------------------------------|------|------|-----|------|------|------|-----|------|-----|----|--|
|   |   |                 | A*                              | N*   | Ru*  | D*  | Ra*  | B*   | S*   | E*  | H*   | G*  | C  |  |
| 6.4 Evaluation of Chemical Dosimeters                         | Recovered dosimeters from 8 stations (location unknown) not later than D+1.   | 3.9             |                                 |      |      |     |      |      | IIB3 |     | IIB2 |     |    |  |
| 6.8 Evaluation of Military Radiac Equipment                   | Performed radiation surveys with experimental radiac equipment on shot day.   | 3.9             | IIC2                            | IIC2 |      | III |      | IIC2 | IIC2 | III | IIC2 |     |    |  |
| 6.8a Initial Gamma Exposure versus Distance                   | Recovered dosimeters at varying distances from GZ on shot day.  | 3.9             | IIC2                            | IIC2 | IIC2 |     | IIC2 | IIC2 | IIC2 | III | IIC2 | III |    |  |
| 6.9 Evaluation of Naval Airborne Radiac Equipment             | Took radiation measurements from aircraft. Dropped dosimeters with telemetry into area. (Retrieval not documented.)         |                 | IA                              | IA   | IA   |     |      | IA   | IA   |     |      |     |    |  |
| 6.10 Evaluation of Rapid Aerial Radiological Survey Technique | Took radiation measurements from aircraft.  |                 | IA                              | IA   |      |     |      | IA   | IA   | IA  | IA   | IA  |    |  |
| 6.11 Indoctrination of TAC Aircrews                           | Flew T-33s in formation with drop aircraft.   |                 |                                 |      |      | IA  |      |      |      | IA  |      |     |    |  |
| 6.12 Determination of Height of Burst and Ground Zero         | Operated various sensors located 13-60 km from GZ from station at least 13 km from GZ.                                      |                 | IA                              | IA   | IA   | IA  | IA   | IA   | IA   | IA  | IA   | IA  | IA |  |
| 6.13 Effectiveness of Fast Scan Radar for Fireball Studies    | Operated radar from station approximates 11 km from GZ.   |                 |                                 |      |      |     |      | IA   | IA   | IA  | IA   |     |    |  |
| 7.1 Electromagnetic Effects of Nuclear Explosions             | Manned stations on-site (14-22 km from GZ) and off-site throughout US.  |                 | IA                              | IA   | IA   | IA  | IA   | IA   | IA   | IA  | IA   | IA  | IA |  |
| 7.3 Detection of Airborne Low Frequency Sound                 | Operated remote stations throughout world.  |                 | IA                              | IA   | IA   | IA  | IA   | IA   | IA   | IA  | IA   | IA  | IA |  |
| 7.4 Seismic Measurements                                      | Manned stations throughout US. Turned off equipment and recovered records from un-manned station in Yucca Flat on shot day. | 3.9             | IA                              | IA   | IA   | IA  | IA   | IIC2 | IA   | IA  | IA   | IA  | IA |  |

\* See Appendix for shot abbreviations.

Table 26. Operation UPSHOT-KNOTHOLE, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT |  | ACTIVITY   |  |  |  |  |  |  |  |  |  |  |  | DTPB |  | SHOTS/CODE (See Section 3 text)                 |  |  |  |  |  |  |  |  |  |  |  |
|--------------|--|--|--|--|--|--|--|--|--|--|--|--|--|------|--|---|--|--|--|--|--|--|--|--|--|--|--|
|              |  | 7.5 Calibration & Analysis of Close-in A-bomb Debris   |  |  |  |  |  |  |  |  |  |  |  |      |  | A* N* Ru* D* RA* B* S* E* H* G* C               |  |  |  |  |  |  |  |  |  |  |  |
|              |  | 8.1a Effects of Thermal and Blast Forces on Aircraft Structure   |  |  |  |  |  |  |  |  |  |  |  |      |  |   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | Inspected aircraft structures and components placed in GZ area no later than D+1.  |  |  |  |  |  |  |  |  |  |  |  | 3.9  |  | IC3 IC3 IC3 IC3 IC3 IC3 IC3 IC3 IC3 IC3 IC3 IC3 |  |  |  |  |  |  |  |  |  |  |  |
|              |  | 8.1b Vulnerability of Parked Aircraft  |  |  |  |  |  |  |  |  |  |  |  |      |  |   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | Inspected aircraft parked in GZ area on shot day.  |  |  |  |  |  |  |  |  |  |  |  | 3.9  |  | IC2 IC2 IC2 IC2 IC2 IC2 IC2 IC2 IC2 IC2 IC2 IC2 |  |  |  |  |  |  |  |  |  |  |  |
|              |  | 8.2 Measurement of Thermal Radiation with Vacuum Microphone  |  |  |  |  |  |  |  |  |  |  |  |      |  |   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | Conducted measurements from instrumented van at least 10 km from GZ and retrieved microphone from location 2-3 km from GZ on shot day. |  |  |  |  |  |  |  |  |  |  |  | 3.9  |  | IC2 IC2 IC2 IC2 IC2 IC2 IC2 IC2 IC2 IC2 IC2 IC2 |  |  |  |  |  |  |  |  |  |  |  |
|              |  | 8.4.1 Protection Against Thermal Radiation Afforded by Operational Smoke Screens   |  |  |  |  |  |  |  |  |  |  |  |      |  |   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | Retrieved data from instrument station 680 m from GZ.  |  |  |  |  |  |  |  |  |  |  |  |      |  | III   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | 8.4.2 Evaluation of Thermal Absorbing Carbon Smoke Screen  |  |  |  |  |  |  |  |  |  |  |  |      |  |   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | Retrieved data from instrument station 680 m from GZ.  |  |  |  |  |  |  |  |  |  |  |  |      |  | III   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | 8.5 Thermal Radiation Afforded to Test Animals by Fabric   |  |  |  |  |  |  |  |  |  |  |  |      |  |   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | Retrieved test animals (pigs) from GZ area (600-2750 m) on shot day.   |  |  |  |  |  |  |  |  |  |  |  | 3.9  |  | IIB2 III  |  |  |  |  |  |  |  |  |  |  |  |
|              |  | 8.6 Performance Characteristics of Clothing Material Exposed to Thermal Radiation  |  |  |  |  |  |  |  |  |  |  |  |      |  |   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | Retrieved textile samples from GZ area (see 8.5) on shot day.  |  |  |  |  |  |  |  |  |  |  |  |      |  | III   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | 8.9 Effects of Thermal Radiation on Materials  |  |  |  |  |  |  |  |  |  |  |  |      |  |   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | Retrieved samples from GZ area on shot day.  |  |  |  |  |  |  |  |  |  |  |  |      |  | III   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | 8.10 Physical Characteristics of Thermal Radiation   |  |  |  |  |  |  |  |  |  |  |  |      |  |   |  |  |  |  |  |  |  |  |  |  |  |
|              |  | Retrieved data from instrument station in GZ area on shot day.   |  |  |  |  |  |  |  |  |  |  |  | 3.9  |  | IIB2 III  |  |  |  |  |  |  |  |  |  |  |  |

\* See Appendix for shot abbreviations.

Table 26. Operation UPSHOT-KNOTHOLE, AFSWP project participants with bone dose commitment less than 150 millirem (Concluded).

| PROJECT/UNIT   | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |      |      |     |      |      |      |     |      |     |     |
|--|--|-----------------|---------------------------------|------|------|-----|------|------|------|-----|------|-----|-----|
|  |  |                 | A*                              | N*   | Ru*  | D*  | Ra*  | B*   | S*   | E*  | H*   | G*  | C   |
| 8.11a Incendiary Effects on Building and Interior Kindling | Inspected demonstration houses and test material in GZ area on shot day. |                 |                                 |      |      |     |      |      |      | III |      | III |     |
| 8.11b Ignition and Persistent Fires                        | Inspected test materials in GZ area on shot day.                         |                 |                                 |      |      | III |      |      |      | III |      | III |     |
| 8.12a Sound Velocities Near Ground                         | Inspect and collect data from instruments in GZ area on shot day.        | 3.9             |                                 |      |      |     |      |      | IIB2 | III |      | III |     |
| 8.12b Supplementary Pressure Measurement                   | Retrieved data from GZ area (460-920 m) on shot day.                     |                 |                                 |      |      |     |      |      |      | III |      | III |     |
| 8.13 Study of Fire Retardant Paint                         | Inspected test panels in GZ area several days after shot.                |                 |                                 |      |      |     |      |      |      | III |      |     |     |
| 9.1 Technical Photography                                  | Took photographs in support of projects.                                 |                 | IICb                            | IICb | IICb | III | IICb | IICb | IICb | III | IICb | III | III |
| 9.6 Product Stabilization                                  | Inspected treated area near GZ on shot day.                              |                 |                                 |      |      |     |      |      |      | III |      | III |     |
| 9.7 Experimental Soil Stabilization                        | Inspected treated area near GZ on shot day.                              |                 |                                 |      |      |     |      |      |      | III |      | III |     |

\* See Appendix for shot abbreviations.

Table 27. Operation UPSHOT-KNOTHOLE, other project participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT  | ACTIVITY  | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |      |      |     |      |      |      |     |      |     |     |
|---|---|-----------------|---------------------------------|------|------|-----|------|------|------|-----|------|-----|-----|
|   |   |                 | A*                              | N*   | Ru*  | D*  | Ra*  | B*   | S*   | E*  | H*   | G*  | C   |
| 13.1 Radiochemistry Sampling  | Flew through clouds to collect samples (crew on 100% oxygen).   |                 | IB                              | IB   | IB   | IB  | IB   | IB   | IB   | IB  | IB   | IB  | IB  |
| 18.3 Spectroscopy   | Operated spectrometers in Bldg. 400 near CP. Retrieved film from close in station (3 km from GZ) on shot day.       | 3.9             | IA                              | IA   | IA   | IA  | IA   | IIC2 | IA   | IA  | IA   | IA  |     |
| 23.1 Biological Effectiveness of Ionizing Radiation within Shelters                 | Retrieved test animals from earth protected shelters near GZ on shot day.   | 3.9             | III                             |      | IIB2 | III |      |      |      | III | IIB2 |     | III |
| 23.2 Bacteriological Studies on Animals Exposed to Neutron Radiation                | Retrieved test animals from earth protected shelters near GZ on shot day.   | 3.9             | III                             |      | IIB2 | III |      |      |      | III | IIB2 |     | III |
| 23.3 Long-Term Studies on Dogs Exposed to Neutron                                   | Retrieved test animals from earth protected shelters near GZ on shot day.   | 3.9             | III                             |      | IIB2 | III |      |      |      | III | IIB2 |     | III |
| 23.17 Neutron Flux Measurements in AEC Shelters and Lead Hemispheres                | Retrieved detectors from shelter used for Projects 23.1, 23.2, and 23.3, and other stations in GZ area on shot day. | 3.9             | III                             |      | IIB2 | III |      |      |      | III | IIB2 | III | III |
| 27.1 Distribution and Characteristics of Fallout at Distances Greater Than 10 Miles | Collected samples and conducted radiological surveys.   | 3.9             |                                 | IIB3 | IIB3 | IA  |      | IIB3 | IIB3 |     |      |     |     |
| 29.1 Comparison and Evaluation of Dosimetric Methods - Gamma                        | Took radiation measurements in and retrieved dosimeter from shot area.  | 3.9             |                                 |      |      | III | IIC3 | IIC5 | IIC5 | III | IIC3 | III | III |

\* See Appendix for shot abbreviations.

