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Fallout caused by an accident at a nuclear power station of Krsko (Slovenia)

Introducing a new colorimetric scale
(BLACK, GREY, RED, ORANGE, YELLOW and WHITE Zones)
to evaluate the effects of radioactive Fallout on civilian populations

Summary

Krsko: nuclear risks at a distance of 130 km from Trieste (Italy). The entire region of Friuli-Venezia Giulia could be contaminated within 3 hours…

A study conducted 20 years ago estimated the amount of damage that Trieste and Friuli-Venezia Giulia would suffer in the case of an accident at the reactor and a leakage of radioactive materials

What would happen if the false alarm of 4th June 2008 were a concrete risk?

With a weak wind of 6 km/h coming from the east, Italy would not be reached by a Fallout from Krsko, besides a weak temporary radioactivity known as White Fallout (0.1 RAD/h), which is not shown on the slides to improve readability (Figure 6-A).

But a steady wind of 15 km/h coming from the east would suffice to let radioactive contamination affect the whole area from Trieste up to Tarvisio, reaching almost Tolmezzo, thus contaminating the greater part of the Friuli-Venezia Giulia within 8-10 hours – Udine included. This scenario would correspond to a Yellow Fallout (0.5 RAD/h), as Krsko is located only 130 km from the Italian border as the crow flies (Figure 6-B). During the following four days the radiation dose absorbed by an individual would range from 10 to 50 RAD, about half of which during the first day.

With a steady wind of 30 km/h, radioactive contamination would affect the entire region of Friuli-Venezia Giulia and a small part of Veneto (Treviso and Venice), showing a level of contamination again corresponding to a Yellow Fallout (0.5 RAD/h), except for Trieste which would have a higher level of radioactivity, i.e. an Orange Fallout (1 RAD/h) (Figure 6-C).

With a steady wind of 50 km/h coming from the east, radioactive contamination would again affect the whole area from Trieste up to Tarvisio, excluding Tolmezzo but contaminating more than half of the region within 4 hours, Udine included. This scenario would correspond to an Orange Fallout (1 RAD/h) (Figure 6-D). In this area, during the 4 days following the accident the radiation dose absorbed by an individual would range from 20 to 100 RAD, about half of which during the first day. The contamination area, called Yellow Zone, would extend as far as Bologna, where the radiation dose absorbed by an individual would also range from 10 to 50 RAD, about half of which during the first day.

With a steady wind of 70 km/h coming from the east, radioactive contamination from Orange Fallout (1 RAD/h) would affect almost the entire region of Friuli-Venezia Giulia, except for Pordenone and the Veneto region, where there would be a Yellow Fallout (0.5 RAD/h) within the first 12 hours following the accident, together with a wide part of Emilia Romagna and Trentino-Alto Adige (Figure 6-E).

With a steady wind of 100 km/h coming from the east, the Orange Fallout Zone would include Pordenone, Treviso and Venice, while the Yellow Fallout Zone would affect even greater areas of Emilia Romagna and Trentino-Alto Adige regions (Figure 6-F).

In the southern part of Austria (Klagenfurt, Graz), with winds coming from the south and faster than 70 km/h, there would mostly be a contamination from Red Fallout, i.e. with radiation doses absorbed by the population during the first four days ranging from 100 to 500 RAD.

Slovenia and Croatia – instead – would be affected by severe consequences caused by Black Fallout and Grey Fallout. The former would cause levels of contamination for each inhabitant ranging from 1,000 to 5,000 RAD within the first four days, half of which absorbed during the first day; the latter would instead cause lower but still lethal levels of radioactivity, with doses ranging from 200 to 1,000 RAD in the first four days.

Fortunately, in Krsko there was only a leak of water from the cooling plant inside the reactor, which did not cause any radioactive leakage in the environment. That is why the emergency was called off: thanks to the timeliness of the turn-off procedure the nuclear power plant was safe again within a few hours. In short, there were no risks for the population. But the episode revives the fear of a new Chernobyl, close to Croatian, Hungarian and Austrian borders.

Such an assumption was made about twenty years ago by the author of this paper, when he was a young student of medicine, after three years from the disaster occurred in the Soviet Union. The title of the study was: *Krsko: nuclear radiations and civil protection in Trieste.*

He explained in the study: *Let us suppose that the most serious accident that could happen in a water reactor – i.e. the total leak of the liquid used to cool the uranium core – occurred at the nuclear power station in Krsko. In this unlucky case, the core would get overheated, molten materials would enter into contact with turbine water and transform it into steam. This would cause the opening of the control container and consequently the leakage of radioactive materials. Let us also suppose that a third of all radioactive cores present in the reactor were released into the air because of this explosion.*

According to studies dating back more than 8 years, [[404]] *in this kind of accident the radioactivity of leaked material would be about 1.5 billion curie and the radioactive cloud – with a wind of 24 km/h – would have an extent of tough contamination (Black Fallout) over a radius of 68 km from the Krsko nuclear power station. At this point it is possible to evaluate the different levels of radioactive contamination that would affect Trieste and the Friuli-Venezia Giulia region..."*

However, medical consequences should also be analysed in detail.

There are two types of radiations: alpha or beta radiations – which are dangerous only if radioactive cores producing them are inhaled or absorbed by foods and water – and gamma radiations, which are emitted by radioactive cores and do not need to be absorbed by the body to kill.

Furthermore, the author noted: *The dose of gamma radiations that can affect an individual is expressed in REM, a unit of measurement that can be considered equivalent to RAD.*

Gamma radiations of 500 RAD – if absorbed in few days – would also cause the death due to damaged bone marrow in half the population within a month, because of the destruction of white blood corpuscles and platelets; gamma radiations of 200 RAD would lead to the death of only a tenth of exposed individuals but all surviving people could no longer conceive children (permanent sterility).

As regards the possibility of falling ill with cancer during the following years – the author warned – *nobody could exclude it.*

In the Yellow Zone, during the 4 days following the accident, the radiation dose absorbed by an individual would range from 10 to 50 RAD, about half of which during the first day.
Other about 50-70 RAD during the following 30 days.

In the Orange Zone, during the 4 days following the accident, the radiation dose absorbed by an individual would range from 20 to 100 RAD, about half of which during the first day.
Other about 100-150 RAD during the following 30 days.

In the Red Zone, during the 4 days following the accident, the radiation dose absorbed by the individual would range from 100 to 500 RAD, about half of which during the first day.
Other about 500-700 RAD during the following month.

In the Grey Zone, during the 4 days following the accident, the radiation dose absorbed by an individual would range from 200 to 1,000 RAD, about half of which during the first day.

In the Black Zone, during the 4 days following the accident, the radiation dose absorbed by an individual would range from 1,000 to 5,000 RAD, about half of which during the first day.

The outlook is not reassuring – and it was already supposed twenty years ago.

Nowadays the paper – which was presented for the first time at the Circolo Ufficiali di Presidio (Garrison Officers' Club) in Trieste, - in 27th January 1989 – is again alarmingly topical, given recent news alleging that the Krsko nuclear power station was built next to a dangerous seismic fault. It cannot be excluded that a new earthquake, such as those which razed Ljubljana to the ground in 1511 and 1895, would damage the base of the nuclear power station and lead to a leak of its cooling water.

The Fallout

The Fallout is characterized by radioactive dust falling to earth after a severe accident in a nuclear power station, as happened in Chernobyl (SEE third part), or after the nuclear explosion of an atomic bomb on the ground (SEE fourth part).

Fallouts from nuclear power plant have instead an irregular development because of continuous changes of winds which cause a radioactive "fan-shaped" Fallout, according to a theoretic model using concentric circles (see Figure 6-A, B, C, D, E, F "Krsko").

Fallouts from nuclear explosion have a "cigar"-type progress (see Nomogram of Figure 1 and the isodose curves in Figure 7), the extension of which depends on the explosive power of the bomb and the speed of the wind.

The effects of Fallout on man can be summarized thus [1-3, 5-8]

1) *acute ray syndrome*: death within a few weeks or even days; from a clinical point of view the white blood cells, the red blood cells and the platelets in the bone marrow may stop producing completely ("*Bone Marrow Death*"); the gastro-intestinal system is seriously damaged ("*Intestine Death*"). In these two cases death occurs within a few weeks because of infection or hemorrhages. In the case of even higher doses of radiation, death occurs within a few days through the *"Collapse of the Central Nervous System*".
2) *Delayed ray syndrome*: death occurs within 6-8 months, because of serious damage to the respiratory system.
3) *Leukemia or cancers*: death occurs over the succeeding years among a high percentage of the survivors.
4) *Genetic mutations*: there is a high rate of miscarriages and deformed babies.

