Fallout Fundamentals

Fallout consists of dust particles that have been coated with radioactive by-products from atomic explosions. This occurs when the nuclear or atomic blast is a ground rather than air-burst (air-burst meaning that the fireball is far enough from the earth's surface that there is no ground material uptake into the high temperature portion of the mushroom cloud). In an air-burst the bomb products condensate into such very small particles that they are aloft for such a long time that they are mostly non-radioactive by the time they come down, typically months or years. The fission process gives off hundreds of different radioactive elements and isotopes. Also, a certian portion of the fission mass does not fission. The fussion portion of nuclear bombs is clean and gives off only helium, the atomic bomb trigger (fission) which starts the nuclear bomb (fussion) is the portion of the bomb that leaves radioactive by-products.

These by-products can be classified by their characteristics. One characteristic is half-life. The half-life is the length of time it takes for an element to give off one-half of its total radioactivity. This would also be the length of time required for a given amount to change to one-half the radioactive level, in other words if something was giving off radiation that would yield 3 Rads/hours, after one half-life it would give off 1.5 Rads/hour.

An unstable isotope only emits radioactivity when one atom decays to another isotope or element (which may or not be stable, stable being non-radioactive). Therefore the portions of the element that are not in the process of decaying are not giving off any radioactivity. If you have "X" number of atoms of a radioactive element, "X/2" of those atoms will give off their radioactivity in the half-life period and become a different element or isotope. If an element has a half-life of 1 day, a given amount of it will give off 1/2 of its total radiation during the 1st day, 1/4 during the second day, 1/8 the 3rd day, 1/16th the 4th, 1/32 the 5th, 1/64 the 6th, 1/128th the 7th, et cetra. If you have a short half-life like Iodine 131 of 8, days most of the radioactivity (99+%) will be emitted in two months. In a long half-life element like plutonium 239 with a 24,400 year half-life, 1,000,000 atoms would in 24,400 years give of 1/2 of their radioactivity leaving 500,000 atoms of plutonium 239 at the end of those 24,400 years. 500,000 decays over 24,400 years equals approx. 21 decays per one year.

Another characteristic is the type of radiation given off, Alpha, Beta, or Gamma radiation. Neutron radiation is only given off by the actual blast itself and is not given off by the fallout itself. Only neutron radiation can MAKE something that is not radioactive become radioactive. This is why fallout can not cause something (like food inside a can) to become radioactive.
Alpha, beta, and gamma radiation can NOT make anything become radioactive.
Alpha radiation (helium nucleus, 2 protrons and 2 neutrons), like from plutonium, can be shielded with one layer of Cellophane or newspaper or several inches of air. Beta radiation (an electron) can be shielded by a layer of drywall, or several feet of air. Gamma radiation is electromagnetic radiation.
Neutron radiation is a neutron and is about twice as hard to stop as Gamma.
Gamma and neutron are harder to stop, you need several feet of dirt or concrete to absorb them. See below for specifics for stopping Gamma radiation.

One factor that most people don't realize about fallout is how fast it decays. Fallout follows the t-1.2 law which states that for every sevenfold increase in time after detonation there is a tenfold drop in radiation output.
Example, a reading of X level of radioactivity at Y hours after detonation would indicate a level of radioactivity of .1X at 7Y hours after detonation.
This is accurate for 2,500 hours (14 weeks) following the explosion, thereafter the doserate is lower than t-1.2 would predict. Example, if a dose rate of 100 REM/hr was found at 1 hour after detonation(this assumes all significant fallout from the bomb has fallen, therefore starting with the seven hour point is probably more realistic) would be 10 REM/hr at 7 hours, 1 REM/hr at 49 hours(2 days), .1 REM/hr at 343 hours(2 weeks), .01 REM/hr at 2401 hours (14 weeks). A "survival safe" dose of radiation (this being defined as no short term effects or disability) is 3 to 12 Rads/day. This dose rate of

3-12 Rads/day can only be taken to an accumulated dose of 150-200 rads if done day after day. This would occur (assume 6 Rads/day) in this example at 150 hours for 24 hour exposure, or at 49 hours for a 6 hours per day outside of shelter. Note though that since the level of activity is decreasing the time spent outside every day would increase. If you increase the radiation by a factor of 10 for another example would be where you would have 1,000 Rem/hr at 1 hr, 100 Rem/hr at 7 hrs., 1 Rem/hr at 343 hrs., .1 Rem/hr at 2401 hrs. The 24 hour exposure would be at 1,000 hours(41 days) and 6 hour work day outside of shelter at 300 hours(12 days).