Table 28. Operation TEAPOT, Desert Rock support participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT              | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |     |        |      |     |    |     |     |     |     |    |     |      |      |  |
|---------------------------|--|-----------------|---------------------------------|-----|--------|------|-----|----|-----|-----|-----|-----|----|-----|------|------|--|
|                           |  |                 | W*                              | Mo* | Te*    | Tu*  | H*  | B* | E*  | A1* | W1* | HA* | P* | ME* | A2*  | Z*   |  |
| CDR Headquarters          | Command functions.   |                 |                                 |     |        |      |     |    | III |     |     |     |    |     |      | IIC1 |  |
| Control Gp                | Supervised troop activities in forward area.   | 6.0             | IA                              | IA  | IIC1** | IIC3 |     |    | III | IA  | III |     |    |     | IA   | IIC1 |  |
| Instructor Gp             | Presented orientation courses and accompanied troops during tours of display areas.                              | 6.0             | IA                              | IA  | IIC1** | IIC3 |     |    | III | IA  | III |     |    |     | IA   | IIC1 |  |
| 505th MP Bn               | Controlled traffic to and from forward area on shot day.   | 0.15            | IA                              | IA  | IIC1** | IIC3 | III |    | IA  | III |     |     |    |     | IA   | IIC1 |  |
| 95th Engr Bn              | Pre-shot trench and test structure construction. Inspected/evaluated test structures after Shot MET (D+5 to 11). | 0.123           |                                 |     |        |      |     |    |     |     |     |     |    |     | IIB7 |      |  |
| 26th Trans Bn             | General support at CDR.  |                 |                                 |     |        |      |     |    |     |     |     |     |    |     |      |      |  |
| 23rd Trans Trk Co         | Provided transportation for maneuver troops, observers and technical project personnel to and from forward area. | 6.0             | IA                              | IA  | IIC1** | IIC3 | IA  |    | III | IA  | III | IA  |    | IA  | IA   | IIC1 |  |
| 31st Trans Trk Co         | Provided transportation for maneuver troops, observers and technical project personnel to and from forward area. | 6.0             | IA                              | IA  | IIC1** | IIC3 | IA  |    | III | IA  | III | IA  |    | IA  | IA   | IIC1 |  |
| 2nd Trans Trk Co          | Provided transportation for maneuver troops, observers and technical project personnel to and from forward area. | 6.0             | IA                              | IA  | IIC1** | IIC3 | IA  |    | III | IA  | III | IA  |    | IA  | IA   | IIC1 |  |
| Evacuation Hosp (-)       | General support at CDR and established aid station in observer trench area.                                      | 6.0             | IA                              | IA  | IA     | IIC3 | IA  |    | IA  | IA  | IA  | IA  |    | IA  | IA   | IA   |  |
| 94th Med Det              | General support at CDR.  |                 |                                 |     |        |      |     |    |     |     |     |     |    |     |      |      |  |
| 90th Repl Bn, Hq & Hq Det | General support at CDR.  |                 |                                 |     |        |      |     |    |     |     |     |     |    |     |      |      |  |
| 71st Repl Co              | General support at CDR.  |                 |                                 |     |        |      |     |    |     |     |     |     |    |     |      |      |  |
| 53rd QM Co                | General support at CDR.  |                 |                                 |     |        |      |     |    |     |     |     |     |    |     |      |      |  |
| 163rd QM Co               | General support at CDR.  |                 |                                 |     |        |      |     |    |     |     |     |     |    |     |      |      |  |
| 433rd Army Band           | General support at CDR.  |                 |                                 |     |        |      |     |    |     |     |     |     |    |     |      |      |  |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

NOTE: CDR Support troops may have witnessed one or more shots as CDR Observers (see table 30).

Table 29. Operation TEAPOT, Air Force support participants with bone dose commitment less than 150 millirem.

| SHOTS/CODE (See Section 3 text) |  |     |    |     |     |     |    |    |    |     |     |     |    |     |     |    |
|---------------------------------|--|-----|----|-----|-----|-----|----|----|----|-----|-----|-----|----|-----|-----|----|
| PROJECT/UNIT                    | ACTIVITY   | DTB | W* | Mo* | Te* | Tu* | H* | B* | E* | Al* | W'* | HA* | P* | ME* | A2* | Z* |
| 4925th Test Gp (A)              | Dropped nuclear device from aircraft.  |     | IA |     |     |     |    |    |    |     | IA  | IA  |    |     |     |    |
| 4935th Air Base Sq              | Flew pre-shot security sweeps and provided general support at ISAFB (Aircraft decon not considered). |     |    |     |     |     |    |    |    |     |     |     |    |     |     |    |
| 4926th Test Sq (S)              | Flew cloud sampling missions in support of Projects 11.2, 21.2 and 40.8 (Crew breathed 100% oxygen). |     | IB | IB  | IB  | IB  | IB | IB | IB | IB  | IB  | IB  | IB | IB  | IB  | IB |
| 55th Weather Recon Sq           | Flew cloud tracking missions in B-29s and B-50s. Did not penetrate cloud.                            |     | IA | IA  | IA  | IA  | IA | IA | IA | IA  |     |     | IA | IA  | IA  | IA |
| 4901st AB Wing**                | Flew courier missions.   |     | IA | IA  | IA  | IA  | IA | IA | IA | IA  | IA  | IA  | IA | IA  | IA  | IA |
|                                 | Flew terrain survey missions.  |     | IA | IA  | IA  | IA  | IA | IA | IA | IA  | IA  | IA  | IA | IA  | IA  | IA |
|                                 | Flew cloud tracking missions in B-25s. Did not penetrate cloud.                                      |     | IA | IA  | IA  | IA  | IA | IA | IA | IA  | IA  | IA  | IA | IA  | IA  | IA |

\* See Appendix for shot abbreviations.  
 \*\* Became 4900th Air Base Group on 5 May 1955.

Table 30. Operation TEAPOT, observers with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                                 | ACTIVITY  | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |     |     |        |    |     |    |     |     |     |    |     |      |    |
|--|---|-----------------|---------------------------------|-----|-----|--------|----|-----|----|-----|-----|-----|----|-----|------|----|
|  |   |                 | W*                              | Mo* | Te* | Tu*    | H* | B*  | E* | A1* | W1* | HA* | P* | ME* | A2*  | Z* |
| Service and CDR Observers<br>(Shot Wasp)     | Observed shot from News Nob, tour of display area cancelled.  |                 | IA                              |     |     |        |    |     |    |     |     |     |    |     |      |    |
| Service and CDR Observers<br>(Shot Moth)     | Observed shot from trenches 2290 m WSW of GZ. Returned to CDR shortly thereafter.   |                 |                                 | IA  |     |        |    |     |    |     |     |     |    |     |      |    |
| Service and CDR Observers<br>(Shot Tesla)    | Observed shot from trenches 2190 m SW of GZ. Toured portion of display area by H+2.   | 1.1             |                                 |     |     | IIC1** |    |     |    |     |     |     |    |     |      |    |
| Service and CDR Observers<br>(Shot Turk)     | Observed shot from trenches 5030 m SE of GZ. Toured display area on D+1.  | 1.24            |                                 |     |     | IIC3   |    |     |    |     |     |     |    |     |      |    |
| Service Observers<br>(Shot Bee)              | Observed shot from trenches 3200 m SW of GZ. Toured display area shortly after shot.  |                 |                                 |     |     |        |    | III |    |     |     |     |    |     |      |    |
| Service and CDR Observers<br>(Shot Ess)      | Observed shot from open area 8230 m SW of GZ. (Area was contaminated by Shot Turk fired 16 days earlier.) Returned to CDR after shot. | 0.043           |                                 |     |     |        |    |     | IA |     |     |     |    |     |      |    |
| Service and CDR Observers<br>(Shot Apple I)  | Observed shot from trenches 3200 m SSW of GZ. Toured display area immediately after shot.   |                 |                                 |     |     |        |    |     |    | III |     |     |    |     |      |    |
| CDR Observers<br>(Shot MET)                  | Observed shot from open area 9330 m SW of GZ. Returned to CDR shortly after shot.   |                 |                                 |     |     |        |    |     |    |     |     |     |    | IA  |      |    |
| Service and CDR Observers<br>(Shot Apple II) | Observed shot from trenches 3200 m S of GZ. Toured display area shortly after shot.   | 0.34            |                                 |     |     |        |    |     |    |     |     |     |    |     | IIC1 |    |
| VIP Observers<br>(Shot Apple II)             | Observed shot from trenches 4700 m SW of GZ. Did not tour display area.   |                 |                                 |     |     |        |    |     |    |     |     |     |    |     | IA   |    |
| Volunteer Observers<br>(Shot Apple II)       | Observed shot from trenches 2380 m S of GZ. May have toured display area after shot with service observers.                           | 0.34            |                                 |     |     |        |    |     |    |     |     |     |    |     | IIC1 |    |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

Table 31. Operation TEAPOT, maneuver and troop test participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                                 | ACTIVITY  | Dose  | SHOTS/CODE (See Section 3 text) |     |     |     |    |     |    |     |     |     |    |     |      |    |
|--|---|-------|---------------------------------|-----|-----|-----|----|-----|----|-----|-----|-----|----|-----|------|----|
|  |   |       | W*                              | Mo* | Te* | Tu* | H* | B*  | E* | A1* | W1* | HA* | P* | ME* | A2*  | Z* |
| 40.16 Army Demolition Munitions              | Emplaced and detonated the device. No post shot recovery/inspection activities documented. (May have observed shot with Service observers).   |       |                                 |     |     |     |    |     | IA |     |     |     |    |     |      |    |
| 40.18 Location of Atomic Bursts              | Manned stations at least 8 km SE to SW of GZ during shot.   |       | IA                              | IA  | IA  | IA  | IA | IA  | IA | IA  | IA  |     | IA | IA  | IA   |    |
| 41.1 Infantry Regimental Communications Test | Observed shot with Apple II Service observers. Went to posts located between 1.3 and 1.7 km S of GZ, 0.8 and 1.1 km E of GZ, and 2.2 km W of GZ shortly after shot to test and repair communications equipment. Returned to CDR at H+2 hours. | 6.0   |                                 |     |     |     |    |     |    |     |     |     |    |     | IIB1 |    |
| 41.2 Task Force RAZOR                        | Conducted helicopter supported armored (tanks and armored personnel carriers) maneuver and toured display area by H+4 hours.  | 1.8   |                                 |     |     |     |    |     |    |     |     |     |    |     | IIA1 |    |
| 41.6 Marine Brigade Exercise (3rd MCPAEB)    | Conducted air (helicopter airlift) and ground maneuver in old (Turk + 15 days) fallout field on shot day.   | 0.001 |                                 |     |     |     |    | IA  |    |     |     |     |    |     |      |    |
|  | Toured Bee display area on shot day.  |       |                                 |     |     |     |    | III |    |     |     |     |    |     |      |    |

\* See Appendix for shot abbreviations.



Table 32. Operation TEAPOT, AFSWP project participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                                  | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |        |        |      |      |      |      |      |     |     |      |      |     |    |
|---|--|-----------------|---------------------------------|--------|--------|------|------|------|------|------|-----|-----|------|------|-----|----|
|   |  |                 | W*                              | Mo*    | Te*    | Tu*  | H*   | B*   | E*   | A1*  | W1* | HA* | P*   | ME*  | A2* | Z* |
| 1.1 Measurement of Free Air Blast Pressures   | Recovered instrument canisters dropped from aircraft over shot area. (Turk & HA recoveries on shot day; Apple 1 recovery time presumed to be also.)            | 3.9             |                                 |        |        | IIC2 |      |      |      | IIC2 |     | IA  |      |      |     |    |
| 1.2 Shock Wave Photography                    | Recovered film from cameras placed at various distances from GZ.   | 3.9             | III                             |        | IIB2** | IIB3 |      | IIB2 | IIBa | IIB  | III | IA  | IIBa | IIB2 |     |    |
| 1.3 Microbarographic Pressure at Ground Level | Recovered data from recording stations near surface zero.  |                 |                                 |        |        |      |      |      |      |      |     | IA  |      |      |     |    |
| 1.9 Material Velocity Measurements            | Aircraft produced smoke trails just prior to detonation. Ground crews photographed distortion in trails due to shock wave.                                     |                 |                                 |        |        |      |      |      |      |      |     | IA  |      |      |     |    |
| 1.11 Special Measurements of Dynamic Pressure | Recovered data and instruments from stations at least 4 km S and 6 km E of Turk GZ and 0.4-2.4 km N, W, and S of MET GZ. Recovery took approximately two days. |                 |                                 |        |        | IIBb |      |      |      |      |     |     |      | IIBb |     |    |
| 1.12 Drag Force Measurements                  | Recovered data and instruments from stations between 600 m and 1350 m south of GZ on shot day.   | 3.9             |                                 |        |        |      |      |      |      |      |     |     |      | IIB2 |     |    |
| 1.13 Dust Density vs. Time & Distance         | Recovered data and instruments from stations located 760 and 910 m S and W of GZ and 610 to 910 m S of GZ. Recovery activities took approximately 2 days.      |                 |                                 |        |        |      |      |      |      |      |     |     |      | IIBb |     |    |
| 1.14a Transient Drag on Spherical Models      | Performed activities similar to Project 1.12. Data and equipment recovery lasted approximately 10 days.  |                 |                                 |        |        |      |      |      |      |      |     |     |      | IIBc |     |    |
| 2.1 Gamma Exposure vs. Distance               | Recovered dosimeters (film packets) from several stations upwind from GZ on shot day. Recovered canisters dropped through cloud (Shot HA only).                | 3.9             | III                             | IIC2** | IIC2** | IIC2 | IIC2 | III  | IIC2 | IIC2 | III | IA  | III  | IIC2 |     |    |
| 2.2 Neutron Flux Measurements                 | Removed neutron detectors from stakes in GZ area and cable dragged from GZ. area shortly after shot. Recovered canisters dropped through cloud (HA only).      | 3.9***          | III                             | IIB1** | IIBa** |      | IIB1 | IIB1 |      | IIB1 | III | IA  | III  | IIB1 |     |    |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values derived from table 2.

\*\*\* Does not include Shot Tesla dose. Code used for Tesla does not require specific dose information.

