Nuclear Bomb Effects Computer, Based on Data from *The Effects of Nuclear Weapons*, Revised Edition 1977

GENERAL

As a convenience to those interested in the effects of nuclear weapons, this circular computer was designed to make effects data easily available—some as functions of yield and range or of yield alone and others not directly related to yield or range. Taken from **The Effects of Nuclear Weapons** (ENW), Revised Edition 1977, and subject to the limitations noted below, the information on the computer shows the many environmental variations associated with nuclear detonations that represent a potential hazard to man. In order to help establish the significance of the effects parameters, tabular material are also presented on the computer which relate particular values of the effects parameters to various levels of biologic trauma and structural damage. See tables in large window (when rotated beyond the blast-effects scales) and on the back of the computer.

Although a number of factors—such as burst conditions, weather, terrain, and weapon design—introduce uncertainties in assessing weapons effects, the data presented offer the best available approximations for purposes of orientation and protective planning. The ease with which quick-reference information may be obtained necessitates simplicity of presentation, required by those new to the weapons field and desired for many purposes by fully informed personnel from technical to professional levels.

Blast Parameters (Ch. III)

The blast parameters presented are those which would exist near the ground in open areas assuming a "near ideal" surface and standard sea-level atmosphere. Maximum overpressure, maximum dynamic pressure, maximum wind speed, arrival time of the blast wave, and duration of the positive-pressure phase of the blast wave are detailed for two burst conditions, viz, surface burst and optimum burst height. The latter is defined as a burst at that height which maximizes an effect for a particular ground range and yield; e.g., at a 1.2-mi range from a 1 MT detonation, a burst height of 5,000 ft maximizes the overpressure, whereas at a 4.4-mi range, a 10,000 ft height would be required. Maximum wind speeds for the optimum burst height were computed by using the maximum dynamic pressures for optimum burst height and the associated maximum overpressures. The optimum burst height for maximum overpressure was used to compute the corresponding arrival time and duration of the blast wave.

To read the blast parameters shown in the large window, it is necessary only to set the ground range of interest opposite the yield. For example, if 1.3-mi range is placed opposite 100 KT, the maximum overpressure can be determined in the large window to be 10 psi for optimum burst height. It is of interest to note that this overpressure is applicable to any number of yield-range combinations which can be read directly from the two scales, e.g., 1 KT at 0.28-mi range or 20 MT at 7.5 mi.

Duration and arrival time of the blast wave can be read in the appropriate window on the small disk. The only rule setting necessary for these readings involves moving the hairline on the tab to the yield of interest. By setting the hairline on 100 KT, it is found (reading in the second window from the center) that for a surface burst the blast wave of 10-psi maximum overpressure arrives 2.0 sec after the detonation and has a duration of 1.1 sec.

Reflected Overpressure (Ch. III)

When an ideal or classical blast wave strikes a flat surface head-on, i.e., at normal incidence, there is an instantaneous rise in overpressure to two or more times the incident value. Values of reflected overpressure vs. incident overpressure are plotted on the middle disk near the range scale. Suppose, for example, that a blast wave with maximum overpressure of 30 psi strikes the front of a building head-on; by reading the reflected overpressure scale opposite 30-psi incident overpressure, it can be determined that 100-psi overpressure results from this reflection.

Translational Velocities for Man (Ch. XII)

The maximum translational velocity that would be obtained by a man within the first 10 ft of travel is indicated as a function of ground range on the small disk for both a surface burst and an optimum burst height. The velocities apply to a 165-lb man standing in an open area at the time of arrival of the blast wave. The only rule setting required is to move the tab hairline to the yield of interest. By setting the hairline on 100 KT, it is found that at a 1.4-mi ground range the translational velocity for man would be 40 ft/sec for an optimum burst height.

Thermal Radiation (Ch. VII)

The thermal-radiation scales to be found in red on the back of the circular computer apply to slant ranges for a burst height of $200W^{1/3}$ ft and a visibility of 16 mi. To estimate the thermal dose at a given location, set the slant range opposite yield on the front of the computer and place the tab hairline over this setting. Without moving the scales, turn the computer over and read the thermal scale at the intersection of the red spiral and the red hairline, e.g., if 3.4 KT and 0.20-mi slant range are set under the tab hairline, 100 cal/cm^2 is read on the thermal scale.

Note the dashed lines on the thermal scale which indicate as a function of yield the thermal dose necessary for first-, second-, and third-degree burns to bare, medium skin. Thus, if the tab hairline is set on 1 KT, the thermal dose necessary for a second-degree burn is determined to be about 4 cal/cm^2. For a 10-MT yield however, the dose required to produce this burn is about 8 cal/cm^2.