The amount of radiation absorbed because of local Fallout, expressed in REM or centi-Sievert (1 REM = 1 centi-Sievert) and referring to a certain period of time in which the civil population is exposed to this Fallout, is thought to be very high near the nuclear power station (atomic reactor) and less and less as you move away from the city where the nuclear power station (atomic reactor) occurred [1-3, 5-8]. This Fallout is thought to be extensive when there is an strong winds [1-3,7,8]

This research has been so divided:

1) Units of radiation measurement: Roentgen, RAD, REM, Sievert, Gray, Curie and Becquerel.
2) The biological effects of the different amounts of radiation absorbed, expressed in REM.
3) The different levels of radioactive contamination classified on the proposal of the Author, that is: the Black Zone (the most contaminated area) the Gray Zone, the Red Zone, the Orange Zone, the Yellow Zone and the White Zone (the least contaminated area). Examples of contamination following nuclear accident of atomic reactor of power station of Krsko (Slovenia) and with different wind speeds, with practical explanations on the use of a Nomogram to predict Fallout.
4) The different levels of radioactive contamination classified on the proposal of the Author, that is: the Black Zone (the most contaminated area) the Gray Zone, the Red Zone, the Orange Zone, the Yellow Zone and the White Zone (the least contaminated area). Examples of contamination following nuclear explosions of atomic bomb (of different power) in Italian city of Milano, with equal wind speeds, with practical explanations on the use of a Nomogram to predict Fallout.
5) Residual radioactivity from Caesium 137, Strontium 90, Iodine 131, Plutonium and Uranium
6) Fallout caused by an accident at a nuclear power station: the disaster of Chernobyl
7) The Testament of Chernobyl
8) From the atomic Bomb to genetic Bomb: the Threat of Genetically Modified Organism

FIRST PART

Units of radiation measurement: Roentgen, RAD, REM, Sievert, Gray, Curie and Becquerel.

The ionizing radiation emitted by Fallout is of the gamma, beta and alpha types [1,6-20]

Gamma radiation rays are the most dangerous of all, since they have a range of about 40 meters and are only partly stopped by concrete, lead, bricks, earth or water. Local Fallout is rich in these rays.

Beta radiation rays are much less dangerous, since they have a range of only a few centimeters, and can be completely stopped by clothes and skin. Alfa radiation rays have a range of less than a centimeter and can be completely stopped in the air. Both beta and alpha rays are therefore only dangerous if they come from radioactive substances left on the skin (skin ulcers, phalanx loss. skin cancer [1,7,21-24], or breathed in through the lungs such as Uranium and Plutonium (radiation-induced pneumonia, lung cancer [1,6,7,21], or swallowed in water or food, such as Strontium 90 (cancers [1,6-8,21,25-27]). Some of these, like Iodine131, can easily accumulate in elective organs, for example the thyroid gland, with the risk of radiation-induced tumors, particularly in children, as has been painfully demonstrated at Chernobyl [27-32]. For the purposes described in this chapter (Acute Radiation Syndrome, Delayed Radiation Syndrome, genetic mutations, and cancer and leukemia caused only by the gamma rays of the Fallout) both beta and alpha radiations have been taken into account, for the risk of breathed in through the lung (Uranium or Plutonium), and contaminated food, where Strontium 90 has been taken into consideration.

Thus gamma radiations are the most important, because they are fatal within the first few hours, the first few days and the first few weeks of local Fallout on an un-protected population, that is, one without a nuclear Fallout shelter [1-3,7,8].

For beta and gamma rays, different units of measurement such as Roentgen, RAD, REM, Sievert and Gray can be considered as equivalent, that is: 1 Roentgen = 1 RAD = 1 REM = 1 centi-Gray=1 centi-Sievert.

On the other hand to measure alpha rays this ratio alters in the following way: 1 Roentgen = 1 RAD = 1 centi-Gray = 10 REM = 10 centi-Sievert. The biological importance of alpha radiation can be considered important for Plutonium 238, Plutonium 239, Plutonium 240, Uranium 234, Uranium 235, Uranium 238, and for Polonium 210, respect to gamma radiation from local Fallout, and also beta radiations from Strontium 90 and Iodine 131 [1-3,7,8,21]

Measuring Instruments [9-20]

Instruments to measure Fallout in the air are calibrated in Roentgen/hour, or in milli-Roentgen/hour, (one thousandth of a Roentgen).

Practically speaking this dose of radiation present in the air, in Fallout in the deposition phase, hundreds of kilometers downwind from the point of the explosion, corresponds to the dose absorbed by general material (walls, houses, clothes....) expressed in RAD (Radiation Absorbed Dose) and characterized by a certain intensity of absorption which can be predictably estimated within a certain period of time, which is generally one hour: RAD/hour.

Other units of measurement are: milli-RAD/hour (one thousandth of a RAD); Gray/hour or centi-Gray/hour (one hundredth of a Gray) or milli-Gray/hour (one thousandth of a Gray) or micro-Gray/hour (one millionth of a Gray) where 1 Gray = 100 RAD.

The absorption on the part of a living being needs a further calculation (not covered in this article), the calculation is reached like this: REM/hour, or milli-REM/hour (one thousandth of a REM) or Sievert/hour or centi-Sievert/hour (one hundredth of a Sievert) or milli-Sievert/hour (one thousandth of a Sievert) or micro-Sievert/hour (one millionth of a Sievert) where 1 Sievert= 100 REM. Roentgen, RAD, REM, centi-Gray and centi-Sievert are not in fact so equal, but to simplify the calculations, in the light of local Fallout from an atomic explosion, the units of measurement indicated here must be considered equal, in order to simplify and speed up the evaluation of Fallout on a vast extent of built-up and/or rural land.

Even if they are different, the units of measurement, like Roentgen, RAD, REM, centi-Sievert or centi-Gray, must be considered equivalent, that is equal to the same unit of measurement, because only gamma and beta radiations are considered.

1 Roentgen =1 RAD = 1 REM = 1 centi-Gray = 1 centi-Sievert

We must also take into consideration the fact that 1 centi-Gray is 1 hundredth of a Gray, just as 1 centi-Sievert is 1 hundredth of a Sievert, since nowadays the frequent use of sub-units which differ in scale, such as for example values expressed in Gray or milli-Gray, in Sievert or milli-Sievert (units of measurement frequently used nowadays) risks making the calculations of the biological effects of local Fallout wrong, unless careful attention is paid to the sub-unit of measurement (centi-, milli-, micro-...) Therefore in this study we shall only use REM (or RAD) with 1 REM (or 1 RAD) = 1 Roentgen = 1 centi-Gray = 1 centi-Sievert.

In radio communications to the civilian population or for those civilians who are part of the Civil Defense Corps, according to the Author, it is preferable to use RAD, since it is the easiest unit of measurement to remember (a practical, mnemonic way of remembering RADiation).

Furthermore, since in the most acute period - the first seventeen days - the intensity of radiation is in the region of few tens or hundreds of RAD/hour, this unit of measurement is once again considered preferable, even with its variants (Roentgen or REM), but keeping it distinct from Gray or Sievert which are much bigger units of measurement, that is 1 Gray = 100 RAD, 1 Sievert = 100 REM, and are more complicated to manage in what would predictably be an already chaotic situation.

Table 1 – Doses allowed in the bone marrow and lethal doses (Bone Marrow Death), in REM, respectively in 5% of cases, 50% of cases, 100% of cases (with no medical therapy). Doses lethal in 50% of radiation cases are shown in bold (for practical/mnemonic use). Author's estimate, based on different sources (SEE text).

Parameters	Max dose absorbable without danger	Lethal dose in 5% of cases due to Bone Marrow Death	Lethal dose in 5% of cases due to Bone Marrow Death	Lethal dose in 100% of cases due to Bone Marrow Death
REM/day	100(*)	210 (*)	230-250 (♣)	580 (“)
REM/week	150 (*)	250 (ʌ)	450 (♦)	1,000 (♠)
REM/month	200 (*)	350 (°)	600 (♥)	1,500 (●)

(*): dose effects substantially equivalent in the different sources
(ʌ): lethal dose in 5% of cases, of which less than 20 REM on the first day, absorbed over one week, estimated by the Author according to a chrono-biodosymmetrical calculation [33-35], based on the dose in 5%, according to equivalent data from different sources, equal to 210 REM.
(°): lethal dose in 5% of cases, of which less than 20 REM on the first day, absorbed over one month, estimated by the Author according to a chrono-biodosymmetrical calculation [33-35], based on the dose in 5%, according to equivalent data from different sources, equal to 210 REM.
(♣): We assume that the effect of a dose of radiation absorbed in less than an hour is equivalent to the same dose absorbed in a day. In reality, there should be a slight difference, which can be estimated according to the Author as a lethal dose 50% equal to 230 REM if absorbed in less than an hour, and a lethal dose 50% equal to 250 REM if absorbed over 24 hours; the instantaneous lethal dose absorbed in one minute (230 REM) was calculated for the populations of Hiroshima and Nagasaki by Japanese authors and then reported by UNSCEAR [21, 36].
(♦): lethal dose in 50% of cases, of which less than 100 REM on the first day, absorbed over one week, estimated by the Author according to a chrono-biodosymmetrical [33-35], based on the instantaneous lethal dose of one minute (230 REM) calculated for the populations of Hiroshima and Nagasaki [21, 36]
(♥): lethal dose in 50% of cases, of which less than 50 REM on the first day, absorbed over one month, estimated by the Author according to a chrono-biodosymmetrical [33-35] based on the instantaneous lethal dose of one minute (230 REM) calculated for the populations of Hiroshima and Nagasaki [21, 36].
(“): lethal dose in 100% of cases based on the instantaneous lethal dose of one minute (230 REM) calculated for the populations of Hiroshima and Nagasaki [21, 36]
(♠): lethal dose in 100% of cases, absorbed over one week, estimated by the Author according to a chrono-biodosymmetrical [33-35], based on the instantaneous lethal dose of one minute (230 REM) calculated for the populations of Hiroshima and Nagasaki [21, 36].
(●):lethal dose in 100% of cases, absorbed over one month, estimated by the Author according to a chrono-biodosymmetrical [33-35], based on the instantaneous lethal dose of one minute (230 REM) calculated for the populations of Hiroshima and Nagasaki [21, 36].
Table prepared by the Author based on data partly reported in literature (SEE text)

Radiation Intensity [1-3, 9-20, 33-35]

To measure the time needed to absorb a certain amount of radiation requires an understanding of the intensity of the radiation: 250 REM absorbed within a few minutes are lethal (Table 1), because they are very intensive; on the contrary 250 REM absorbed over a period of 50 years have an almost negligible biological effect (very light radiation), because over a period of 50 years the human body can repair a lot of the biological damage. Thus it is also very important to indicate the period of time in which people are exposed to a certain amount of radiation, (hours, days, weeks or months).