Table 32. Operation TEAPOT, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT  | ACTIVITY   | D <sub>GR</sub> | SHOTS/CODE (See Section 3 text) |     |     |      |    |    |      |      |     |     |    |        |      |    |
|---|--|-----------------|---------------------------------|-----|-----|------|----|----|------|------|-----|-----|----|--------|------|----|
|   |  |                 | W*                              | Mo* | Te* | Tu*  | H* | B* | E*   | A1*  | W'* | HA* | P* | ME*    | A2*  | Z* |
| 2.3b Gamma Radiation Fields Above Contaminated Ground     | Took radiation measurements at station 2300 m SE of GZ on D+9 and along NE-SW access road on D+16.   |                 |                                 |     |     |      |    |    | IICb |      |     |     |    |        |      |    |
| 2.6 Radiation Absorbed by Human Phantoms                  | Placed instrumented mannequins in radiation fields up to 3.5 R/hr. Retrieved later.  |                 | III                             |     |     | IICa |    |    | IICa | IICa |     |     |    | IICa   | IICa |    |
| 2.8a Contact Radiation Hazard from Contaminated Aircraft  | Took radiation measurements at various distance from aircraft surfaces and removed film taped to aircraft surface.   |                 | IA                              | IA  | IA  | IA   | IA | IA |      | IA   | IA  | IA  | IA | IA     | IA   | IA |
| 2.8b Manned Penetration of Atomic Clouds                  | Flew T-33s through cloud. Crew breathed 100% oxygen.   |                 |                                 |     |     |      |    | IB |      | IB   |     |     |    | IB     | IB   | IB |
| 3.2 Study of Drag Loading of Structures in Precursor Zone | Recovered data/instruments from concrete buildings located 1200-1800 m South of GZ on shot day.  | 3.9             |                                 |     |     |      |    |    |      |      |     |     |    | IIC2   |      |    |
| 3.6 Evaluation of Earth Cover                             | Inspected and recovered data/instruments from 8 underground shelters located 460-900 m from GZ.  |                 |                                 |     |     |      |    |    |      |      |     |     |    | IIBb   |      |    |
| 3.7 Effect of Positive Phase Length of Blast              | Inspected, photographed and recovered data from test structures at 4 locations, 1100-1750 m south of GZ.   |                 |                                 |     |     |      |    |    |      |      |     |     |    | IICb   |      |    |
| 3.8 Test of Concrete Panels                               | Inspected and recovered data from concrete panels located 1070 and 1480 m from GZ.   |                 |                                 |     |     |      |    |    |      |      |     |     |    | IICb   |      |    |
| 3.9 Response of Small Petroleum Tanks                     | Photographed and inspected damage to tanks.  |                 |                                 |     |     |      |    |    |      |      |     |     |    | IICb** |      |    |
| 3.10 Structures Instrumentation                           | Recovered data/instruments from 16 test structures located 1000-1800 m south of GZ.  |                 |                                 |     |     |      |    |    |      |      |     |     |    | IIBb   |      |    |
| 5.1 Destructive Loads on Aircraft in Flight               | Tracked aircraft from radar sites 18-27 km S of GZ. Flew QF-80 drones (unmanned) near Shots Bee & MET detonation. Drones did not penetrate cloud; recovered at Indian Springs. |                 |                                 |     |     |      |    | IA |      | IA   |     | IA  |    | IA     | IA   |    |
| 5.2 Effects on Fighter Type A/C in Flight                 | Flew F-84 aircraft near detonation (slant range 4-8 km) aircraft did not penetrate cloud. Project 5.1 personnel tracked aircraft from ground station near CP.                  |                 |                                 |     |     | IA   | IA | IA |      | IA   |     |     |    | IA     | IA   |    |

\* See Appendix for shot abbreviations.

\*\* Elements of category code are adjusted to shot specific values from table 2.

Table 32. Operation TEAPOT, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT   | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |        |        |     |      |      |      |      |      |     |    |     |      |    |  |
|--|--|-----------------|---------------------------------|--------|--------|-----|------|------|------|------|------|-----|----|-----|------|----|--|
|  |  |                 | W*                              | Mo*    | Te*    | Tu* | H*   | B*   | E*   | A1*  | W1*  | HA* | P* | ME* | A2*  | Z* |  |
| 6.1.1a Evaluation of Military Radiac Equipment                   | Field tested radiac equipment and recovered dosimeters from stations 900-2700 m from GZ on shot day.   | 3.9             | III                             |        |        |     | IIC2 | IIC2 | IIC2 | IIC2 | IIC2 |     |    |     | IIC2 |    |  |
| 6.1.1b Evaluation of Radiological Defense Warning System         | Recovered detector systems from stations located outside of contaminated areas.  |                 | IA                              | IA     | IA     | IA  | IA   | IA   |      | IA   |      |     |    |     |      |    |  |
|  | Tested radiac equipment in 5-10 R/hr field on shot day and D+1.  | 3.9             |                                 |        |        |     | IIC3 |      |      | IIC3 |      |     |    |     |      |    |  |
| 6.1.2 Accuracy of Military Radiacs                               | Tested radiac equipment in 3-4 R/hr fields on shot day.  | 3.9             |                                 |        |        |     |      |      | IIC2 | IIC2 |      |     |    |     | IIC2 |    |  |
| 6.2 Effects on Selected Components and Systems                   | Recovered test equipment from positions 400-500 m from GZ.   |                 |                                 |        |        |     |      |      |      | IICb |      |     |    |     | IICb |    |  |
| 6.3 Missile Detonation Locator                                   | Manned station in California.  |                 | IA                              | IA     | IA     | IA  | IA   | IA   | IA   | IA   | IA   | IA  | IA | IA  | IA   | IA |  |
| 6.4 Test of IBDA Equipment                                       | Tested IBDA equipment in aircraft near shot area. Did not penetrate cloud.   |                 | IA                              | IA     | IA     | IA  | IA   | IA   | IA   | IA   | IA   | IA  | IA | IA  | IA   | IA |  |
| 6.5 Test of Airborne Naval Radars for IBDA                       | Tested IBDA equipment in aircraft near shot area. Did not penetrate cloud.   |                 |                                 |        |        | IA  | IA   | IA   |      | IA   |      |     |    | IA  | IA   | IA |  |
| 8.1 Measurement of Direct and Ground-Reflected Thermal Radiation | Flew aircraft in vicinity of shot (slant range at least 3.4 km). Turned away from shot shortly after detonation. Ground crews tracked aircraft from radar station south of GZ. |                 |                                 |        |        | IA  |      | IA   |      | IA   |      |     |    | IA  | IA   |    |  |
| 8.4a Thermal Measurements from Aircraft in Flight                | Took thermal radiation measurements in delivery aircraft. Aircraft did not penetrate cloud.  |                 |                                 |        |        |     |      |      |      |      |      | IA  |    |     |      |    |  |
| 8.4b Thermal Measurements from Fixed Ground Installations        | Recovered data/instruments from stations near GZ.  |                 | III                             | IIBa** | IIBa** |     | IIBa | IIBa |      |      | III  | IA  |    |     | IIBa |    |  |
| 8.4c Thermal Measurements Prior to First Minimum                 | Took measurements from delivery aircraft and/or Bldg. 410 near Control Point.  |                 | IA                              |        |        |     |      |      |      |      | IA   | IA  |    |     |      |    |  |
| 8.4d Spectrometer Measurements                                   | Took measurements in Bldg. 410 near CP except at Shot Apple 1 when measurements were taken at station 7.5 km from GZ.  |                 | IA                              | IA     | IA     |     | IA   | IA   |      | IA   | IA   | IA  | IA |     |      |    |  |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

Table 32. Operation TEAPOT, AFSWP project participants with bone dose commitment less than 150 millirem (Concluded).

| PROJECT/UNIT                  | ACTIVITY   | Dose | SHOTS/CODE (See Section 3 text) |     |      |     |    |    |    |     |    |     |    |     |     |    |
|-------------------------------|--|------|---------------------------------|-----|------|-----|----|----|----|-----|----|-----|----|-----|-----|----|
|                               |  |      | W*                              | Mo* | Te*  | Tu* | H* | B* | E* | Al* | W* | HA* | P* | ME* | A2* | Z* |
| 8.4f Bolometer Measurements   | Took measurements in Bldg. 410 near CP.  |      | IA                              | IA  |      | IA  | IA | IA |    |     | IA | IA  | IA |     |     |    |
| 9.1 Technical Photography     | Photographed detonation from RC-47 aircraft. (B-50 at HA).   |      | IA                              | IA  | IA   | IA  | IA | IA | IA | IA  | IA | IA  |    | IA  |     |    |
|                               | Photographed damage to equipment in shot area.   | 3.9  |                                 |     | IIC6 |     |    |    |    |     |    |     |    |     |     |    |
|                               | Manned ground stations at least 10 km from GZ.   |      |                                 |     |      | IA  |    |    | IA |     |    | IA  |    |     |     |    |
| 9.4 Atomic Cloud Growth Study | Took theodolite measurements from CP areas. Photographed cloud from aircraft and/or ground stations at least 9 km from GZ. |      | IA                              | IA  | IA   | IA  | IA | IA | IA | IA  | IA | IA  | IA | IA  | IA  | IA |
| 9.6 Weather Reconnaissance    | Flew pre-shot weather recon mission in F-84.   |      | IA                              | IA  | IA   | IA  | IA | IA | IA | IA  | IA | IA  | IA | IA  |     | IA |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

Table 33. Operation TEAPOT, technical service project participants with bone dose commitment less than 150 millirem.

|   |   | SHOTS/CODE (See Section 3 text) |     |        |        |      |      |      |      |      |     |     |    |     |      |      |
|---|---|---------------------------------|-----|--------|--------|------|------|------|------|------|-----|-----|----|-----|------|------|
| PROJECT/UNIT  | ACTIVITY  | D <sub>FB</sub>                 | W*  | Mo*    | Te*    | Tu*  | H*   | B*   | E*   | A1*  | W'* | HA* | P* | ME* | A2*  | Z*   |
| 40.9 Navy Passive Defense Training                                | Observed Shot Bee from trenches 3200 m SW of GZ. Did not tour display area.                                 |                                 |     |        |        |      |      |      | IA   |      |     |     |    |     |      |      |
|   | Observed Shot Ess from trenches 8200 m SW of GZ and established 0.25 and 2.5 R/hr lines on shot day.        | 0.49                            |     |        |        |      |      |      |      | IIC2 |     |     |    |     |      |      |
|   | Conducted simulated rescue exercises in contaminated area on D+1.   | 0.22                            |     |        |        |      |      |      |      | IIB3 |     |     |    |     |      |      |
|   | Conducted simulated rescue exercises in contaminated area on D+3.   | 0.60                            |     |        |        |      |      |      |      | IIB5 |     |     |    |     |      |      |
| 40.14 Chemical, Biological and Radiological Defense Shelter Tests | Inspected field bunker 430 m from GZ on shot day. Some digging required.                                    | 6.0                             |     |        |        |      |      |      |      |      |     |     |    |     | IIB2 |      |
| 40.15 Engineer Field Fortification and Equipment Tests            | Inspected field fortifications 300-420 m from GZ.   |                                 |     |        |        |      |      |      |      |      |     |     |    |     | IIBb |      |
| 40.15a Engineer Heavy Equipment Test                              | Inspected heavy equipment placed in trenches 480-810 m from GZ.   |                                 |     |        |        |      |      |      |      |      |     |     |    |     | IIBb |      |
| 40.17 Effects on Steel Transporters or Containers                 | Inspected various cargo packages placed at stations 1020-2510 m from MET GZ and 500-880 m from Apple II GZ. |                                 |     |        |        |      |      |      |      |      |     |     |    |     | IIBb | IICb |
| 40.20 Clothing Test   | Inspected and recovered clothing from 9 mannequins located 1800-3300 m from GZ.                             |                                 |     |        |        |      |      |      |      |      |     |     |    |     | IIBb |      |
| 40.21 Ordnance Vehicular Equipment Test                           | Inspected ordnance equipment as close as 500 m from GZ.   |                                 | III | IICa** |        | IICa | IICa | IICa | IICa | IICa | III |     |    |     | IICa |      |
| Damage Effects Evaluation   | Inspected weapons, emplacements, and vehicles as close as 500 m from GZ.                                    |                                 |     |        | IICa** |      |      |      |      | IICa |     |     |    |     |      | IICa |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