For various levels of contamination a "no short term effects" dose of 6 Rads per day would be something like this: (for 80 col. printout)(measurements at boundries of the oval shaped pattern)

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Hours from   Dose rate   Hours of "safe" work outside per day, medical effect
explosion
   EXAMPLE A   An area 10 miles wide by 30 miles downwind directly downwind
               from of a missle field that gets dozens of hits
1 hr.      10,000 R/hr  None, 100% dead at 6 minutes of exposure
7 hrs.      1,000 R/hr  None, 100% dead at 1 hour of exposure
2 days        100 R/hr  None, 50% dead within 3-4 hour continuous exposure
2 weeks        10 R/hr  36 minutes. 50% dead for 2 day continuous exposure.
14 wks(3 mo)    1 R/hr  6 hours/day. 50% dead for 1 month continuous exposure
                        5% dead for 15 day continuous exposure, no medical care
                        and no deaths for 1 week continuous exposure.
   EXAMPLE B  An area 10 miles wide by 30 miles downwind of a single 1 MT
              ground burst
1 hr        1,000 R/hr  None, 100% dead at 1 hour of exposure
7 hrs.        100 R/hr  None, 50% dead within 7-8 hour of continuous exposure
2 days         10 R/hr  36 minutes. 50% dead for 5 days of continuous exposure.
2 week          1 R/hr  6 hours/day. 50% dead for 1 month continuous exposure.
14 weeks      0.1 R/hr  All day.  0% deaths from radiation hereafter.
    EXAMPLE C An area 12 miles wide by 95 miles downwind for a single 1 MT
              ground burst
1 hr         radiation has not arrived yet.
7 hrs.         50 R/hr  12 minutes, 50% dead for 18 hour continuous exposure
2 days          5 R/hr. 1 hour, 5% dead for 2 week continuous exposure
2 weeks       0.5 R/hr  12 hours/day.
14 weeks     0.05 R/hr  Unlimited.
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The above three examples indicate conditions and exposures that would only be acceptable in wartime. In these examples the wind is continuous in direction and velocity. A real wind would not make such nice neat ovals. It should be noted that even in real wind conditions, marching perpendicular to the depositing wind will remove you from a individual fallout zone.

Here is an example of the levels of contamination from a single 1 MT ground burst with a 15 MPH wind

Area downwind (boundries) in miles	Arrival time for fallout	Accumulated total radiation dose 1 week	4 weeks	15 weeks	100 yrs	Dose Rate in Rads/hr at 7 hrs.	2 days(14 hrs)
33 x 7	1.5 hrs	3000 R	3300 R	3600 R	4600 R	100 R/hr	10 R/hr
95 x 12	5 hrs.	900 R	1200 R	1400 R	1700 R	~50 R/hr	5 R/hr
160 x 18	10 hrs.	300 R	400 R	460 R	650 R	not there yet	2 R/hr
245 x 20	16 hrs	90 R	120 R	150 R	240 R	not there yet	0.7 R/hr

For shelter from Gamma radiation the standard rule of thumb is 150 pounds of mass per square foot of cross section of shelter wall yields a PF, protection factor, of 40. This means if you had two shelters on a flat contaminated field with one having walls of one layer of cellophane and the other of walls and ceiling of something that had for its thickness 150 lbs/sq. ft.(note this would be a thickness of 2.5" of lead, 4" of steel, 12" of concrete, 18" of soil, 30" of water, 200' of air) you would recieve 1/40th the dose in the 150 lb/sq.ft. walled shelter. This effect can be multiplied. If the sq. ft. cross section was 300 lbs. that would be 1/40th of 1/40th or 1/1,600th of the unprotected dose. Take for example a dose rate starting at 100 Rem/hr at 1 hr.,10Rem/hr at 7 hrs.,1 Rem/hr at 49 hours, etc. If exposure started at 1 hour the total dose would be 240 R in 1 day, 310 R in 1 week, 350 R in 4 weeks, 390 R in 15 weeks. The same in a PF 40 shelter would be 6 R in 1 day, 7.7 R in 1 week, 8.7 R in 4 weeks. The difference would be 5% fatalities-most others suffering from nausea and taking about 1 month to recover without the protection versus 0% fatalities-0% sickness with protection of PF40 in this case.

Another example with a dose rate starting at 1,000 Rem/hr at 1 hr., 100 Rem/hr at 7 hrs., 10 Rem/hr at 49 hours, etc. If exposure started at 1 hour the total dose would be 2,400 R in 1 day, 3,100 R in 1 week, 3,500 R in 4 weeks, 3,900 R in 15 weeks. This in a 40 PF shelter would be 60 R in 1 day, 77 R in a week, 87 R in 4 weeks. In a 1,600 PF shelter this would be 1.5 R in 1 day, about 2 R in 2 weeks, about 2.5 R in 15 weeks. The differences here would be - no protection = 100% fatalities in several hours - PF 40 = 0% fatalities, 25% suffer nausea(at the most) with total recovery in 7 days, - PF 1600 no effects.

Please note that protection factor increases as a multiple. If 150 lbs/ft. sq. = a PF of 40(1/40th or 2.5%), 300 lbs/ft sq. = a PF of 1,600(1/1,600th or 0.0625%), and 450 lbs/ft. sq. = a PF of 64,000(1/64,000th or 0.0015625%)

Typical Swiss domestic shelters have a PF of 16,000 to over 2,500,000.