In general the units of measurement evaluate the doses measured in the air over a period of an hour, since the measuring instruments (Geiger) are generally calibrated for Roentgen/hour and practically speaking 11 Roentgen/hour of Fallout, measured one meter from ground level, can be considered as 1 REM/hour absorbed by a man standing (an approximate correlation, but actually very practical and useful).

Therefore: 1 REM/hour = 1 Roentgen/hour = 1 RAD/hour = 1 centi-Gray/hour = 1 centi-Sievert/hour.

Otherwise it must be stressed, as it has in some parts of this study, that absorption can happen over one day, one week, or 17 days, or a month and not in an hour.

A good example of the importance of the intensity of the dose absorbed, expressed, that is, in REM/day or REM/week or REM/month, and not just in REM, can be easily understood, taking into consideration 'Death from bone marrow disease'; in half the cases of those exposed to Acute Ray Syndrome: these values are the most important of all those considered in Table 1, and they are those which must always be remembered:

- 50% lethal dose for a dose absorbed in less than one day = 230-250 REM [1,35-37].
- 50% lethal dose for a dose absorbed in a week = 450 REM (Author's estimate [35]).
- 50% lethal dose for a dose absorbed in a month = 600 REM (Author's estimate [35]).

In comparison, the natural or background radiation (BKG) actually present in the world, is about 135 milli-RAD/year, comparable that is to 0.015 milli-RAD/hour [38]. From the personal monitoring made by the Author, in the North of Italy BKG is still lower, about 0.008 milli-Rad/hour. As a further example; a standard chest X-ray means the patient absorbs about 2 milli-REM to the lungs [39]; on the other hand a CAT to the head means the patient absorbs about 4 REM in the brain [40].

Other units of measurement [9-19]

Both Curie and Becquerel are units of measurement which indicate the concentration of radioactive isotopes at ground level, for example: 1 Curie = $3.7 x 10^{10}$ Becquerel.
1 Becquerel = $2,7 \times 10^{-11}$ Curie

Then, 1,000 Becquerel = 1 kilo-Becquerel (= 0,001 Rutherford = 37 micro-Curie)
1,000 kilo-Becquerel = 1 Mega-Becquerel (= 1 Rutherford = 37 milliCurie)
1,000 Mega-Becquerel = 1 Giga-Becquerel (= 1 kilo-Rutherford = 37 Curie)
1,000 Giga-Becquerel = 1 Tera-Becquerel (= 1 Mega-Rutherford = 37 kilo-Curie)
1,000 Tera-Becquerel = 1 Peta-Becquerel (= 1 Giga-Rutherford = 37 Mega-Curie)
1,000 Peta-Becquerel = 1 Exa-Becquerel (1 Tera-Rutherford = 37 Giga-Curie)

If 1 Curie of radioactive material from Fallout present at ground level corresponds to a certain quantity of intense radiation, expressed in Roentgen/hour at a distance of one meter from the measuring instrument (for example: a Geiger counter), this intensity of radiation, then measured at 50 cms, will increase 4 times (for example: from 10 Roentgen/hour to 40 Roentgen/hour. If this intensity of radiation is measured at 40 cms it will increase 6 times (60 Roentgen/hour). If it is measured at 10 cms from the ground it will increase 100 times. Vice versa if it is measured at 2 meters the intensity of the radiation will diminish a good 4 times compared to the preceding measurement taken at one meter distance, and will therefore diminish (in the example of 10 Roentgen/hour of Fallout) to 2.5 Roentgen/hour, and will give an incorrect estimate of the real amount of Fallout present (which must always be measured at 1 meter from the ground, so as to subsequently classify the Black, Gray, Red, Orange zones). Therefore, special calculations must be used if the measurement is carried out by a low-flying helicopter (60-70 meters of altitude) or planes (100-150 meters of altitude [1]).

The following procedure is therefore necessary: Fallout must be evaluated at one meter from the ground [18], with instruments calibrated for Roentgen/hour or its equivalent, and intended to measure only the gamma rays. Measuring at a distance of only one meter from the ground is the most practical way, because in this way we are sure to pick up only the gamma rays, because the beta rays cannot reach a meter into the air. In any case Geiger instruments are equipped with a little plastic top which blocks all beta and alpha radiation rays which come from the invisible radioactive dust still in the air. (Fallout) thus making the measuring much more accurate. The plastic top is not able to stop or reduce the gamma radiation rays from Fallout, which are extremely penetrating.

SECOUND PART :

The biological effects

The biological effects of radiation Fallout can be considered thus [1,21]
1) Acute ray syndrome
2) Delayed ray syndrome
3) Leukemia and cancer
4) Genetic mutations in descendants

Acute ray syndrome:
death from bone marrow disease; intestine or brain damage [1-3,6-8,21,33-37,41-88]

With the absorption of 200 REM or more, the white blood corpuscles, the red blood corpuscles and the platelets in bone marrow may stop normal production, in which case death from bone marrow disease follows; diarrhea if it is present is never with hemorrhaging so it is not of clinical significance.

With the absorption of 500-600 REM or more there is not only serious damage to the bone marrow but also to the epithelium of the intestine, causing serious diarrhea with hemorrhaging; hydro-electrolytic imbalance, shock, haemo-concentration, infections; peritonitis and death for all those who cannot receive treatment. In both cases (death from bone marrow disease and death from intestinal damage) death will occur within a few weeks (3-4) mainly because of infection or hemorrhage.

For doses of radiation higher than 1,600-3,000 REM, death occurs much more rapidly, within a few days or even within a few hours, caused by serious damage to the brain (Brain death).

Death from bone marrow is caused because of serious damage to the tissue itself. It can no longer produce white blood corpuscles, red blood corpuscles or platelets. Death occurs through infection complications within two months at the most (and usually within one month).

The first day: a general feeling of overall sickness, nausea, vomiting, lack of appetite, prostration, tiredness, diarrhea without hemorrhaging, and the possible loss of hearing within 3 weeks.

The second day: a latent period begins which could last for about 15 days. The person exposed to radiation feels relatively well, even if serious mutations are occurring in his/her bone marrow and also in the blood. From the second week there is a notable tendency for various organs and the skin (petechia) to start hemorrhaging. Spontaneous bleeding from the mouth, the walls of the intestines, the urinary tract and the retina is frequent. Hair loss begins after 15 days.

Death from infection begins at about 20-30 days for 50% of those who have been exposed to radiation of the following strengths: 230-250 REM in one day [21,36,37], or 450 REM in one week, of which (personal estimate [35]) less than 100 REM in one day or 600 REM in one month, of which less than 50 REM in one day (personal estimate [35]), (Table 1).

Death from infection occurs within 20 days for 100% of those who have been exposed to doses of radiation absorbed of at least 550-580 REM/day [21,35-37,41], or 1,000 REM/week (personal estimate [35]) or 1,550 REM/month (personal estimate [35]), (Table 1).

It is important to remember the 8 levels of the Anno scale [41], which give us a more precise idea of the pathology in relation to the effective dose presumably absorbed by the patient, although we do not have exact dose-measures; this would give us a sufficiently clear clinical picture in order to decide the best treatment to use, given the limited amount of medication available. Such medication substantially consists of physiological water given in drip form, a wide range of antibiotics and a special diet with anti-oxidizing herbal and vitamins components [42].

The Anno scale is based on an accurate description of the patient's symptoms and objective signs, taken from a considerable number of published scientific works [43-87] In this work, the scale has been partially modified, in the sense that the lethal dose on the third level of the Anno scale has been made worse.

First level [41]: Low-grade dose of from 50 to 100 REM: the symptoms are limited to nausea, vomiting, anorexia and weakness, in a small percentage of those affected and only on the first day.

Second level [41]: Dose from 100 to 200 REM: in 50% of cases symptoms are more pronounced, with a temperature from infection; the latter has proved to be the cause of death (around 200 REM) within 2 months for 2-5% of those affected.

Third level [41]: Dose from 200 to 350 REM: serious bone marrow damage, with a high death rate within 2 months of around 50% of those affected. The exact lethal dose in 50% of cases is still a debatable point because of the very varied data which has been reported, it is , however, within the values given here [1-3,21,35-37,41-87,89].