Table 34. Operation TEAPOT, training project participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                                     | ACTIVITY  | SHOTS/CODE (See Section 3 text) |            |             |             |             |            |            |            |             |             |             |            |             |             |            |
|--|---|---------------------------------|------------|-------------|-------------|-------------|------------|------------|------------|-------------|-------------|-------------|------------|-------------|-------------|------------|
|  |   | <u>D<sub>FB</sub></u>           | <u>W</u> * | <u>Mo</u> * | <u>Te</u> * | <u>Tu</u> * | <u>H</u> * | <u>B</u> * | <u>E</u> * | <u>A1</u> * | <u>W'</u> * | <u>HA</u> * | <u>P</u> * | <u>ME</u> * | <u>A2</u> * | <u>Z</u> * |
| 40.1 Evaluation of IBDA Equipment and Techniques | Checked equipment during simulated bomb drop missions in B-47s over GZ area (34,000-40,000 feet) at shot time.                  |                                 |            |             |             | IA          |            |            |            | IA          |             |             |            | IA          |             | IA         |
| 40.2 Crew Indoctrination (SAC)                   | Observed detonation from KC-97 about 10 miles south of GZ.  |                                 |            |             |             |             |            |            |            |             |             | IA          |            |             |             |            |
| 40.3 Crew Indoctrination (TAC)                   | Flew simulated bomb delivery missions in F-84s over GZ area at shot time. Ground support crew manned radar station south of GZ. |                                 |            | IA          | IA          | IA          | IA         | IA         | IA         | IA          | IA          |             |            | IA          |             | IA         |
| 40.4 Gust Effects on B-36                        | Flew simulated bomb delivery mission in B-36 over GZ at shot time.  |                                 |            |             |             | IA          |            |            |            |             |             |             |            | IA          |             |            |
| 40.5 Reconnaissance Crew Indoctrination          | Photographed cloud from B-47s at 43,000-47,000 feet over GZ area.   |                                 |            |             |             | IA          |            |            |            |             |             |             |            | IA          | IA          |            |
| 40.5a Location of EMP                            | Monitored detonation from off-site remote location.   |                                 |            |             |             |             |            |            |            |             |             |             |            |             | IA          |            |
| 40.6 Calibration of Electromagnetic Effects      | Manned stations at least 10 km from GZ at shot time. Recovered data from unmanned recording stations 10-20 km from GZ.          |                                 | IA         | IA          | IICb**      | IICb        | IICb       | IA         | IICb       | IA          | IA          | IA          | IA         | IA          | IICb        | IICb       |
| 40.8 Calibration of Bomb Debris                  | Analyzed samples collected by Project 11.2 aircraft.  |                                 | IA         | IA          | IA          | IA          | IA         | IA         |            | IA          | IA          | IA          | IA         | IA          | IA          | IA         |
| 40.10 Delivery Crew Indoctrination               | Flew simulated weapons delivery maneuvers at 24,000-34,000 feet above GZ. Did not penetrate cloud.                              |                                 |            |             |             | IA          | IA         |            |            | IA          |             |             | IA         | IA          | IA          | IA         |
| 40.12 Delivery Crew Indoctrination (Dive Bomb)   | Simulated dive bomb maneuver over GZ at shot time.  |                                 |            |             |             |             | IA         |            |            |             |             |             |            |             |             |            |
| 40.13 Tactical Indoctrination Marine Aircrew     | Observed shot from aircraft at least 35 km from GZ.   |                                 |            |             |             | IA          |            | IA         |            | IA          |             |             |            | IA          | IA          |            |
| 40.23 Crew Indoctrination (ADC)                  | Observed shot from aircraft 25 km SE of GZ.   |                                 |            |             |             |             |            |            |            |             |             | IA          |            |             |             |            |
| 40.24 Crew Indoctrination (ARDC)                 | Flew F-100s at 50,000 feet over GZ at shot time.  |                                 |            |             |             |             |            |            |            |             |             |             |            |             |             | IA         |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

Table 35. Operation PLUMBBOB, Desert Rock support participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                      | ACTIVITY   | Dys | SHOTS/CODE (See Section 3 text) |    |    |     |     |     |      |    |    |    |     |     |     |     |      |    |     |     |     |    |    |     |    |    |  |  |
|-----------------------------------|--|-----|---------------------------------|----|----|-----|-----|-----|------|----|----|----|-----|-----|-----|-----|------|----|-----|-----|-----|----|----|-----|----|----|--|--|
|                                   |  |     | B*                              | F* | L* | W1* | P*  | H*  | D1*  | J* | K* | O* | St* | Sh* | Do* | F1* | Sm*  | G* | Wh* | LP* | Fl* | N* | R* | Wy* | C* | M* |  |  |
| CDR Headquarters                  | Command functions.   |     |                                 |    |    |     |     | III |      |    |    |    |     |     |     |     | IA   |    |     |     |     |    |    |     |    |    |  |  |
| 293rd MP Co                       | Provided traffic control to forward areas on shot day. Accompanied monitors to establish 20 mR/hr line on contaminated access roads.     | 5.0 | IA                              |    |    | V1  | III | III | IIC1 |    | V1 | IA | IA  | IA  | IA  | IA  | IA   | IA |     |     |     |    |    |     |    |    |  |  |
| 232nd Sig Co                      | Established and maintained communications network (laid wire, etc) in forward area. Signal pictorial teams took photos in display areas. |     |                                 |    |    |     | III | III | IA   |    | IA |    |     |     |     |     | IICb |    |     |     |     |    |    |     |    |    |  |  |
| 26th Trans Bn (-)<br>Hq and Hq Co | General support at CDR.  |     |                                 |    |    |     |     |     |      |    |    |    |     |     |     |     |      |    |     |     |     |    |    |     |    |    |  |  |
| 38th TC Co (HV)                   | Transported maneuver troops, observers and technical project personnel to and from forward area.   | 5.0 | IA                              | IA | IA | V1  | III | III | IIC1 | IA | V1 | IA | IA  | IA  | IA  | IA  | IICa | IA | IA  | IA  | IA  | IA | IA | IA  | IA | IA |  |  |
| 531st TC Co (Med)                 | Transported maneuver troops, observers and technical project personnel to and from forward area.   | 5.0 | IA                              | IA | IA | V1  | III | III | IIC1 | IA | V1 | IA | IA  | IA  | IA  | IA  | IICa | IA | IA  | IA  | IA  | IA | IA | IA  | IA | IA |  |  |
| 2nd TC Trk Co (Plt)               | Transported maneuver troops, observers and technical project personnel to and from forward area.   | 5.0 | IA                              | IA | IA | V1  | III | III | IIC1 | IA | V1 | IA | IA  | IA  | IA  | IA  | IICa | IA | IA  | IA  | IA  | IA | IA | IA  | IA | IA |  |  |
| 8th Field Hosp (-)                | Established aid station in forward area and provided ambulance service.  | 5.0 |                                 |    |    | V1  | III | III | IIC1 |    | V1 |    |     |     | IA  |     | IA   | IA |     |     |     |    |    |     |    |    |  |  |
| 53rd QM Sub Sup Co,<br>Det        | General support at CDR.  |     |                                 |    |    |     |     |     |      |    |    |    |     |     |     |     |      |    |     |     |     |    |    |     |    |    |  |  |
| 163rd Ldry Co                     | General support at CDR.  |     |                                 |    |    |     |     |     |      |    |    |    |     |     |     |     |      |    |     |     |     |    |    |     |    |    |  |  |
| QM Petrol Sup Co (-)              | General support at CDR.  |     |                                 |    |    |     |     |     |      |    |    |    |     |     |     |     |      |    |     |     |     |    |    |     |    |    |  |  |
| 433rd Army Band                   | General support at CDR.  |     |                                 |    |    |     |     |     |      |    |    |    |     |     |     |     |      |    |     |     |     |    |    |     |    |    |  |  |

\* See Appendix for shot abbreviations.

NOTE: All may have observed one or more shot as CDR Observers (see table 37).

Table 36. Operation PLUMBBOB, Air Force support participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                           | ACTIVITY   | Dys | SHOTS/CODE (See Section 3 text) |    |    |     |    |    |     |    |    |    |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|--|--|-----|---------------------------------|----|----|-----|----|----|-----|----|----|----|-----|-----|-----|-----|-----|----|-----|-----|-----|----|----|-----|----|----|
|  |  |     | B*                              | F* | L* | Wl* | P* | H* | Di* | J* | K* | O* | St* | Sh* | Do* | F'* | Sm* | G* | Wh* | LP* | Fl* | N* | R* | Wy* | C* | M* |
| 4950th Test Gp (N)                     | General support at ISAFB (Except decon).   |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 4952nd Sup Sq                          | General support.   |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 4926th Test Sq (S)                     | Flew cloud sampling missions in support of Projects 11.2, 21.2 and 53.1 (Aircrews breathed 100% oxygen). |     | IB                              | IB | IB | IB  | IB | IB | IB  | IB | IB | IB | IB  | IB  | IB  | IB  | IB  | IB | IB  | IB  | IB  |    | IB | IB  | IB |    |
| 55th Weather Recon Sq                  | Flew cloud tracking missions. Did not penetrate cloud.   |     | IA                              | IA | IA | IA  | IA | IA | IA  | IA | IA | IA | IA  | IA  | IA  | IA  | IA  | IA | IA  | IA  | IA  |    | IA | IA  | IA |    |
| 4900th Air Base Gp                     | Flew courier missions.   |     | IA                              | IA | IA | IA  | IA | IA | IA  | IA | IA | IA | IA  | IA  | IA  | IA  | IA  | IA | IA  | IA  | IA  |    | IA | IA  | IA |    |
| 4935th Air Base Sq                     | Flew security sweeps prior to shots.   |     | IA                              | IA | IA | IA  | IA | IA | IA  | IA | IA | IA | IA  | IA  | IA  | IA  | IA  | IA | IA  | IA  | IA  | IA | IA | IA  |    |    |
| 21st Helicopter Sq (Det 1)             | Flew aerial survey and search and rescue missions.   |     | IA                              | IA | IA | IA  | IA | IA | IA  | IA | IA | IA | IA  | IA  | IA  | IA  | IA  | IA | IA  | IA  | IA  | IA | IA | IA  |    |    |
| * See Appendix for shot abbreviations. |  |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |     |     |    |     |     |     |    |    |     |    |    |

\* See Appendix for shot abbreviations.



Table 37. Operation PLUMBBOB, observers with bone dose commitment less than 150 millirem.

| PROJECT/UNIT   | ACTIVITY  | Dya | SHOTS/CODE (See Section 3 text) |    |    |    |    |     |     |    |    |    |     |     |     |     |     |    | Others |
|--|---|-----|---------------------------------|----|----|----|----|-----|-----|----|----|----|-----|-----|-----|-----|-----|----|--------|
|  |   |     | B*                              | F* | L* | W* | P* | H*  | Di* | J* | K* | O* | St* | Sh* | Do* | F** | Sm* | G* |        |
| Service** (53.3) and CDR Observers (Shot Boltzmann)              | Observed shot from open 13 km S of GZ. Returned to CDR after shot.  | IA  |                                 |    |    |    |    |     |     |    |    |    |     |     |     |     |     |    |        |
| Service (50.2, 52.2 & 53.3) and CDR Observers (Shot Wilson)      | Observed shot from observation area near BJY (7 km from GZ). Evacuated area at H+5 min due to unexpected fallout.   |     |                                 |    |    |    |    | V1  |     |    |    |    |     |     |     |     |     |    |        |
| Service** (50.2, 52.2 & 53.3) and CDR Observers (Shot Priscilla) | Observed shot from open 11 km SW of GZ. Toured display area to 5 R/hr line on shot day.                             |     |                                 |    |    |    |    | III |     |    |    |    |     |     |     |     |     |    |        |
|  | Observed shot from trenches 4000 m SW of GZ. Toured display area to 5 R/hr line on shot day.                        |     |                                 |    |    |    |    | III |     |    |    |    |     |     |     |     |     |    |        |
| Service** (50.2 & 53.3) Observers (Shot Hood)                    | Observed shot from open 10 km SW of GZ or from trenches 5 km SW of GZ. Toured display area for 2 hours on shot day. |     |                                 |    |    |    |    | III |     |    |    |    |     |     |     |     |     |    |        |
| Marine Observers (Shot Hood)                                     | Observed shot from trenches 5 km SW of GZ. Toured display area on shot day.   |     |                                 |    |    |    |    | III |     |    |    |    |     |     |     |     |     |    |        |
| CDR Observers (Shot Hood)  | Observed shot from News Nob, 23 km S of GZ. Returned to CDR after shot.   |     |                                 |    |    |    |    | IA  |     |    |    |    |     |     |     |     |     |    |        |
| Service** (50.2, 52.2 & 53.3) and CDR Observers (Shot Diablo)    | Observed shot from trenches 3810 m SE of GZ. Toured Hood display area after shot.                                   |     |                                 |    |    |    |    | III | IA  |    |    |    |     |     |     |     |     |    |        |
| Service** (50.2, 52.2 & 53.3) and CDR Observers (Shot John)      | Observed shot from 5900 m SE of GZ.   |     |                                 |    |    |    |    |     |     |    |    | IA |     |     |     |     |     |    |        |
| Volunteer (53.3) Observers (Shot John)                           | Observed shot from directly under detonation. Returned to CDR at H+2.   |     |                                 |    |    |    |    |     |     |    |    | IA |     |     |     |     |     |    |        |
| Service (50.2, 52.2 & 53.3) and CDR Observers (Shot Kepler)      | Observed shot from trenches 3200 m SW of GZ. Evacuated trenches due to fallout immediately after shot.              |     |                                 |    |    |    |    |     |     |    |    | V1 |     |     |     |     |     |    |        |
| Service (50.2 & 53.3) and CDR Observers (Shot Owens)             | Observed shot from open 20 km S of GZ. Returned to CDR after shot.  |     |                                 |    |    |    |    |     |     |    |    |    |     | IA  |     |     |     |    |        |
| Service (50.2) CDR Observers (Shot Stokes)                       | Observed shot from News Nob, 16 km S of GZ. Returned to CDR after shot.   |     |                                 |    |    |    |    |     |     |    |    |    |     | IA  |     |     |     |    |        |
| HUMRO and CDR Observers (Shot Shasta)                            | Observed shot from News Nob, 20 km S of GZ. Returned to CDR after shot.   |     |                                 |    |    |    |    |     |     |    |    |    |     |     | IA  |     |     |    |        |

\* See Appendix for shot abbreviations.