The rate of delivery of thermal radiation is indicated in a window on the small disk on the front of the computer. Because of changes that were made too late to be incorporated, the thermal times read on the computer vary from 3 percent greater than, at 1 KT, to 7 percent less than, at 20 MT, the times given in ENW. All thermal times were computed for a surface burst. For a burst height of 200W$^{1/3}$ ft, the times should be decreased from 0.3 to 13 percent as the yield varies from 1 KT to 20 MT. By setting the tab hairline on 20 MT, it can be determined that 40 percent of the thermal energy is emitted in 5.0 sec. Note that the time of maximum fireball temperature and thermal power in the second pulse corresponds to the time at which 20 percent of the thermal energy has been emitted.

Initial Nuclear Radiation (Ch. VIII)

Initial nuclear radiation, gamma plus neutron, is indicated on the computer in a manner similar to that used for thermal radiation. The nuclear-radiation scales apply to slant ranges for 0.9 sea-level air density, a burst height of 200W$^{1/3}$ ft, and an RBE of 1.0 for both gamma and neutron radiation. The curves in ENW which apply to thermonuclear weapons were used to compute the initial-nuclear-radiation doses for yields between 100 KT and 20 MT (assuming 50 percent of the total yield is derived from fission). For yields between 1 KT and 100 KT, the radiation doses that appear on the computer fall between the doses derived from the offensive and defensive curves, in ENW, for fission weapons. The doses from the fission weapons were chosen in such a way as to give continuous, smooth curves on the initial-nuclear-radiation scale. The dashed portions of the scale were obtained by extrapolation. To illustrate an evaluation of initial nuclear radiation, set the tab hairline over 1.05-mi slant range and 100-KT yield and read 1000 rems on the initial-nuclear-radiation scale at the intersection of the black spiral and black hairline.

Early Fallout Dose Rate (Ch. IX)

The early-fallout-dose-rate scales appearing on the small and middle disks on the front of the computer are independent of all the other scales. If, after the fallout is complete, a dose rate is measured at a known time after detonation, then the dose rate at a later time can be estimated. Suppose that 80 r/hr were measured 2 hrs after a detonation at which time the fallout was complete. For convenience in reading the dose-rate scale at long periods of time, let 100 scale units represent 1 r/hr. Thus, 80 r/hr would correspond to 80x100=8,000 scale units. Set 8,000 opposite 2 hrs, and read 1200/100= 12 r/hr at 10 hours; 110/100=1.1 r/hr at 3 days; and 6.8/100=0.068 r/hr at 30 days. Note that this procedure is essentially the same as moving the decimal point two places to the left on all dose-rate numbers on the computer.

Crater Dimensions (Ch. VI)

The crater dimensions defined on the computer apply to surface bursts where the surface material is described as M_1 (wet soil or wet soft rock), M_2 dry soil, dry soft rock, or wet hard rock), or M_3 (dry hard rock). The three crater dimensions used are illustrated by a diagram on the computer. The dimension R_A is the radius of the apparent crater, i.e., not including the rupture zone. R_E is the radius of the continuous ejecta and D is the depth of the crater measured from the undisturbed ground-level to the bottom of the crater. The crater and ejecta radii presented on the computer for M_2 differ by small amounts (less than 4%) from the radii given in ENW, the exact difference depending on the specific surface material of interest.

Crater dimensions are evaluated by setting the tab hairline on the appropriate yield and reading the dimensions described above in the window nearest the center of the computer. Thus, a 20-MT surface burst is found to produce a crater 0.10 mi deep (refer to dimension D) in dry soil (refer to medium M_2). The corresponding radius of the continuous ejecta (R_E) would be 0.48 mi.

Maximum Fireball Radius and Minimum Height of Burst for Negligible Early Fallout (Ch. II)

The maximum fireball radius for an air or surface burst is presented on the small disk of the computer. The production of early (or local) fallout is dependent on the relative size of the fireball radius and the height of the burst. The empirically determined minimum height of burst required for negligible early fallout is shown by a separate indicator on the same scale that defines the fireball radius.

To evaluate the parameters described above, it is necessary to set the tab hairline on the yield of interest and refer to the scale in the appropriate window on the small disk. For example, a 20-MT airburst produces a fireball with maximum radius of 2.2 mi. The minimum height of burst for negligible early fallout, read in the same window, is 1.8 mi.

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