A light attack of diarrhea occurs within 5 hours after exposure; but this symptom must be differentiated from serious diarrhea with hemorrhaging, which occurs after an absorbed dose higher than at least 500-600 REM. Such a level also causes not only serious radiation damage to the bone marrow, but also gastro-intestinal damage, with hydro-electrolytic imbalance, peritonitis and death (SEE level 5). The general clinical picture is characterized by temperature, infection and ulcers 3-5 weeks after exposure. In the fourth and fifth weeks diarrhea may be experienced again, but not yet hemorrhaging. The most common infections are those in the lungs.

The Author maintains that the lethal dose in 50% of cases can be put at around 230-250 REM of acute exposure (instantaneous or within 24 hours), values based both on a Japanese study [36] later confirmed by UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) in 1988 [21], but already confirmed by prior Japanese studies also confirmed by UNSCEAR in 1972 [89]. In both cases only instantaneous exposure of one minute was considered, since only Hiroshima and Nagasaki were considered, where the nuclear devices exploded in the air, without significant levels of Fallout. The values reported [21,36,37,89] were therefore subsequently integrated by the Author, with chrono-biodosymmetric calculations according to the time of continuous exposure to radiation, as in the case of Fallout (over 1 week and 1 month) and reported in Table 1. These evaluations are therefore theoretical, since they have been calculated using the Chrono-Dose-Erythema (C.D.E. [33-35]) system but always intended to discover the lethal dose in 50% of cases, thus obtaining increasing theoretical values of 450 REM/week (of which less than 100 REM in one day), and 600 REM/month (of which less than 50 REM in one day), in both cases to be considered as lethal doses in 50% of cases (Table 1). It should therefore be noted that the basic value of an instantaneous dose used by the Author as reported in Table 1 (230 REM), is worse than that reported in the Anno scale (325 REM [41]).

The fourth level [41] - Dose from 350 REM to 550 REM (according to the Author, on the basis of Japanese studies [36], the dose is from 230 REM). The symptoms are even worse, resulting in death within 2 months for between 50% and 99% of those affected. About 10% have either slight or severe diarrhea within 3 -5 hours of exposure, followed by electrolytic imbalance. The estimate of the Author (580 REM, lethal in 99% of cases) reported in Japanese studies [21 35 36] is almost comparable to that reported by Anno (550 REM, lethal in 995 of cases) [41].

The fifth level [41] - Dose from 550 REM to 750 REM: the symptoms are much worse, resulting in death within one month in 100% of those affected, unless they receive medical treatment. All those affected have the following symptoms within 3 - 5 hours of exposure: vomiting, nausea, hypotension, dizziness and disorientation. From the fourth day they suffer from diarrhea with resulting hydro-electrolytic imbalance. The general clinical picture is characterized by temperature, infections and gastro-intestinal ulcers occurring within 2 weeks. There is serious diarrhea with bleeding, since there is damage not only to the bone marrow but also to the gastro-intestinal system, severe dehydration and peritonitis, resulting in death if there is no medical treatment.

The sixth level [[41]] - Dose from 750 REM to 1,000 REM: survival time for all those affected is no more than 2 weeks. Right from the first day they have a temperature and all those symptoms already listed above for the preceding levels. There is also moderate to severe headaches from the first day. In the absence of medical treatment death is inevitable.

The seventh level [[41]] - Dose from 1,000 REM to 2,000 REM: severe nausea and vomiting start within 30 minutes of exposure. From the fourth hour severe headaches begin and continue for 2-3 days. Gastro-intestinal damage is predominant, beginning from the fourth day, and causing more vomiting, nausea, anorexia and diarrhea, with bleeding and high temperature, abdominal swelling and peristalsis without paralytic ileum [[90]]. From the second week there is severe dehydration with cardio-circulatory collapse and septicemia. Even in the case of adequate medical treatment many of those affected will die. According to other studies [[33,34]] from 1500 REM to 1600 REM there is already the beginning of brain damage.

The eighth level [[41]] - Dose from 2,000 REM to 3,000 REM: the symptoms are more severe. The main damage is gastro-intestinal, further complicated by cardio-vascular lesions. Tiredness and severe headaches begin immediately after exposure and can persist during the next phase of gastro-enteritis. Several hours after exposure severe dehydration and electrolytic imbalance begin. There is an increase in permeability of the intestinal capillaries [[90-92]]. Death is inevitable even with adequate medical treatment. According to other studies [[33,34]] from 1500 REM to 1600 REM there may already be brain damage.

The ninth level (not considered on the Anno scale). - Dose absorbed of more than 3,000 REM: the predominant picture is of serious brain damage. Even with medical treatment death is certain. The symptoms show that there are pathological lesions in the nerve cells and lesions in the blood vessels of the brain. Other symptoms are irritability, headaches, vomiting, salivating, diarrhea, an inability to coordinate movement (ataxia), disorientation, stupor, trembling, frequent shaking, nystagmus, convulsions, prostration, coma and respiratory failure.

Death occurs within 5 days if the radiation is 3,000 REM [[88]].

Death occurs within 2 days if the radiation is at least 8,000 REM [[88]].

Death occurs within a few hours if the radiation is at least 16,000 REM [[88]].

Pharmacological Treatments and extemporaneous herbal remedies

The following treatments are possible: physiological water through an intravenous drip; antibiotics and anti-oxidation compounds from herbal-chemical sources (the latter are substantially based on extracts from plants known in pharmacopoeia, brought to 200 degrees Celsius and then put in glycerin to preserve the efficacy of their principle ingredients for at least 5 years); radio-protective drugs such as *Amifostina* (WR2721) to be taken, however, 30 minutes before exposure to radiation [93-104]: it is a particularly efficient drug because it doubles of the ionizing dose needed to cause death. After exposure it is necessary to take anti-emetics such as *Granisetron*, to have further intravenous drips and give a wide range of antibiotics as already demonstrated in Moscow in 1986 [21,106]; and finally to give drugs able to stimulate the recovery of the immune system and the bone marrow and so avoid having to give blood transfusions. According to the Author, an immune plan similar to that followed in oncological radio-therapy could be considered [107], choosing *Timopentina* [108] or *Timostimolina* [109] or *Betaseron* [110] or *Levamisole* [111] or *Timosina* α [112] or rHu GM-CSF [113]). Recently it has been discovered that an aminobiphosphonate, *Risedronate*, is able to stimulate the immune system of the Lymphocytes T gamma delta [114,115]. According to the author it could therefore be useful to induce an immune recovery in those affected by radiation, using at the same time mineral salts such as *Germanium sesquioxide 132* [116-123]. Vitamin C can also act as an antioxidant, and remove the free radicals thus reducing the damage caused at the genome level, and so acting as a preventative measure [124-151] together with other vitamins (SEE later). Given the conditions of absolute emergency and the probable absence of an efficient medical organization, it would also be possible to use extemporaneous herbal remedies, which are already known in medical literature as capable of inducing immune activity. These include *Viscum album* [152], to be injected under the skin, or *Aloe arborescens*, to be mixed with honey and alcohol and eaten. The proportions are: 2-3 soupspoons of liquidized fresh leaves mixed with honey on a 2-1 ratio, with added alcohol. There have been some interesting uses made of this plant in medical literature for various pathological conditions, not only to restore the immune system but also to cure other pathological conditions present in Acute Ray Syndrome such as radio-gastritis, radio-enteritis, radio-pneumonia and skin burns caused by Fallout [153-169]. In particular, concerning this latter pathology, following American nuclear experiments in Nevada in 1953, *Aloe* proved to be the best ointment to use on skin burns caused by beta rays from Fallout [22]. More recently, *Melaleuca alternifoglia* (code NATO: NCAGE - A9355) has been proposed, and is currently being evaluated to use against skin flame burns [170].

In conclusion: all these treatments, if well applied, can double the dose of radiation needed to cause death, above all in the case of haematopoietic damage only (Table 1) If, on the contrary, the damage is associated with serious intestinal damage with relative hydro-electrolytic imbalance, inability to take nutrition and above all peritonitis, a treatment combining an intravenous drip and antibiotics may no longer be sufficient.

It is important, too, to consider the possibility of using laboratory analyses, both through blood samples and urine samples, according to what is already reported in Literature [21, 171-183]. In particular, from the works by UNSCEAR in 1988 [21], we would point out the estimate of the total gamma dose absorbed according to the haematic-lymphocyte count [184], an estimate based on the count of the peripheral lymphocytes during the first nine days after exposure, and on the average count in days 4-7 and days 1-8, both counts taken after exposure to radiation. This data has been obtained on the basis of the values in the fall of lymphocytes measured in 115 patients hospitalized after the Chernobyl disaster in 1986; they are thus considered the most reliable data currently available, both for the precision of the systems of analysis used and for the number, statistically valid, of the observations made (Figures 2,3).

Retarded Ray Syndrome: Death from Pneumonia from radiation

The pathology begins 2-3 weeks after radiation, with bronchial-alveolitis symptoms, coughing and crepitus and sub-crepitus wheezing which correspond to necrotic changes in the alveolar epithelium. If the person exposed to radiation survives the concomitant lung infection, 6 months after exposure there is a fibroblastic proliferation and finally fibrosis, more or less extensive, of the bronchial and vascular structures, without leucocytic infiltration. The delicate pulmonary epithelium that acts in the oxygen-carbon dioxide exchange becomes like pasteboard and is insufficient for breathing [[21,33-34,185]]. According to the Author, the use of cortisone in an aerosol, after the III-IV month of exposure to Fallout, could be used as a prevention, even in the case of serious immune deficiency caused by serious damage to the bone marrow. Unfortunately there is no corroborating data.