\*\* Navy observers (no project number) were also present.

Table 37. Operation PLUMBBOB, observers with bone dose commitment less than 150 millirem (Concluded).

|  |  | SHOTS/CODE (See Section 3 text) |           |           |           |                       |           |           |            |           |           |           |            |            |            |                       |            |           |               |
|--|--|---------------------------------|-----------|-----------|-----------|-----------------------|-----------|-----------|------------|-----------|-----------|-----------|------------|------------|------------|-----------------------|------------|-----------|---------------|
| PROJECT/UNIT   | ACTIVITY   | <u>D<sub>pa</sub></u>           | <u>B*</u> | <u>F*</u> | <u>L*</u> | <u>W<sub>i</sub>*</u> | <u>P*</u> | <u>H*</u> | <u>Di*</u> | <u>J*</u> | <u>K*</u> | <u>O*</u> | <u>St*</u> | <u>Sh*</u> | <u>Do*</u> | <u>F<sub>i</sub>*</u> | <u>Sm*</u> | <u>G*</u> | <u>Others</u> |
| Service (50.2 & 53.3) and CDR Observers (Shot Doppler)       | Observed shot from trenches 2900 m SW of GZ. Returned to CDR after shot. |                                 |           |           |           |                       |           |           |            |           |           |           |            |            | IA         |                       |            |           |               |
| Service** (50.2, 52.2 & 53.3) and CDR Observers (Shot Smoky) | Observed shot from News Nob. Returned to CDR after shot.                 |                                 |           |           |           |                       |           |           |            |           |           |           |            |            |            |                       | IA         |           |               |

\* See Appendix for shot abbreviations.

\*\* Navy observers (no project number) were also present.

Table 38. Operation PLUMBBOB, maneuver troops with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |                |                |                |                |                |                |                |                |                |                 |                 |                 |                |                 |                |      | Others |
|-----------------------------|--|-----------------|---------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|----------------|-----------------|----------------|------|--------|
|                             |  |                 | S <sup>a</sup>                  | P <sup>a</sup> | L <sup>a</sup> | W <sup>a</sup> | P <sup>a</sup> | H <sup>a</sup> | D <sup>a</sup> | J <sup>a</sup> | K <sup>a</sup> | O <sup>a</sup> | St <sup>a</sup> | Sh <sup>a</sup> | Do <sup>a</sup> | P <sup>a</sup> | Sa <sup>a</sup> | G <sup>a</sup> |      |        |
| 52.1 4th MCPAEB             | Observed Shot Priscilla from trenches 4000 m SW of GZ. Toured Priscilla display area on shot day.  |                 |                                 |                |                |                | III            |                |                |                |                |                |                 |                 |                 |                |                 |                |      |        |
|                             | Observed Shot Priscilla from News Nob or Camp Desert Rock  |                 |                                 |                |                |                | IA             |                |                |                |                |                |                 |                 |                 |                |                 |                |      |        |
|                             | Observed Shot Hood from trenches 5000 m SW of GZ. Toured display area or marched to 5 R/hr line; air-lifted or trucked to objective arena. |                 |                                 |                |                |                | III            | III            |                |                |                |                |                 |                 |                 |                |                 |                |      |        |
|                             | Observed Shots Franklin Prime and Smoky from News Nob.   |                 |                                 |                |                |                |                |                |                |                |                |                |                 |                 |                 | IA             | IA              |                | IA   |        |
| 50.1 Task Force<br>BIG BANG | Observed Shot Galileo and conducted rifle disassembly test in open area 4500 m E of GZ.  |                 |                                 |                |                |                |                |                |                |                |                |                |                 |                 |                 |                |                 |                |      |        |
|                             | Trucked and marched through Smoky fallout (D+2) on way to infiltration course.   | 3.0             |                                 |                |                |                |                |                |                |                |                |                |                 |                 |                 |                |                 |                | IIC4 |        |
|                             | Crawled through infiltration course contaminated by Shot Smoky (D+2).  | 0.03            |                                 |                |                |                |                |                |                |                |                |                |                 |                 |                 |                |                 |                | IIB4 |        |

\* See Appendix for shot abbreviations.

Table 39. Operation PLUMBBOB, service project participants with bone dose commitment less than 150 millirem.

|   |   | SHOTS/CODE (See Section 3 text) |    |      |     |     |      |     |     |    |    |    |     |     |      |     |     |      |     |     |     |    |    |     |    |    |  |
|---|---|---------------------------------|----|------|-----|-----|------|-----|-----|----|----|----|-----|-----|------|-----|-----|------|-----|-----|-----|----|----|-----|----|----|--|
| PROJECT/UNIT  | ACTIVITY  | Dys                             | B* | F*   | L*  | W1* | P*   | H*  | DI* | J* | K* | O* | St* | Sh* | Do*  | F1* | Sm* | G*   | Wh* | LP* | F1* | N* | R* | Wy* | C* | M* |  |
| 50.3 Detonation Detection and Cloud Tracking System   | Fallout prediction unit operated from van located at Camp Mercury.  |                                 | IA | IA   | IA  | IA  | IA   | IA  | IA  | IA | IA | IA | IA  | IA  | IA   | IA  | IA  | IA   | IA  | IA  | IA  | IA |    |     | IA |    |  |
|   | Manned meteorology station near Alamo, 50 km E of test site. A second fallout prediction unit also operated from this site.   |                                 |    |      |     |     | V1   | IA  | IA  | IA | IA | IA | IA  | IA  | IA   | IA  | V1  | IA   | IA  | IA  | IA  | IA |    |     | IA |    |  |
|   | Operated radar equipment at site located SE of Yucca Lake.  |                                 | IA | IA   | IA  | IA  | IA   | IA  | IA  | IA | IA | IA | IA  | IA  | IA   |     |     |      |     |     |     |    |    |     |    |    |  |
|   | Operated radar equipment (AN/CPS-9) from sites 40-100 miles from test area.   |                                 |    |      |     |     |      |     |     |    |    |    |     |     |      |     | IA  | IA   | IA  | IA  | IA  | IA | IA |     | IA |    |  |
|   | Operated radar equipment (AN/MPG-1 and AN/TPS-1D) at minimum safe distance (5-6 km from GZ) on shot day                       | 5.0                             |    |      |     |     |      |     |     |    |    |    |     | IA  | IIC2 | IA  | IA  |      |     |     |     |    |    |     |    |    |  |
|   | Operated radar equipment from site at least 13 km from GZ.  |                                 |    |      |     |     |      |     |     |    |    |    |     |     |      |     |     |      |     | IA  | IA  | IA | IA |     |    | IA |  |
|   | Obtained data from USAF radar site at Angel's Peak.   |                                 |    |      |     |     |      |     |     |    |    |    |     |     |      |     |     | IA   | IA  |     | IA  | IA | IA |     |    |    |  |
| 50.4 Evaluation of Water Decon Methods                | Collected and analyzed soil and water samples taken from GZ area. Tested various water decon methods.                         | 0.54                            |    |      |     |     | IIB6 |     |     |    |    |    |     |     |      |     |     |      |     |     |     |    |    |     |    |    |  |
| 50.6 Protection Afforded by Field Fortifications      | Inspected foxholes, gun emplacements, etc., 435-900 m SW of GZ.   |                                 |    |      |     |     | III  |     |     |    |    |    |     |     |      |     |     |      |     |     |     |    |    |     |    |    |  |
| 50.7 Test of Ordnance Material                        | Evaluated dosimetry data obtained from Project 2.4.   |                                 |    | IA   | IA  | IA  |      | IA  |     |    |    |    |     |     |      |     |     |      |     |     |     |    |    |     |    |    |  |
|   | Inspected damage to foxholes 550 m from GZ (915 m at Hood).   | 5.0                             |    | IIC2 | III | III |      | III |     |    |    |    |     |     |      |     |     |      |     |     |     |    |    |     |    |    |  |
|   | Inspected damage to tanks and armored vehicles placed from 300 to 550 m from GZ (550-730 m at Hood; 375-850 m at Smoky)       | 5.0                             |    | IIC2 | III | III |      | III |     |    |    |    |     |     |      |     |     | IIC6 |     |     |     |    |    |     |    |    |  |
|   | Recovered fuses buried at distances of 365-1067 m from GZ   |                                 |    |      |     |     |      | III |     |    |    |    |     |     |      |     |     |      |     |     |     |    |    |     |    |    |  |
| 50.8 Detection of Atomic Bursts & Radioactive Fallout | Operated AN/TVS-1 Flash Ranging Equipment, M65 Scopes, or M2 Aiming Circle at least 15 km S-SW of GZ. (13 km NW of Priscilla) |                                 |    |      |     |     | IA   | IA  | IA  | IA | IA | IA | IA  | IA  |      |     |     |      |     |     |     |    |    |     |    |    |  |
|   | Operated AN/GAS-1 Flash Detector on Angel's Peak, approximately 60 miles from site.   |                                 |    |      |     |     |      | IA  |     |    |    |    |     |     | IA   |     |     |      |     |     |     |    |    |     |    |    |  |
|   | Operated AN/MPQ-10 Radar from site at least 17 km S of GZ. (12 km WNW of Priscilla; 8 km S of Shasta).                        |                                 |    |      |     |     | IA   | IA  | IA  | IA | IA | IA | IA  | IA  |      |     |     |      |     |     |     |    |    |     |    |    |  |

\* See Appendix for shot abbreviations.

Table 39. Operation PLUMBBOB, service project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT                                   | ACTIVITY   | Dose | SHOTS/CODE (See Section 3 text) |      |     |      |      |     |      |    |      |     |     |      |     |    |     |    |     |     |     |    |    |     |
|--|--|------|---------------------------------|------|-----|------|------|-----|------|----|------|-----|-----|------|-----|----|-----|----|-----|-----|-----|----|----|-----|
|  |  |      | B*                              | F*   | L*  | Mi*  | P*   | H*  | Di*  | J* | K*   | O*  | St* | Sh*  | Do* | F* | Sm* | G* | Wh* | LP* | FI* | N* | R* | My* |
|  | Operated AN/MPQ-21 Radar from site at least 37 km S of GZ. (20 km WNW of Priscilla; 15 km S of Shasta).                  |      |                                 |      |     |      | IA   | IA  | IA   | IA | IA   | IA  | IA  | IA   |     |    |     |    |     |     |     |    |    |     |
|  | Operated AN/ASH-4 Bhangmeter from site at least 14 km from GZ. (8 km from Priscilla and Stokes).                         |      |                                 |      |     | IA   | IA   | IA  | IA   | IA | IA   | IA  | IA  | IA   |     |    |     |    |     |     |     |    |    |     |
|  | Operated GR-8 Sound Ranging Set from site at least 16 km S-SW of GZ.   |      |                                 |      |     |      | IA   | IA  | IA   | IA | IA   | IA  | IA  | IA   |     |    |     |    |     |     |     |    |    |     |
|  | Operated NIKE-AJAX, AN/FPS-ID, and AN/FPS-M33 radars from sites ranging from 5 to 50 km from GZ.                         |      |                                 |      |     | V1   | IA   | IA  | IA   | IA | V1   | IA  | IA  | IA   | IA  | IA | IA  | IA | IA  | IA  | IA  | IA | IA | IA  |
|  | Operated AN/FPS-36 radar from site at least 70 km from GZ.   |      |                                 |      |     | IA   | IA   | IA  | IA   | IA | IA   | IA  | IA  | IA   | IA  | IA | IA  | IA | IA  | IA  | IA  | IA | IA | IA  |
|  | Manned AN/MTQ-1 Operations Center.   |      |                                 |      |     | IA   | IA   | IA  | IA   | IA | IA   | IA  | IA  | IA   | IA  | IA | IA  | IA | IA  | IA  | IA  | IA | IA | IA  |
|  | Provided weather data from site 200 miles away.  |      |                                 |      |     | IA   | IA   | IA  | IA   | IA | IA   | IA  | IA  | IA   | IA  | IA | IA  | IA | IA  | IA  | IA  | IA | IA | IA  |
|  | Made fallout predictions from Command Post and compared with survey data.  |      |                                 |      |     | IA   | IA   | IA  | IA   | IA | IA   | IA  | IA  | IA   | IA  | IA | IA  | IA | IA  | IA  | IA  | IA | IA | IA  |
|  | Conducted aerial radiological survey to 100 R/hr line on shot day.   |      |                                 |      |     |      | IA   | IA  | IA   |    | IA   |     |     |      |     |    |     |    |     |     |     |    |    |     |
|  | Conducted ground radiological surveys downwind to 5 R/hr line on shot day.   | 5.0  |                                 |      |     | IIC2 | IIC2 | III | IIC2 |    | IIC2 |     |     |      |     |    |     |    |     |     |     |    |    |     |
|  | Flew B-26 aircraft (H-21 helicopter at Smoky) approximately 15 miles from GZ. Did not penetrate cloud.                   |      |                                 |      |     |      |      |     | IA   |    | IA   | IA  | IA  | IA   | IA  | IA | IA  | IA | IA  |     |     |    |    |     |
| 6th Army CBR Teams                             | Observed shot from observer area and conducted radiological survey in areas less than 5 R/hr.                            | 5.0  | IIC5                            |      |     |      |      | III | IIC5 |    |      |     |     | IIC5 | III |    |     |    |     |     |     |    |    |     |
|  | Conducted radiological surveys in residual radiation field less than 5 R/hr.   | 0.58 | IIC8                            | IIC7 | III |      |      |     |      |    |      |     |     |      |     |    |     |    |     |     |     |    |    |     |
|  | Observed Shot Stokes from observer area and conducted radiological surveys in residual radiation field less than 5 R/hr. | 2.1  |                                 |      |     |      |      |     |      |    | IIC7 | III | III |      |     |    |     |    |     |     |     |    |    |     |
| 51.1 Navy Radiological Safety Monitor Training | Participation in Boltzmann cancelled due to delays.  | 0.0  | IA                              |      |     |      |      |     |      |    |      |     |     |      |     |    |     |    |     |     |     |    |    |     |
| 51.3 Navy Heavy Attack Indoctrination          | Flew simulated bomb run offset from GZ. Were at least 8 km from GZ at detonation time.                                   |      |                                 |      |     |      |      |     |      |    |      |     |     |      |     |    |     |    |     |     |     |    |    | IA  |
| 52.3 Marine Fly-by Indoctrination (A4D/F4D)    | Observed detonation from aircraft at least 25 km from GZ.  |      |                                 |      |     |      |      | IA  |      |    |      |     |     |      |     |    |     |    |     |     |     |    |    |     |

\* See Appendix for shot abbreviations.