One could however estimate that the dose necessary to cause radio-pneumonia must be about 1,000 REM accumulated on the first day, or 1500 REM accumulated in the I week, or 1,800 REM accumulated in the I month (Author's estimates based on the chrono-biodosymmetrical data of other authors [[33,34]]). Radiation doses partly deriving from external gamma rays (total radiation of the chest), the latter no higher than level three on the Anno scale, and in part deriving from alpha and beta rays caused by radioactive Fallout dust which has settled in the alveoli and bronchi. On the X-Ray, due to the cumulative effect of external gamma radiation on all of the chest, and of local alpha and beta radiation, areas of fibrosis should be visible, with an X-ray picture similar to that of silicosis. Due to a cumulative effect of external gamma doses, there will be radioactive dust deposits from alpha (Plutonium, Uranium, Polonium) and beta emissions in the alveoli and the interstices.

Leukemia and cancer

In 1988 UNSCEAR (the United Nations Scientific Committee on the Effects of Atomic Radiation) published a new document on the risks of ionizing radiation [[21]]. The data reported (Table II) show worse results than previous works from I.C.R.P.26 of 1977 [[186]]. This had an influence on the drawing up of the new ICRP61 values in 1991 [[187]]. At low doses, the beginning of neoplasia is thought to follow a characteristic development: leukemia is thought to begin starting from the II year after exposure to radiation, reaching a peak of probability appearing in the VI-VII year after exposure, and then with reduced frequency until it disappears as a neoplastic risk 25 years after exposure to radiation. Solid tumors are thought to begin to appear at least ten years after exposure to radiation and then to increase more and more as time goes on (Figure 4) [[188]].

Carcinomas of the thyroid gland are an exception, they are thought to begin after 6-7 years, as has already been demonstrated after Chernobyl [[27-32]].

Comparing Table II with Figure 4 one can assume that the overall risk is high: assuming we can apply the data reported in Table II with those reported in Figure 4, the result is that for doses of 1 REM a year, the relative risk of the onset of leukemia within 25 years, is equal to 8.5 cases out of a population of 100,000, with the onset from the II year and peaking at the VI-VII year.

For all tumors, on the whole, the risk is thought to be 50 cases out of 100,000 inhabitants within 50 years, with a dose of 1 REM a year, and for solid tumors the onset tends to be around the tenth year from exposure to radiation, with linear progress initially equal to a few cases every 100,000 inhabitants who have each been exposed to 1 REM.

From which figures we can deduce the following data:

Cases of leukemia within 25 years:

- about 90 cases for every 100,000 people exposed to Fallout of 10 RAD each;
- about 900 cases for every 100,000 people exposed to Fallout of 100 RAD each;
- about 1,800 cases for every100,000 people exposed to Fallout of 200 RAD each;
- about 3,600 cases for every 100,000 people exposed to Fallout of 400 RAD each.

TABLE II – Deaths from neoplasms caused by radiation (100 REM) per 10,000 persons.

		ICRP 26	UNSCEAR 1988
Organ or tissue at risk			
Bone marrow		20	85
Skeleton		5	5
Lung		20	100
Thyroid		5	10
Breast		25	20
Subtotals		75	220
Other organs			
Gastro-intestinal tract	not differentiated		150
Ovary	not differentiated		30
Bladder	not differentiated		15
Multiple myeloma	not differentiated		15
Skin	not differentiated		2
Other	not differentiated		68
Subtotals		50	280
Total		125	500

Table elaborated by the Author based on data partly reported in: UNSCEAR 1988 "United Nations Scientific Committee on the Effects of Atomic Radiation, 1988", *Sources, Effects and Risks of Ionizing Radiation*, United Nations, New York, 1988.

Cancer cases within 50 years:

The onset of cancers is thought to begin from the tenth year after exposure to radiation, with an initial risk which is slightly less than that of leukemia, but within 50 years it is thought to reach a final value 6 times higher in risk than leukemia.

Only the availability of Shelters and of anti-radiation drugs like WR2721 [93-104] or immune modulants [107-123,152,154,158,159,162-164,167,169] could reduce the cancerogenous effects of the accumulated radiation.

However, taking certain vitamins possibly has a preventative effect: vitamin A [188-301], vitamin C [124-151], vitamin D [302-315], vitamin E [316-337] and Selenium [338-357].

Genetic mutations in descendants.

Radiation causes genetic mutations in the descendants of those affected which can be divided into two categories: genetic (or punctiform) mutations and chromosome aberrations. Punctiform genetic mutations can be defined substantially as alterations in only one gene, and can be classified as dominant, recessive or connected to the gender chromosome. The chromosome aberrations are characterized by alterations of large sections of the chromosome, by additions or losses (deletions) of whole chromosomes. Small losses of chromosomes are also described as sub-deletions, very similar to punctiform mutations but different from them in that genetic mutations can also be characterized only by the substitution or loss of only one base of the genetic code. The most important and fearsome effects of radiation on the genetic code are sub-chromatic, chromatic or chromosome aberrations, because they are due to one or more breaks in the double helix of the DNA, and are not subsequently repaired by the cell. Of these the most notable are Down, Klinefelter and Turner syndromes.

According to consolidated data, now several decades old [21,185, 358-362], nearly 70% of spontaneous miscarriages, with development stopping before the eighth week from conception, show chromosome anomalies, half of which are autosomic trisomies. The rest are monosomies, triploidy and tetrapoloidy. It is also possible to subdivide the same chromosome aberrations into those caused by a single break in the chromosome chain, which is a linear function of the dose and not the intensity, and those caused by complex breaks in the chromosome chain. The latter are much worse, given the difficulty the cell has to repair the damage, and they increase more rapidly than the linear increase with respect to the dose absorbed and also in direct ratio to the intensity of the radiation. Still using data consolidated in literature, one can maintain that 50 double breaks, happening in less than 15 minutes, are sufficient in 63% of cases to kill a normal human cell: much less to cause irreparable chromosome aberrations. The interaction of the lesions in non-duplicated chromosomes or in chromatids therefore determines the birth of new chromosomes that derive from an asymmetric or symmetric exchange of their genetic material. Asymmetric exchanges always give rise to one or more acentric fragments which do not become part of the new duplicated cell and are therefore lost . The cells remaining are unstable and in general do not survive long, given also the formation of dicentric bridges which block the mechanical separation of daughter cells. Vice versa, symmetrical alterations of chromosomes, if complete, are defined as stable and are potentially more dangerous than unstable aberrations, insofar as they pass through subsequent reproduction cycles.

Considering the different published works [21, 358-362] one can estimate that about 15-16% of all conceptions, found starting from the fifth week of pregnancy, end in spontaneous miscarriage or in still births. Of these about 30-60% are associated with chromosome anomalies; the rest are associated with other causes such as infectious illnesses or accidents. Again considering globally the data already published [21, 358-362] one can therefore sustain that about 5-9% of all conceptions (starting from the fifth week of pregnancy) are affected by chromosome damage incompatible with life.

However, with regard to chromosome anomalies still compatible with life, these were estimated as equal to 0.40% of all live births according to studies done in 1977 [360]; equal to 0.6% of all live births according to another study done in 1982 [359]. On the basis of more recent studies [361], the values have again been slightly modified (Table III), bringing those values to about 0.44%. Dominant autosomic illnesses and those connected to the gender chromosome have remained practically unchanged with respect to the preceding values of 1977 [360]. Vice versa, congenital malformations, anomalies of genetic origin expressed in later years, constitutional and degenerative illnesses have changed from 9% [360], to 2-3%, according to data from 1990 [361]. These last data are shown in Table III: they concern a study done on the basis of experiments with animals, mainly mice (Table IV), on the mortality rates of children born from survivors of Hiroshima and Nagasaki, on the natural incidence of the different types of genetic diseases known, in order to calculate the additional increase in illnesses caused by the absorption of 1 REM of a low dose of radiation of low intensity gamma rays, in a population of one million live births. This required knowing the double dose on man, that is, the dose of radiation that exactly doubles the natural rate of genetic mutation. This presupposed that the natural frequencies of the different classes of genetic diseases in man were known and to what extent these incidences remained constant in the population; finally, that there existed a proportion between the rate of spontaneous mutation and the rates induced by radiation, so that the incidence increased in the same way as radiation. The double dose in man was estimated as equal to 100 REM [361].