Table 39. Operation PLUMBBOB, service project participants with bone dose commitment less than 150 millirem (Concluded).

| PROJECT/UNIT  | ACTIVITY   | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |     |     |      |     |     |      |     |      |     |     |     |     |     |     |     |     |     |     |    |    |    |    |    |
|---|--|-----------------|---------------------------------|-----|-----|------|-----|-----|------|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|----|
|   |  |                 | S*                              | P*  | L*  | M1*  | P*  | B*  | D1*  | J*  | K*   | O*  | St* | Sh* | Do* | P1* | Sm* | G*  | Wh* | L3* | P1* | N* | R* | W* | C* | M* |
| 53.1 Aerial Sampling Missions (ANG)                       | Flew cloud sampling missions in T-33 aircraft. Breathed 100% oxygen.   |                 | IB                              | IB  | IB  | IB   | IB  | IB  | IB   | IB  | IB   | IB  | IB  | IB  | IB  | IB  | IB  | IB  | IB  |     |     |    |    |    |    |    |
| 53.4 Radiological Defense Training                        | Observed shot from observer area and conducted radiological survey to 5 R/hr line on shot day.                                     | 5.0             | IIC2                            |     |     | IIC2 |     | III | IIC2 |     | IIC2 |     | III |     | III |     |     |     |     |     |     |    |    |    |    |    |
| 53.5 Aircrew Indoctrination-Early Cloud Penetration (ANG) | Flew jet aircraft through atomic cloud. Breathed 100% oxygen.  |                 | IB                              |     |     | IB   | IB  | IB  | IB   | IB  | IB   |     |     |     |     |     |     |     |     | IB  | IB  |    |    |    |    |    |
| 53.7 IBDA (WADC)  | Tested IBDA equipment in F-89 aircraft. Aircraft did not penetrate cloud.  |                 | IA                              | IA  | IA  | IA   | IA  | IA  | IA   | IA  | IA   | IA  | IA  | IA  | IA  | IA  | IA  |     |     |     |     |    |    |    |    |    |
| 53.8 IBDA (SAC)   | Tested IBDA equipment in B-47 aircraft. Aircraft did not penetrate cloud.  |                 |                                 |     |     |      |     |     |      |     |      |     |     |     |     |     |     | IA  |     |     | IA  |    |    |    |    | IA |
| 53.9 Photo-Recon Training (ANG)                           | Flew photo recon missions over GZ approximately 10 minutes after detonation. Did not penetrate cloud, but may have flown under it. | 5.0             | IV1                             | IV1 | IV1 | IV1  | IV1 | IV1 | IV1  | IV1 | IV1  | IV1 | III |     | III | IV1 | IV1 | IV1 |     |     |     |    |    |    |    |    |

\* See Appendix for shot abbreviations.

Table 40. Operation PLUMBBOB, AFSWP project participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT  | ACTIVITY  | Dys | SHOTS/CODE (See Section 3 text) |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
|---|---|-----|---------------------------------|----|----|-----|----|----|-----|----|----|----|-----|-----|-----|----|-----|----|-----|-----|-----|----|----|-----|----|----|
|   |   |     | B*                              | F* | L* | Wl* | P* | H* | Di* | J* | K* | O* | St* | Sh* | Do* | F* | Sa* | G* | Wh* | LP* | Fl* | N* | R* | Wy* | C* | M* |
| 1.2 Field Test of Airborne Gauges for Measuring Blast Phenomena | Flew and photographed an instrumented balloon over 40 km S of GZ.   |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
|   | Fired instrumented rockets from station 4610 m SW of GZ.  |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
| 1.3 Airblast Phenomena in High Pressure Region                  | Recovered gauges from stations 23-1350 m W of GZ.   |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
| 1.4 Ground Acceleration, Stress & Strain                        | Recovered data from recording station W (assumed) of GZ on shot day.  |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
| 1.5 Ground Motion Studies                                       | Recovered gauges from instrument array 23-410 m W (assumed) of GZ.  |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
| 1.7 Loading on Simulated Buried Structures                      | Recovered instrumented drums buried in trenches 230-410 m W of GZ.  |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
| 2.0 Neutron and Gamma Radiation from Shot La Place              | Project 2.10 personnel recovered neutron detectors from a cable dragged out of GZ area shortly after the shot. Delivered detectors to lab for analysis. |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
|   | Project 2.3 personnel took radiation measurements at station 730 m NW of GZ at R+2,3,4,7,8,14 and 15.   |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
|   | Recovered neutron detectors, film badges, and other dosimeters (some buried) from a line extending 90-2740 m from GZ.                                   |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
| 2.1 Soil Activation by Neutrons                                 | Took radiation measurements in GZ area by lowering instrument from helicopter.  |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
|   | Recovered soil samples from stations 180-460 m from GZ.   |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
| 2.2 Neutron-Induced Activities in Soil Elements                 | Recovered samples (some buried) from stations 91-910 m SW of GZ.  |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
|   | Moved M-48 tank used in Project 57 from 900 to 2400 m from GZ. Took radiation measurements inside and outside of tank.                                  |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
| 2.4 Nuclear Radiation Shielding Studies                         | Recovered instruments from armored vehicles (field fortifications at Priscilla) in GZ area.   | 5.0 |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |
|   | Recovered soil specimens from array 180-360 m SW of GZ.   |     |                                 |    |    |     |    |    |     |    |    |    |     |     |     |    |     |    |     |     |     |    |    |     |    |    |

\* See Appendix for shot abbreviations.

Table 40. Operation PLUMBBOB, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT  | ACTIVITY   | D <sub>75</sub> | SHOTS/CODE (See Section 3 text) |      |     |      |     |     |     |      |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|---|--|-----------------|---------------------------------|------|-----|------|-----|-----|-----|------|----|-----|-----|-----|-----|-----|-----|----|-----|-----|-----|----|----|-----|----|----|
|   |  |                 | B*                              | F*   | L*  | W1*  | P*  | H*  | D1* | J*   | K* | O*  | St* | Sh* | Do* | F1* | Sm* | G* | Wh* | LP* | Pi* | N* | R* | My* | C* | M* |
| 2.5 Initial-Gamma Radiation Intensity & Neutron-Induced Radiation of MTS Soil | Recovered data/dosimeters from 7 stations 1430-1920 m SE of GZ.  |                 | IIBb                            |      |     |      |     |     |     |      |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Recovered data/instruments from 7 stations located 460-3660 m from GZ.   |                 |                                 | IIBb | III | IIBb |     | III |     |      |    |     |     | III |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Recovered dosimeter from 4 balloon stations along the ground station line mentioned above.   |                 |                                 |      | III | IIBb |     | III |     |      |    |     |     | III |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Recovered dosimeters from M-48 tank in GZ area.  |                 |                                 |      |     |      |     | III |     |      |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Recovered dosimeters from Project 2 9 aircraft.  |                 |                                 |      |     |      |     |     |     | IA   |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 2.6 Evaluation of New Radiacs   | Recovered dosimeters from GZ area on shot day. Evaluation of radiac by Rad-Safe teams at Hood only.  | 5.0             |                                 | IIC2 | III | III  | III | III |     |      |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 2.7 Radio-Wave Attenuation Studies  | Manned receiver station near Bldg. 400 near CP.  |                 | IA                              |      | IA  | IA   | IA  | IA  | IA  |      | IA | IA  |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Recovered transmitter/equipment from Banded Mountain.  |                 | IIBb                            |      |     |      |     |     |     |      |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Recovered data from and maintained equipment in/around bunkers located 840-1460 m N of balloon shot area in Area 9.                          |                 | IIBb                            |      | III | III  |     | III | IA  |      | IA | III |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Recovered transmitter/equipment from Frenchman Flat.   |                 |                                 |      |     |      |     | III |     |      |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 2.8 Evaluation of Military Radiacs  | Placed instrumented phantoms in 50 R/hr induced activity field shortly after shot; retrieved phantoms 53 hours later                         |                 |                                 |      |     | III  |     |     |     |      |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Placed instrumented phantoms in 10-20 R/hr induced field shortly after shot; retrieved phantoms 52 hours later.                              |                 |                                 |      |     |      |     | III |     |      |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Placed instrumented phantoms and dosimeter rack in 2-7 R/hr induced field shortly after shot; retrieved phantoms and rack 32-56 hours later. |                 |                                 |      |     |      |     |     | III |      |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Placed instrumented phantoms in 50 R/hr field shortly after shot; retrieved phantoms 6.5 and 30 hours later.                                 | 5.0             |                                 |      |     |      |     |     |     | IIC4 |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 2.9 Nuclear Radiation Received by Aircrews Firing the MB-1 Rocket             | Launched MB-1 rocket from F-89 aircraft. Flew in formation with launch aircraft.   |                 |                                 |      |     |      |     |     |     | IA   |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Recovered dosimeters from Project 2.9 aircraft.  |                 |                                 |      |     |      |     |     |     | IA   |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |

\* See Appendix for shot abbreviations.



Table 40. Operation PLUMBBOB, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

|   |  | SHOTS/CODE (See Section 3 text) |                |                |                |                  |                |                |                  |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
|---|--|---------------------------------|----------------|----------------|----------------|------------------|----------------|----------------|------------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|----------------|-----------------|----------------|-----------------|------------------|-----------------|----------------|----------------|-----------------|----------------|----------------|
| PROJECT/UNIT  | ACTIVITY   | D <sup>FB</sup>                 | B <sup>*</sup> | F <sup>*</sup> | L <sup>*</sup> | W <sup>i</sup> * | P <sup>*</sup> | H <sup>*</sup> | D <sup>i</sup> * | J <sup>*</sup> | K <sup>*</sup> | Q <sup>*</sup> | St <sup>*</sup> | Sh <sup>*</sup> | Do <sup>*</sup> | F <sup>*</sup> | SA <sup>*</sup> | G <sup>*</sup> | Wh <sup>*</sup> | L <sup>P</sup> * | Fl <sup>*</sup> | N <sup>*</sup> | R <sup>*</sup> | Wy <sup>*</sup> | C <sup>*</sup> | H <sup>*</sup> |
| 2.10 Initial Neutron and Gamma Air-Earth Interface Measurements       | Recovered dosimeters from ground stations 1520 and 1830 m NNW of GZ and from the Franklin tower 5210 m S of GZ on shot day.                          | 5.0                             | IIC2           |                |                |                  |                |                |                  |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
|   | Recovered dosimeters from ground stations at 460 m intervals from GZ. Recovered dosimeter from balloon mooring cables at 4 stations along this line. |                                 |                |                |                | III              | IIBb           |                | III              |                |                |                |                 | III             |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
|   | Recovered dosimeters from Shasta and Whitney Towers.   |                                 |                |                |                |                  |                |                | IA               |                | IA             |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
|   | Recovered dosimeters from surface GZ area.   |                                 |                |                |                |                  |                |                |                  | IA             |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
|   | Recovered neutron detectors from cable dragged out of GZ areas.  |                                 |                |                |                |                  |                |                |                  |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 | III            |                |                 |                |                |
| 3.1 Underground Concrete-Arch Protective Structures                   | Recovered instruments/data from and inspected underground structures located 250-400 m W of GZ.  |                                 |                |                |                |                  |                |                | III              |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
| 3.2 Buried Conduits as Personnel Shelters                             | Recovered instruments/data from and inspected underground structure located 300-410 m NW of GZ.  |                                 |                |                |                |                  |                |                | III              |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
| 3.3 Earth Covered Pre-Fab Ammo Storage Magazines as Personnel Shelter | Recovered instruments/data from and inspected underground structure located 360-420 m NW of GZ.  |                                 |                |                |                |                  |                |                | III              |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
| 3.4 Blast Effects on U-K and Reapot Structures                        | Recovered instruments/data from and inspected structures 270 m W of GZ.  |                                 |                |                |                |                  |                |                | III              |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
| 3.5 Isolation of Structures from Ground Shock                         | Recovered instruments/data from and inspected buried structures 230-320 m W of GZ.   |                                 |                |                |                |                  |                |                | III              |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
| 3.6 Field Test of Dome and Arch Structures                            | Recovered instruments/data from and inspected dome and arch structures located 370-510 m SW of GZ.   |                                 |                |                |                |                  |                |                | III              |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
| 3.7 Instrumentation of Structures                                     | Recovered instruments used in Projects 3.1, 3.2, 3.3 and 3.6 and CETG Projects 33.2 and 33.5.  |                                 |                |                |                |                  |                |                | III              |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
| 3.8 Soil Survey and Backfill Control                                  | Obtained and analyzed soil samples from various other project areas W of GZ.   |                                 |                |                |                |                  |                |                | III              |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
| 4.1 Effects on Large Biological Specimens                             | Recovered test animals from exposure devices (large metal conduits) on shot day.   | 5.0                             |                | IIB2           |                |                  |                |                |                  |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |
|   | Recovered test animals from exposure devices 790-1070 m (large metal conduits) and a tank 550 m from GZ (SE) on shot day.                            |                                 |                |                |                |                  |                |                | III              |                |                |                |                 |                 |                 |                |                 |                |                 |                  |                 |                |                |                 |                |                |

\* See Appendix for shot abbreviations.

Table 40. Operation PLUMBBOB, AFSWP project participants with bone dose commitment less than 150 millirem (Continued).

|   |   | SHOTS/CODE (See Section 3 text) |    |    |     |      |        |     |      |    |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|---|---|---------------------------------|----|----|-----|------|--------|-----|------|----|----|-----|-----|-----|-----|-----|-----|----|-----|-----|-----|----|----|-----|----|----|
| PROJECT/UNIT  | ACTIVITY  | Dyn                             | B* | F* | L*  | W*   | P*     | H*  | Di*  | J* | K* | O*  | St* | Sh* | Do* | F** | Sm* | C* | Wh* | LP* | Fl* | N* | R* | My* | C* | M* |
|   | Recovered test animals from rears 440-2890 m W of GZ on shot day and D+1.   |                                 |    |    |     |      | III    |     |      |    |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 4.2 Evaluation of Eye Protection                      | Observed detonation from aircraft or ground station, at least 14 km from GZ.  | IA                              |    |    |     | IA   | IA     | IA  | IA   |    |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 5.1 In Flight Structural Response of HSS-1 Helicopter | Flew helicopter in vicinity (at least 1000 m) of detonation. Maintained helicopters.                                    | IA                              | IA |    |     | IA   | IA     |     | IA   |    |    |     | IA  |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 5.2 Structural Response of Airship                    | Recovered instruments/blimps from stations at least 5460 m from GZ.   |                                 |    | IA |     |      |        |     |      |    |    |     | IA  |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 5.3 In Flight Structural Response of FJ-4 Aircraft    | Flew FJ-4 aircraft in vicinity (at least 3000 m) of detonation. Maintained aircraft.                                    | IA                              |    |    |     |      |        | IA  | IA   |    | IA |     |     | IA  | IA  |     | IA  |    |     |     |     |    |    |     |    |    |
| 5.4 In Flight Structural Response of A4D-1 Aircraft   | Flew AD-4 aircraft in vicinity (at least 3000 m) of detonation. Maintained aircraft.                                    | IA                              |    |    |     |      | IA     | IA  | IA   |    |    |     |     | IA  | IA  |     | IA  |    |     |     |     |    |    |     |    |    |
|   | Operated ground support radar for Projects 5.1, 5.3 and 5.4 from site at least 15 km from GZ.                           | IA                              | IA |    |     | IA   | IA     | IA  | IA   |    | IA |     |     | IA  | IA  |     | IA  |    |     |     |     |    |    |     |    |    |
| 5.5 In Flight Structural Response of F-89 Aircraft    | Flew F-89 aircraft in vicinity (at least 2000 m) of detonation. Maintained aircraft.                                    | IA                              | IA |    |     | IA   | IA     | IA  | IA   | IA | IA | IA  | IA  | IA  | IA  | IA  | IA  |    |     |     |     |    |    |     |    |    |
|   | Operated ground support radar from site at least 15 km from GZ.   | IA                              | IA |    |     | IA   | IA     | IA  | IA   | IA | IA | IA  | IA  | IA  | IA  | IA  | IA  |    |     |     |     |    |    |     |    |    |
| 6.1 Minefield Clearance                               | Inspected minefield 350 m NE of GZ shortly after detonation, restored fence. Recovered/detonated surviving mines later. |                                 |    |    |     |      | IIBc** |     |      |    |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 6.2 Measurements of Magnetic Component of EM Field    | Recovered instruments from 5 stations 200-3000 m from GZ (400-4400 m W of Priscilla).                                   |                                 |    |    | III | IIBb | III    | III |      |    |    | III |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Recovered instruments from station 260 m S of GZ.   |                                 |    |    |     |      |        |     | IIBa |    |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 6.2a Effects on Semi-conductor                        | Recovered 14 boxes of semi-conductor buried 240-1050 m from GZ.   |                                 |    |    |     |      | III    |     |      |    |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 6.3 Attenuation of EMR by Ionized Medium              | Flew instrumented aircraft on opposite side of nuclear cloud from ground station. Did not penetrate cloud.              |                                 |    | IA | IA  | IA   | IA     |     |      |    |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
|   | Manned ground receiver station at Frenchman Flat.   |                                 |    | IA | IA  | IA   | IA     |     |      |    |    |     |     |     |     |     |     |    |     |     |     |    |    |     |    |    |
| 6.4 Accuracy and Reliability of NAROL                 | Operated remote stations throughout U.S.  | IA                              | IA | IA | IA  | IA   | IA     | IA  | IA   | IA | IA | IA  | IA  |     | IA  | IA  | IA  | IA | IA  | IA  | IA  | IA | IA |     | IA |    |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix adjusted for shot specific values listed in table 2.

Table 40. Operation PLUMBBOB, AFSWP project participants with bone dose commitment less than 150 millirem (Concluded).

| PROJECT/UNIT                         | ACTIVITY  | DTP | SHOTS/CODE (See Section 3 test) |      |     |      |     |     |      |    |      |     |     |      |     |     |      |      |     |     |      |     |    |      |     |     |
|--------------------------------------|---|-----|---------------------------------|------|-----|------|-----|-----|------|----|------|-----|-----|------|-----|-----|------|------|-----|-----|------|-----|----|------|-----|-----|
|                                      |   |     | B*                              | P*   | L*  | Mi*  | P*  | H*  | DI*  | J* | K*   | O*  | St* | Sh*  | Do* | P*  | Sm*  | G*   | Wh* | Lp* | Fl*  | H*  | H* | My*  | C*  | H*  |
| 8.1 Thermal Protection of Soldiers   | Recovered test animals from 5 stations at slant ranges of 1785 to 3710 m from G2                        |     |                                 |      |     |      | III |     |      |    |      |     |     |      |     |     |      |      |     |     |      |     |    |      |     |     |
| 8.2 Prediction of Thermal Protection | Recovered data/instruments from station 1200 m S of G2. (2250-3650 m from Priscilla; 3150 m from Hood). |     |                                 |      | III | 11Bb | III | III |      |    |      |     |     |      |     |     |      |      |     |     |      |     |    |      |     |     |
| 8.3a Performance of Spectrograph     | Evaluated spectrograph from station at least 12 km from G2.   |     |                                 |      | IA  | IA   | IA  | IA  | IA   | IA | IA   |     |     |      |     |     |      |      |     |     |      |     |    |      |     |     |
| 9.1 Support Photography              | Photographed detonation from C-47 aircraft. Aircraft did not penetrate cloud.                           |     | IA                              | IA   | IA  | IA   | IA  | IA  | IA   | IA | IA   | IA  | IA  | IA   | IA  | IA  | IA   | IA   | IA  | IA  | IA   | IA  | IA | IA   | IA  | IA  |
|                                      | Provided photographic support to technical projects up to 1 week after detonation.                      | 5.0 | 11C6                            | 11C6 | III | 11C6 | III | III | 11C6 | IA | 11C6 | III | III | 11C6 | III | III | 11C6 | 11C6 | III | III | 11C6 | III | IA | 11C6 | III | III |

\* See Appendix for shot abbreviations.

Table 41. Operation HARDTACK II, Air Force support participants with bone dose commitment less than 150 millirem.

|                     |  | SHOTS/CODE (See Section 3 text) |     |    |    |    |     |     |     |     |     |     |    |    |     |     |     |     |     |    |
|---------------------|--|---------------------------------|-----|----|----|----|-----|-----|-----|-----|-----|-----|----|----|-----|-----|-----|-----|-----|----|
| PROJECT/UNIT        | ACTIVITY   | D <sub>FB</sub>                 | Ed* | H* | T* | Q* | Le* | Ha* | Lo* | DA* | RA* | So* | W* | R* | Sa* | DB* | Ev* | Hu* | SP* | B* |
| 4950th Test Gp (N)  | Command and control functions at the Air Operations Centers at Yucca Pass and Angel's Peak.          |                                 |     |    |    |    |     |     |     |     |     |     |    |    |     |     |     |     |     |    |
| 4952d Support Sq.   | General support at ISAFB (except decon). Augmented 4950th Test Gp (N) and 4935th AB Sq.              |                                 |     |    |    |    |     |     |     |     |     |     |    |    |     |     |     |     |     |    |
| 4926th Test Sq (S)  | Flew cloud sampling missions in support of Projects 11.2 and 21.2. (Aircrews breathed 100% oxygen.)  | IB                              | IB  |    |    | IB | IB  | IB  |     | IB  | IB  | IB  | IB | IB | IB  | IB  |     | IB  | IB  | IB |
|                     | Flew high altitude cloud tracking missions in T-33. Did not penetrate cloud.                         | IA                              | IA  |    |    |    | IA  |     |     |     | IA  | IA  |    |    |     | IA  |     |     |     |    |
| 4900th Air Base Gp. | Flew courier missions.   | IA                              | IA  |    |    | IA | IA  | IA  |     | IA  | IA  | IA  | IA | IA | IA  | IA  |     | IA  | IA  | IA |
| 4935th AB Sq.       | Flew security sweep prior to shot. General support at ISAFB (except decon).                          | IA                              | IA  | IA |    | IA | IA  | IA  | IA  | IA  | IA  | IA  | IA | IA | IA  | IA  | IA  | IA  | IA  | IA |
|                     | Flew low altitude cloud tracking missions in C-47, L-20, and B-25 aircraft. Did not penetrate cloud. | IA                              | IA  |    |    | IA | IA  | IA  |     | IA  | IA  | IA  | IA | IA |     | IA  |     | IA  | IA  | IA |
|                     | Flew observers around shot area.   |                                 |     |    |    |    |     | IA  |     |     |     |     |    |    |     |     |     |     |     | IA |
| 20th Helicopter Sq. | Flew aerial radiological survey missions.  |                                 |     | IA |    | IA |     | IA  |     |     |     |     |    |    |     |     |     |     |     |    |

\* See Appendix for shot abbreviations.