TABLE III – Estimate of the genetic effects of 1 REM per generation

Type of genetic disorder	Current incidence for 1 million live births	Additional cases for 1 million live births, from absorption of 1 REM	
		First Generation	Balance
Clinically severe dominant autosomic	2500	5-20	25
Clinically moderate dominant autosomic	7500	1-15	75
Connected to X-chromosome	400	<1	<5
Recessive	2500	<1	V. low increase
Unbalanced chromosome translocation	600 (♠)	<5	V. low increase
Trisomy	3800 (♣)	<1	<1
Congenital abnormalities and complex etiopathogenesis illnesses (♦)	20,000-30,000	10	10-100

Therefore the following data were deduced:

1) If all dominant autosomic illnesses (2,500+7,500) increase proportionately to the dose, and if the double dose is 100 REM, then 1 REM of radiation will determine an increase of 1% on the basic current incidence, that is, 100 new cases of which 25 are clinically severe dominant autosomic and 75 are clinically moderate dominant autosomic [361]. However, of these only 20% will appear in the first generation (for reasons not reported in the study). In Table V, a list of genetic diseases compiled in 1981 by Childs [362] is reported. In this report he describes the different distribution of 5,840 cases of dominant etiopathogenesis genetic diseases every 10^6 live births (this has now been revalued to about 10,000 cases every 10^6 live births according to data from 1990 [361]).
2) The chromosome alterations observed in newborn babies were estimated at 0.44%. Given that 100 REM is the double dose, and therefore able to cause 4400 new cases out of a million live births, one can estimate that 1 REM determines an increase of about 40 new cases, only 10% of which will appear in the first generation, for particular ways in which the damage manifests itself after birth [361].
3) According to the BEIR V report of 1990 (Table VI), of the complex etiopathogenesis illnesses one could have, in a state of equilibrium, about half the 200 new forms of illnesses predicted from exposure to 1 REM [361].

There is still no agreement, however, with regard to the dose of radiation absorbed needed to obtain the same effect on man when exposed to high levels of radiation. To that end, the value of the dose of ionizing radiation able to double the risk of radio-induced genetic damage because of exposure to high, medium and low intensity rays has still to be defined. This fact is very important in this work, given the different levels of intensity of Fallout present respectively in the acute period (the first 30 days of Fallout); the Sub-acute period (from the second month to the sixth month after the nuclear accident of the power reactor); and finally in the Chronic period (residual radioactivity is present from the sixth month onwards). On the basis of an UNSCEAR report from 1977 [360] if we accept 100 REM as the value of a dose of low intensity radiation able to double the normal frequency of punctiform genetic mutations and chromosome anomalies, one can therefore consider this dose, if delivered at very high intensity, equal to 30% of the dose of radiation at low intensity considered above (passing therefore from100 REM to about 30 REM) and if this is delivered at a medium-high intensity, equal to 50% of the dose of radiation at low intensity considered above (passing therefore from 100 REM to about 50 REM): these however are the personal estimates of the Author, even if, in the past, the value of double dosage, in the case of local Fallout, was set as equal to about 30 REM [[1,6]]. However these evaluations must all be considered approximate, given the different behavior of the increase between punctiform genetic mutations (linear) and chromosome anomalies (exponential) [[359]].

Therefore the real genetic damage from natural radiation (Background) can be estimated thus: natural radiation, estimated at around 0.1-0.2 REM a year [[38]] is responsible for about 2-3 REM of radiation absorbed globally by every adult individual (from birth to adulthood, suitable for conceiving children). The genetic damage caused by 2-3 REM of ionizing radiation in the first 20-30 years of life of each parent (with a total of 4-6 REM of potential genetic damage on their unborn child) is thought to be the cause at present of 5-9 cases of miscarriage out of every 100 pregnancies; with between one to two cases of birth of deformed children, or carriers of illnesses of genetic origin which are often not compatible with life (still over 100 pregnancies).

TABLE 1V – Estimate of the dose of radiation believed necessary to induce the doubling of genetic damage, by exposure to low intensity ionizing radiation, and low dose of gamma rays (experiments made mainly on mice)

Genetic damage	Dose of radiation deemed necessary to induce doubling of genetic damage expressed in REM
Dominant lethal mutation for both sexes	40-100
Recessive lethal mutation of both sexes	150-300
Dominant mutation visible in male mouse in:	
Skeleton	75-150
Cataract	200-400
Other	80
Dominant mutation visible in female mouse	40-160
Recessive mutation visible post-implant in female mouse	70-600
Recessive mutation visible in male mouse	114
Reciprocal translocation	
In the male mouse	10-50
In the male monkey (Rhesus)	20-40
Hereditary translocations	
In the male mouse	12-250
In the female mouse	50-100
Congenital malformations	
Post-implant in female mouse	25-250
Post-implant in male mouse	125-1250
In the male mouse	80-2500
Aneuploidia	
Pre-ovulation oocyte	15-150
Small mature oocytes	250-1300

Table taken from: Beir V. *Health Effects of Exposure to low levels of Ionizing Radiation*, "Committee on the Biological Effects of Ionizing Radiations. Board on Radiation Effects Research Commission on Life Sciences National Research Council", National Academy Press, Washington D.C. 1990, Table 2-11, page 102.

Table V – Dominant genetic diseases: frequency for every 10^6 of live births. Mutation rate every 10^6 live births after exposure to 1 REM

Dominant genetic diseases	Frequency at birth	Mutation rate every 10^6 live births
Retinoblastoma	24	6
Colon polyposis	71	7
Neurofibromatosis	350	93
Spherocytosis of erythrocytes	220	22
Huntington's choreic syndrome	300	5
Myotonic Dystrophy	220	28
Anophtalmy	30	10
Congenital deafness	69	24
Rapid onset cataract (congenital)	40	6
Aniridia	15	3
Hare lip	11	1
Polycystic kidney	860	76
Achondroplasia	30	12
Ollier's dischondroplasia	50	8
Imperfect osteogenesis	40	9
Osteopetrosis (Schoenberg's disease)	10	1
Marfan's syndrome	30	5
Tuberous sclerosis	25	10
Rapid onset rare diseases	130	30
Hypercholesterolemia	2,000	<20
Intermittent acute porphyria	15	1
Variegated porphyria	15	<1
Otosclerosis	1,000	<20
Imperfect amelogenesis	60	1
Imperfect dentinogenesis	125	<1
Total	5,840	399

Table taken from Childs J.D. The effect of a change in mutation rate on the incidence of dominant and X-linked recessive disorders in man, "Mutat res." 83, pages 145-158, 1981; in Beir V. *Health Effects of Exposure to low levels of Ionizing Radiation*, "Committee on the Biological Effects of Ionizing Radiations. Board on Radiation Effects Research Commission on Life Sciences National Research Council", National Academy press, Washington D.C. 1990, Table 2-2, page 79.

Table VI – Complex etiopathogenesis illnesses

Complex etiopathogenesis illnesses	Prevalence per 10^6 live births	Hereditary importance
Graves disease	650	0.47
Diabetes mellitus	4,070	0.67
Diabetes mellitus IDDM	200	0.30
Gout	180	0.50
Schizophrenic psychosis	850	0.80
Unipolar affective psychosis	5,000	0.60
Bipolar affective psychosis	1,000	0.90
Multiple sclerosis	40	0.58
Epilepsy	600	0.50
Glaucoma	1,600	0.32
Allergic rinitis	3,600	0.43
Asthma	2,490	0.70
Peptic ulcer	4,600	0.65
Idiopathic colitis	30	0.60
Cholelithiasis	940	0.63
Celiac disease	130	0.80
Kidney stones	900	0.70
Atopic dermatitis	600	0.50
Psoriasis	390	0.75
Systemic Lupus erythematosus	40	0.90
Rheumatoid arthritis	1,310	0.58
Ancylopoietic spondylitis	190	0.79
Scheuermann's disease	500	0.56
Adolescent idiopathic scoliosis	410	0.88
Total	30,320	

Table taken from: Beir V. *Health Effects of Exposure to low levels of Ionizing Radiation*, "Committee on the Biological Effects of Ionizing Radiations. Board on Radiation Effects Research Commission on Life Sciences National Research Council", National Academy Press, Washington D.C. 1990, Table 2-4, page 89

Genetic mutations from local Fallout.

In the case, therefore, of exposure to local Fallout, one can affirm that the number of miscarriages and the number of deformed children born, in the years following the radio-induced genetic damage from Fallout, will double with every dose of ionizing radiation absorbed by the population and comprises between 30 and 100 REM for every future parent. One can deduce, therefore, that doses above 50-100 REM would have serious effects on the genetic patrimony of the populations involved. Furthermore, according to the author, there would be a permanent sterility effect on the populations involved for doses higher than 100-150 REM, if absorbed in the acute phase (because of the higher intensity of the dose and therefore the estimated doubling dose would be around 30 REM, according to the author).

In particular, three distinct periods can be distinguished of the intensity of the dose absorbed from Fallout, which should be taken into account in order to evaluate the effect of radio-induced genetic damage:

a) The Acute Period of absorption: within the first 30 days of local Fallout, characterized by the high intensity of the dose absorbed.
b) The Sub-Acute Period of absorption: from the first 30 days of local Fallout to the sixth month, characterized by medium to high intensity dose absorbed.
c) The Chronic Period of absorption: from the sixth month of local Fallout onwards, characterized by low intensity of the dose absorbed.

Nota : questi periodi (acuto, sub-acuto e cronico) sono validi per *Fall-out locali* da esplosioni nucleari al suolo da bomba atomica; per il *Fall out locale* da incidente a centrale atomica, i tempi di assorbimento dovrebbero essere stimati in maniera molto diversa.