Table 42. Operation HARDTACK II, AFSWP project participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT                              | ACTIVITY  | SHOTS/CODE (See Section 3 text) |     |    |    |      |     |     |     |     |     |     |    |    |     |     |     |     |     |    |
|---|---|---------------------------------|-----|----|----|------|-----|-----|-----|-----|-----|-----|----|----|-----|-----|-----|-----|-----|----|
|   |   | D <sub>FB</sub>                 | Ed* | M* | T* | Q*   | Le* | Ha* | Lo* | DA* | RA* | So* | W* | R* | Sa* | DB* | Ev* | Hu* | SF* | B* |
| 4.3 Effects on Vision of Combat Personnel | Observed detonation from area 1740 m from GZ.                             |                                 |     |    |    |      |     | IA  |     |     |     |     |    |    |     |     |     |     |     |    |
| 6.14 Test of Flash Ranging Equipment      | Operated equipment at sites at least 7 km from GZ. (3 km at Rio Arriba).  |                                 |     | IA |    | IA   | IA  | IA  |     | IA  | IA  | IA  | IA |    |     |     |     |     |     |    |
| 6.15 Electromagnetic Pulse                | Manned station at Boulder City, NV, approximately 160 km SE of NTS.       |                                 |     | IA |    | IA   | IA  | IA  | IA  | IA  | IA  | IA  | IA |    |     |     |     |     |     |    |
| 8.8 Thermal Radiation                     | Manned instrumented trailer at least 2 km from GZ.                        |                                 |     |    |    | V1** |     | IA  |     |     | IA  | IA  |    | IA |     | IA  |     | IA  | IA  |    |
|   | Manned station in Bldg. 400 at Control Point.                             |                                 |     |    |    |      |     |     |     |     | IA  | IA  | IA | IA | IA  | IA  |     | IA  | IA  |    |
|   | Recovered data from instrumented trailer 1 km W of GZ shortly after shot. |                                 |     |    |    |      |     | IA  |     |     |     |     |    |    |     |     |     |     |     |    |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

Table 43. Operation DOMINIC II, Air Force support participants  
with bone dose commitment less than 150 millirem.

| <u>PROJECT/UNIT</u>              | <u>ACTIVITY</u>   | <u>DFB</u> | <u>SHOTS/CODE (See Section 3 text)</u> |            |            |             |
|----------------------------------|---|------------|--|------------|------------|-------------|
|                                  |   |            | <u>LF2*</u>                            | <u>JB*</u> | <u>SB*</u> | <u>LF1*</u> |
| 4900 AB Group                    | Flew radio-relay missions in C-47 aircraft.   |            | 1A                                     |            |            |             |
|                                  | Flew courier missions in C-47 aircraft.   |            | 1A                                     | 1A         | 1A         | 1A          |
|                                  | Flew low altitude cloud tracking missions in U3A aircraft. Did not penetrate cloud. |            | 1A                                     | 1A         | 1A         | 1A          |
| 55th Weather Recon Squadron      | Flew high altitude cloud tracking mission in WB-50. Did not penetrate cloud.        |            |  | 1A         |            |             |
| 1211th Test Squadron (MATS)      | Flew cloud sampling missions in B-57 aircraft. Crew breathed 100% oxygen.           |            | 1B                                     | 1B         | 1B         | 1B          |
|                                  | General A/C maintenance at ISAFB (A/C decon not included).                          |            | 1A                                     | 1A         | 1A         | 1A          |
| 4520th Combat Crew Training Wing | Flew security sweep missions prior to shot.   |            | 1A                                     | 1A         | 1A         | 1A          |

\* See Appendix for shot abbreviations.

Table 44. Operation DOMINIC II, DASA project participants with bone dose commitment less than 150 millirem.

| PROJECT/UNIT  | ACTIVITY  | D <sub>FB</sub> | SHOTS/CODE (See Section 3 text) |     |        |      |
|---|---|-----------------|---------------------------------|-----|--------|------|
|   |   |                 | LF2*                            | JB* | SB*    | LF1* |
| 1.11 Soils Survey                                     | Collected soil samples from GZ area and dug instrument shafts for other projects prior to shot.             |                 |                                 | IA  |        |      |
| 2.1 Initial Radiation Measurements                    | Recovered data/instruments from bunkers 190 and 490 m NE of GZ and stations 1220 m NE of GZ.                |                 |                                 |     | IICa** |      |
| 2.2 Fast-neutron Dose Rate                            | Photographed and recovered data from instruments located at stations 190, 490, and 1220 m NE of GZ.         |                 |                                 |     | IICa** |      |
| 2.7 Off-site Meteorology                              | Collected data from weather stations located 30 to 400 km E of GZ.  |                 |                                 |     | IA     |      |
| 2.10 Physiochemical and Radiochemical Analysis        | Analyzed (laboratory) samples collected by Project 2.9 personnel.   |                 |                                 |     | IA     |      |
| 2.14 Shielding Effectiveness Compartmental Structures | Recovered film packets from steel structures approximately 2900 m from GZ.                                  |                 |                                 |     | IICa** |      |
|   | Measured radiation intensity near project site on D+2.  |                 |                                 |     | IICa** |      |
|   | Made measurements with track-mounted spectrometer about 2900 m from GZ on D+3 thru D+12.                    |                 |                                 |     | IICb** |      |
| 2.15 Effectiveness of Enclosure Shields               | Monitored radiation data from revetment over 6000 m from GZ on shot day thru H+48.                          |                 |                                 |     | IICc** |      |
|   | Conducted radiological survey of enclosure shield area 4880 m NE of GZ on D+1.                              |                 |                                 |     | IICb** |      |
| 3.2 Dynamic Bearing Capacity of Soils                 | Recovered data from instrument shelter 1220 m S of GZ on shot day.  | 3.0             |                                 |     | IIC2** |      |
| 3.3 Buried Model Arch Structures                      | Recovered data from recording shelter (bunker) 730 m S of GZ.   |                 |                                 |     | IIBb** |      |
| 6.9 Correlation of Electric Field Measurements        | Obtained data at recording station (trailer) located 12.3 km NW of GZ.                                      |                 |                                 |     | IA     |      |
| 6.11 Air Conductivity Measurements                    | Recovered data from instrument bunker 500 m W of GZ and recovered transmitter from station 4.4 km NE of GZ. |                 |                                 |     | IIBb** |      |
|   | Manned receiver station 4.5 km SW of GZ.  |                 |                                 |     | IA     |      |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

Table 44. Operation DOMINIC II, DASA project participants with bone dose commitment less than 150 millirem (Continued).

| PROJECT/UNIT   | ACTIVITY   | DFB | SHOTS/CODE (See Section 3 text) |     |        |      |
|--|--|-----|---------------------------------|-----|--------|------|
|  |  |     | LF2*                            | JB* | SB*    | LF1* |
| 6.13 Troposcatter Test Installation                    | Monitored detonation from off site stations at Alamo, NV, and Death Valley, CA.  |     |                                 |     | V1**   |      |
| 7.1.1 Pragmatic Instrument Measurements                | Recovered data from bunker located 210 m SE of GZ.   |     |                                 |     | IICa** |      |
| 7.5 Response of Electrical Power Systems               | Recovered data from recording instruments located in a deep (7 ft) concrete pit 670 m SE of GZ. Recovered 45 KW generator. |     |                                 |     | IIBb** |      |
| 7.6 Evaluation of Aerial Radiac Survey System          | Flew instrumented helicopters over fallout path at H+2, H+6 and H+22.  |     |                                 |     | IA     |      |
|  | Launched and recovered instrumented drones from site 6 km NW of GZ.  |     |                                 |     | IA     |      |
|  | Manned air operations and receiver station 6 km NW of GZ.  |     |                                 |     | IA     |      |
| 7.6.1 Evaluation of Aerial Radiac Systems - Tripartite | In addition to Project 7.6 flights, flew instrumented helicopters over fallout area at H+5, H+24, and H+47.                |     |                                 |     | IA     |      |
|  | Plotted and analyzed data from helicopter surveys.   |     |                                 |     | IA     |      |
| 7.8.1 Magnetic Detection Equipment Test                | Operated instruments at station about 8 km N of GZ.  |     |                                 |     | IA     |      |
| 7.9 Prooftesting Operational Shipboard Material        | Inspected damage to ship components/equipment located 290-400 m SW of GZ.  |     |                                 |     | IICb** |      |
|  | Recovered data from recording station (bunker) 760 m SW of GZ.   |     |                                 |     | IIBa** |      |
| 7.10 Spectral Analysis - Thermal Radiation Pulse       | Recovered data from stations 2, 4, and 6 km S of GZ.   |     |                                 |     | IA     |      |
| 7.13 F-100F/GAM-83B Simulation                         | Flew F-100F near detonation. (Slant range - 4000 m.)   |     |                                 |     | IA     |      |
| 7.14 Bomb Alarm Detector Test                          | Recovered detectors from stations 1-19 km W of GZ.   |     |                                 |     | IIBa** |      |
|  | Manned instrument trailer 6 km W of GZ.  |     |                                 |     | IA     |      |
| 7.15 Effects on B-52/GAM-77                            | Flew B-52 aircraft over GZ at altitudes of 10,600 and 12,581 ft.   |     |                                 |     | IA     |      |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.



Table 44. Operation DOMINIC II, DASA project participants with bone dose commitment less than 150 millirem (Concluded).

| <u>PROJECT/UNIT</u>                             | <u>ACTIVITY</u>   | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |            |            |             |
|---|---|-----------------------|--|------------|------------|-------------|
|   |   |                       | <u>LF2*</u>                            | <u>JB*</u> | <u>SB*</u> | <u>LF1*</u> |
| 7.16 Airborne E-field Measurements              | Flew C-131F at altitude of 9,960 feet directly over detonation.   |                       | IA                                     |            |            |             |
|   | Flew C-131F at an altitude of 13,680 ft, 3230 m E of GZ and an A-3A directly over detonation at an altitude of 18,000 feet. |                       |  |            | IA         |             |
| 8.1 High Time Resolution of First Thermal Pulse | Took measurements from instrument trailers located approximately 3 km S of GZ.  |                       |  |            |            | IA          |
|   | Took measurements from instrument trailer 30-60 km from GZ.   |                       |  |            | IA         |             |
| 8.2 Fallout Hazard Determination                | Took measurements with spectrosopes connected to 35 mm movie cameras located at forward CP.                                 |                       | IA                                     |            |            | IA          |

\* See Appendix for shot abbreviations.

Table 45. Operation DOMINIC II, Project IVY FLATS participants with bone dose commitment less than 150 millirem.

| <u>PROJECT/UNIT</u> | <u>ACTIVITY</u>   | <u>D<sub>FB</sub></u> | <u>SHOTS/CODE (See Section 3 text)</u> |            |            |             |
|---------------------|---|-----------------------|--|------------|------------|-------------|
|                     |   |                       | <u>LF2*</u>                            | <u>JB*</u> | <u>SB*</u> | <u>LF1*</u> |
| Observers           | Observed shot and troop maneuver from bleachers, approximately 3 km SW of GZ.   |                       |  |            |            | IA          |
| Maneuver Troops     | Observed Johnie Boy from remote location.   |                       |  | IA         |            |             |
|                     | Performed ground assault on objective approximately 1.7 km NE of GZ (tank and APC support) shortly after shot. Maneuver completed by H+1. | 0.61                  |  |            |            | IIB1**      |

\* See Appendix for shot abbreviations.

\*\* Elements of category matrix are adjusted to shot specific values from table 2.

## SECTION 4

### LIST OF REFERENCES

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**APPENDIX**  
**CONUS OPERATION AND SHOT ABBREVIATIONS**

| <u>Operation</u>   | <u>Shots</u>   | <u>Operation</u> | <u>Shots</u>     |
|--------------------|--|------------------|------------------|
| B-BUSTER*          | A-Able   | T-Teapot         | W-Wasp           |
|                    | B-Baker  |                  | Mo-Moth          |
|                    | C-Charlie  |                  | Te-Tesla         |
|                    | D-Dog  |                  | Tu-Turk          |
|                    | E-Easy   |                  | H-Hornet         |
| J-JANGLE*          | S-Sugar<br>U-Uncle   | P-Plumbbob       | B-Bee            |
|                    |  |                  | E-Ess            |
|                    |  |                  | A1-Apple 1       |
| W'-Wasp Prime      |  |                  |                  |
| TS-TUMBLER-SNAPPER | A-Able<br>B-Baker<br>C-Charlie<br>D-Dog<br>E-Easy<br>F-Fox<br>G-George<br>H-How  |                  | HA-High Altitude |
|                    |  |                  | P-Post           |
|                    |  |                  | ME-MET           |
|                    |  |                  | A2-Apple 2       |
|                    |  |                  | Z-Zucchini       |
|                    |  |                  | B-Boltzmann      |
|                    |  |                  | F-Franklin       |
|                    |  |                  | L-Lassen         |
| UK-UPSHOT-KNOTHOLE | A-Annie<br>N-Nancy<br>Ru-Ruth<br>D-Dixie<br>Ra-Ray<br>B-Badger<br>S-Simon<br>E-Encore<br>H-Harry<br>G-Grable<br>C-Climax |                  | Wi-Wilson        |
|                    |  |                  | P-Priscilla      |
|                    |  |                  | H-Hood           |
|                    |  |                  | Di-Diablo        |
|                    |  |                  | J-John           |
|                    |  |                  | K-Kepler         |
|                    |  |                  | O-Owens          |
|                    |  |                  | St-Stokes        |
|                    |  |                  | Sh-Shasta        |
|                    |  | Do-Doppler       |                  |
|                    | F'-Franklin Prime  |                  |                  |

\*Often combined as BUSTER-JANGLE (BJ)

| <u>Operation</u>  | <u>Shots</u>   | <u>Operation</u> | <u>Shots</u>   |
|-------------------|--|------------------|--|
| PLUMBBOB (Cont'd) | Sm-Smoky<br>G-Galileo<br>Wh-Wheeler<br>LP-La Place<br>Fi-Fizeau<br>N-Newton<br>R-Rainier<br>Wy-Whitney<br>C-Charleston<br>M-Morgan | HII-Hardtack II  | Ed-Eddy<br>M-Mora<br>T-Tamalpais<br>Q-Quay<br>Le-Lea<br>Ha-Hamilton<br>Lo-Logan<br>DA-Dona Ana<br>RA-Rio Arriba<br>So-Socorro<br>W-Wrangell<br>R-Rushmore<br>Sa-Sanford<br>DB-DeBaca<br>Ev-Evans<br>Hu-Humboldt<br>SF-Santa Fe<br>B-Blanca |
| DII-DOMINIC II    | LF2-Little Feller II<br>JB-Johnie Boy<br>SB-Small Boy<br>LF1-Little Feller I   |                  |  |

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