Based on known data in medical literature (Tables III-VI), considering the Chronic Period of absorption, the author maintains that the increase in miscarriages in the areas contaminated by Fallout, due to the absorption of 100 REM in 30 years (instead of the present 3 REM) should be extremely limited (in the order of 0.5%). Furthermore, it is believed that this trend should remain linear up to doses of radiation equivalent to 3,500 REM absorbed accumulatively over 30 years.

One can thus evaluate the genetic damage caused by low intensity radiation in the Chronic Period, distributed over a period of time: in the Red Zone of nuclear explosion of atomic bomb (SEE Fourth Part of this work) with estimated accumulated doses of about 400 REM in 30 years, miscarriages, on average, should occur in about 12% of pregnancies. In the Black Zone of nuclear explosion of atomic bomb (SEE Fourth Part of this work) with estimated accumulation doses of about 3,500 REM in 30 years, the miscarriages are expected to reach about 26% of the total pregnancies. All this presupposes, in both cases, that the civil population is kept in Shelters [[371]] for the whole of the Acute and Sub-Acute Period (the first six months) before they leave their Shelters.

Vice versa, there is not enough reliable empirical data to estimate the increases in miscarriages and genetic damage for a civil population exposed to very high intensity doses (Acute period: the first 30 days of Fallout of nuclear explosion of atomic bomb) or medium to high intensity (Sub-Acute Period: from the 30th day to the first 6 months of Fallout of nuclear explosion of atomic bomb). It is therefore impossible, for these periods, to identify exactly the average values and the distribution of probability: one can only hypothesize that we are dealing with a distribution of probability of the Gaussian type, and that they are characterized by a very low variance (this means that it is very improbable that the number of miscarriages will differ significantly from the average value of the distribution, which is also the most probable value). Furthermore, one can affirm with reasonable certainty that the relation between radiation and miscarriages is of the exponential type, because it is determined by chromosome anomalies.

On the basis of this data, one can therefore maintain that with the absorption of very high doses by civilians (the Acute Period), 100-120 REM could be enough to cause miscarriages in the following years and in almost all the future expectant mothers (permanent sterility). For populations exposed to medium-high doses, that is from the 30^{th} day to the sixth month (excluding exposure to radiation in the Acute Period), one can predict (author's personal estimate) that accumulated doses of about 150 REM, could already determine an incidence of miscarriages equal to about 30%; one must add to this, however, the additional effect of doses absorbed during the Chronic Period (SEE above). With more than 250 REM there would be permanent sterility.

Conclusions: the use of radio-protective drugs such as *Amifostina* [[93-104]] and of anti-oxidant herbal-chemical complexes could only partially mitigate the effect of mutagenic radiation on the genetic patrimony of the population. Only the presence of Shelter Facilities, equipped to keep the population closed indoors during all of the Acute Period and Sub-Acute Period (a total of 5-6 months) could guarantee their safety, exposing them only to the intensity of radiation in the Chronic Period, which varies from Zone to Zone (SEE the Fourth Part).

Note: anti-oxidant herbal-chemical complexes (as VITAMINS [405-504])

(From "*Thousand Plants against Cancer without Chemo-Therapy"October 2008, in:* National Health Federation http://www.thenhf.com/about_us.html).

Aminoacid NOT found in proteins: Mimosine

Anthraquinones: Aloctin A, Aloctin B (Barbaloin), Emodin, and OTHER;

Ascorbic acid (vitamin C)

B group : B1 (Thiamine), B2 , B3 (Niacin), B4 , B5, B6, B7, B8 (Biotin) B9 (Folic acid) , B10, B11, B12, B13, B14, B15, B16, B17 (Amigdalin), ….and OTHER….
Note: "Laetrile" acronym for "LAEvomandeloniTRILE-glucoside") as Amygdalin: Laetrile has two molecules of glucose, Amygdalin has more. Indeed, the chemical structure of Laetrile is D-1 mandelonitrile–beta-glucuronide, while for Amygdalin it is D-mandelonitrile-bi-glucoside.

Carotenoids: a family of pigments with at least six-hundred members, as Axerophthol palmitate, alpha and beta Carotene, trans-Retinoic acid, Lycopene, Lutein, Canta-xantine, Cripto-xantine, Zea-xantine, ….and OTHER …

E group: This liposoluble substance consists of a group of various components, called *Tocopherols*. Seven of these exist in nature; *alpha-Tocopherol, beta-Tocopherol, gamma- Tocopherol, delta-Tocopherol, epsilon-Tocopherol, zeta-Tocopheros* and *eta-Tocopherol.*

F group: polyunsaturated fatty acids : arachidonic acid, Linoleic cis-cis natural acid (vitamin F1) as: alpha-lipoic acid, alpha-linolenic acid, ….and OTHER…..

Flavonoids is a group of more 4,000 polyphenolic compounds. These compounds possess a common phenyl-benzopyrone structure (C6-C3-C6) , and they are categorized according to the saturation level and opening of the central pyran ring, mainly into seven main groups: Flavonones, Flavanols, Flavones, Flavonols, Flavanonols, and Isoflavones.
Es.: Acacetin, Apigenin, Baicalein, Baicalin, Bilabetol, Biochanin A, Campherol, Catechin, Chrysin, Citrin, Daidzein, Diosmin, Epicatechin, Epigallocatechin, Epigallocatechin-3-gallate, Equol, Eriodictyol, Fisetin, Formononetin, Galangin, Gallocatechin, Genistein, Genistin, Ginketol, Gitogenin, Glycitein, Hesperidin, Hyperoxide, Isoamnetin, Isoginketol, Kampherol, Liquiritin, Luteolin, Morin, Munetone, Myricetin, Naringenin, Naringin, Nobiletin, Pychnogenol, Quercetin, Robinetin, Ruscogenin, Rutin, Silydiamin, Silymarin, Silychristin, Tangeretin, Taxifolin, Wogonin , and OTHER

Indole glucosinolates : as Indol-3-carbinol, and OTHER (Brassica vegetables); conversion to isothiocyanates

Isoprenoides : Abscisic acid, Acorenone, Alloaromadendrene, Aromadendrene, Bergamotene, Bisabolene, Borneol, Bornyl acetate, Isoborneol, Cadinene, Camphene, Caranol, Carene, Carvacrol, Carvone, Pinocarvone, Caryophyllene, Cedrine, Cineole, Cinnamaldehyde, Cinnamate, Citral, Cyclocitral,, Citronellal, Citronellyl acetate or butyrate or propionate, Copaene, Cresol, Cubebene, Cymene, Damascenone, Elemene, Estragol, Eugenol, Farnesene, Fencone, Geraniol, Germacrene, Hotrienol, Humulene, Ionol, Ionone, Isopinocamphone, Isopulegol, Limonane, Linalool, Longifolene, Mentol, Neomenthol, Menthone, Isomenthone, Murolene, Myrcenol, Myrcene, Myrtenol, Neral, Nerol, Nerolidol, Nootkatone, Ocimene, Ocimenol, Perillaldehyde, Phellandrene, Pinene, Pinocamphone, Piperitol, Piperitone, Pristane, Pulegone, Sabinene, Sabinol, Santalol, Selinadiene, Selinene, Sinensal, Styrene, Terpinene, Terpineol, Terpinolene, Thymol, Tricyclene, Vanillin, Valencene, Verbenone, Vitispirane, …and OTHER…

Lecithins : as Alexin B, ….and OTHER

Minerals (organic) : organic Boron, organic Calcium, organic Chromium, organic Germanium, Organic Iodine, organic Iron, organic Magnesium, organic Manganese, organic Molybdenum, organic Selenium, organic Silicium, organic Vanadium, organic Zinc, …. and OTHER….

Note:
allyl Sulfur (an organo-Sulfur compound) (*)
Diallyl sulfide [DAS], (an organo-Sulfur compound) (*)
Diallyl disulfide [DADS], (an organo-Sulfur compound) (*)
Diallyl trisulfide [DATS], (an organo-Sulfur compound) (*)
(*)which are decomposition products of Allicin
Germanium sesquioxide
Manganese Superoxide Dismutasis (SOD),
Selenium derivatives (sodium Selenite, Seleno-DL-Methionine, Se-methyl-selenocysteine)

Oxindole alkaloids: Pteropodin, Specrofillin, Hystopteropodin, Uncaria F, Isomitrofillin, …and OTHER…..

Saponins : Ginsenoides, Saikosaponin D, ….and OTHER….

Stilbenes: is a group of polyhenols : Resveratrol, …. and OTHER….

Styryl-lactones : Altholactone, Goniothalamin, ….and OTHER….

Tannins: is a group of polyhenols; tannins are divided into 2 chemically distinct groups:

1) the condensed tannins (Proanthocyanidin)
2) the hydrolysable tannins (as hydrolysable Ellagitannins, such as Woodfordin C (macrocyclic ellagitannin dimmer), Oenothein B, Camellin B, …..and OTHER…..

NOTE: Anthocyanins: Peonidine-3-glucoside, Cyanidin-3-glucoside , ….and OTHER….

Terpenes: Alisol B acetate, Atractylon, Atractylenolides, Betulinic acid, Bisabolol, Boswellic acid, Carnosic acid, Ferutidin, Ferutinin, Myristicin, Oleanolic acid, Parthenolide, Pomolic acid, Tymoquinone, …and OTHER…

Vanillys-phenols : is a group of polyhenols; share structural similarities possessing both the vanillyl (4-hydroxy 3-methoxyphenyl) moiety and the ketone functional group in their structure; Paradols, Gingerols, Yakuchinone B, Curcumin (diferuloyl methane), Capsaicin (homo-vanillic acid derivative : 8 methyl-N-Vanillyl-6-nonenamide),…and OTHER….:

….and OTHER….

THIRD PART:

Contamination levels from local Fallout from atomic accident at a nuclear power station: proposal for a colorimetric classification by means of a Nomogram to predict a Fallout, with a practical explanation for use in emergency.

The third part introduces a new practical system of evaluating the different levels of Fallout present in the territory after an *atomic accident at a nuclear power station* with leakage of radioactivity. The colorimetric classification system, proposed by the author, has been studied by comparing radioactive decay curves after nuclear explosions of atomic bombs on the ground with radioactive decay curves after an accident at the civil nuclear reactor (SEE Figure 5: "Two decay curves"[[404]]). Substantially, it can be said that both curves cross each other 100 hours after the initial event. In the initial phase, a Fallout from an atomic explosion is about 1,000 more severe than that released by a nuclear power station. After the crossing, intensity levels of gamma radiation rays – caused by Fallout from atomic bomb – fall down rapidly, whereas those caused by Fallout from nuclear power station maintain very high levels of gamma radioactivity:

Table VII:

Radioactivity of *Fallout* from atomic bomb (in Black Zone A) and *Fallout* from nuclear power station (in Black Zone A) (SEE Fig. 5)

TIMES from explosion	*Fallout* from atomic bomb, in RAD /h	*Fallout* from nuclear station power in RAD / h
First hour	4,500	about 60
after 100 hours (4 days)	15	15
after 5 days	12	12.5
after 1 week	4-5	12
After first month	1	11.5
After 2 months	0.3	9.5
After 3 months	0.15	8.5
After 4 months	0.12	6.8
After 5 months	0.11	6
After 6 months	0.09	5
After 7 months	0.08	4.5
After 8 months	0.07	3.6
After 9 months	0.07	3
After 10 months	0.06	2
After 11 months	0.06	1.8
After 12 months (1 year)	0.06	1.5
After 30 months (2,5 years)	0.01	0.75
After 5 years	0.009	0.4
After 12 years	0.008	0.12
After 25 years	0.006	0.06

Note: natural Background = 0.008 milliRAD/h

Gamma radiations from Fallout from atomic bomb after 5 days are equivalent to gamma radiations from Fallout from nuclear power station after about 1 month (12 RAD/h if Black Zone).

Gamma radiations from Fallout from atomic bomb after 7 days are equivalent to gamma radiations from Fallout from nuclear power station after about 7 months (4.5 RAD/h if Black Zone).

Gamma radiations from Fallout from atomic bomb after 2-3 weeks are equivalent to gamma radiations from Fallout from nuclear power station after about 10 months (2 RAD/h if Black Zone).

Gamma radiations from Fallout from atomic bomb after 30 days are equivalent to gamma radiations from Fallout from nuclear power station after about 18 months (1 RAD/h if Black Zone).

Gamma radiations from Fallout from atomic bomb after 2 months are equivalent to gamma radiations from Fallout from nuclear power station after about 5 years (0.4 RAD/h if Black Zone).

Gamma radiations from Fallout from atomic bomb after 3 months are equivalent to gamma radiations from Fallout from nuclear power station after about 12 years (0.1 RAD/h if Black Zone).

It must therefore be said that both types of Fallouts – from atomic bomb and from nuclear power station – tend to have very different levels, differing very slightly during the first week, by a factor of 10 after the first month, and subsequently settling at a difference of 50 times. This gap in radioactivity levels remains also after a very long period of time (25-30 years after the event).

As far as the first 4 days of Fallout are concerned, it must be underlined that both curves cross each other. If precise radioactivity values are known after 72 hours from a Fallout from atomic bomb, radiation levels in various radioactive zones can be substantially predicted with reasonable certainty. Similarly, an approximate estimate could be made of radioactivity levels from nuclear power station in the following weeks and months.

Calculation system

Different levels of radioactive contamination are taken into consideration:
Black Zone: it is the most contaminated zone, both in case of a nuclear explosion of an atomic bomb on the ground or of an accident at the civil nuclear reactor. Its Fallout is called “black” Fallout.

Grey Zone: it is a radioactive zone where the contamination level would be 5 times lower than that of the Black Zone. By an explosion occurring on ground level, the “grey” Fallout starts half an hour after the explosion. It is not known if this time span (half an hour) exists also in case of a Fallout from nuclear power station.

Red Zone: it is a radioactive zone where the contamination level would be 10 times lower than that of the Black Zone. By an explosion occurring on ground level, the “red” Fallout starts 2 hours after the explosion. It is not known if this time span (2 hours) exists also in case of a Fallout from nuclear power station.

Orange Zone: it is a radioactive zone where the contamination level would be 50 times lower than that of the Black Zone. By an explosion occurring on ground level, the “orange” Fallout starts 3 hours after the explosion. It is not known if this time span (3 hours) exists also in case of a Fallout from nuclear power station.

Yellow Zone: it is a radioactive zone where the contamination level would be 100 times lower than that of the Black Zone. By an explosion occurring on ground level, the "yellow" Fallout starts 5 hours after the explosion. It is not known if this time span (5 hours) exists also in case of a Fallout from nuclear power station.

White Zone: it is a radioactive zone where the contamination level would be 1,000 times lower than that of the Black Zone. By an explosion occurring on ground level, the "white" Fallout starts 8 hours after the explosion. It is not known if this time span (8 hours) exists also in case of a Fallout from nuclear power station.

Fallouts from nuclear explosion have a "cigar"-type progress (SEE Nomogram of Figure 1 and the isodose curves in Figure 7), the extension of which depends on the explosive power of the bomb and the speed of the wind. Fallouts from nuclear power plant have instead an irregular development because of continuous changes of winds which cause a radioactive "fan-shaped" Fallout, according to a theoretic model using concentric circles (SEE Figure 6-A, B, C, D, E, F "Krsko").

Supposing that 72-100 hours after the event – i.e. a nuclear explosion on the ground or an accident at a nuclear power station – the two decay curves cross each other, it is possible to evaluate precisely the intensity of radioactivity in the areas:

Black Zone: 10 RAD/h (2,500 [1,000-3,000] times higher the white level)
Grey Zone: 2 RAD/h (500 times higher the white level)
Red Zone: 1 RAD/h (250 [100-300] times higher the white level)
Orange Zone: 0.2 RAD/h (50 times higher the white level)
Yellow Zone: 0.1 RAD/h (10 times higher the white level)
White Zone: 0.01 RAD/h (0,05-2 times higher the natural BKG)

Figure 5 "Two decay curves" [[404]] shows that radioactivity intensity is initially 5-6 times higher.

It has consequently been deemed correct to multiply all above-mentioned values by five in order to obtain the initial values of radiation at the beginning of the Fallout, as is common practice when estimating Fallouts from nuclear explosions.

The resulting picture is the following:

Black Zone: initial Fallout of 50-60 RAD/h
Grey Zone: initial Fallout of 10-12 RAD/h
Red Zone: initial Fallout of 5-6 RAD/h
Orange Zone: initial Fallout of 1-2 RAD/h
Yellow Zone: initial Fallout of 0.5 RAD/h
White Zone: initial Fallout of 0.1-0.2 RAD/h

If these estimates were correct, the following radiation levels during the first 4 days following the accident could be estimated:

Black Zone: it is the area where the intensity dose absorbed by an individual would be 50-60 RAD/h during the first hour after the accident and 10 RAD/h at the end of the fourth day, totalling 1,000-5,000 RAD absorbed by an individual within four days, half of which during the first day.

Grey Zone: it is the area where the intensity dose absorbed by an individual would be 10-12 RAD/h in the first fall phase of the Fallout (half an hour?) after the accident and 2 RAD/h at the end of the fourth day, totalling 200-1,000 RAD absorbed by an individual within four days, half of which during the first day.

Red Zone: it is the area where the intensity dose absorbed by an individual would be 5-6 RAD/h in the first fall phase of the Fallout (2 hours ?) after the accident and 1 RAD/h at the end of the fourth day, totalling 100-500 RAD absorbed by an individual within four days, half of which during the first day.

Orange Zone: it is the area where the intensity dose absorbed by an individual would be 1 RAD/h in the first fall phase of the Fallout (3 hours ?) after the accident and 0.2 RAD/h at the end of the fourth day, totalling 20-100 RAD absorbed by an individual within four days, half of which during the first day.

Yellow Zone: it is the area where the intensity dose absorbed by an individual would be 0.5 RAD/h in the first fall phase of the Fallout (5 hours?) after the accident and 0.1 RAD/h at the end of the fourth day, totalling 10-50 RAD absorbed by an individual within four days, half of which during the first day.

White Zone: it is the area where the intensity dose absorbed by an individual would be 0.05 RAD/h in the first fall phase of the Fallout (8 hours?) after the accident and 0.01 RAD/h at the end of the fourth day, totalling 1-5 RAD absorbed by an individual within four days, half of which during the first day.

After the fourth day

From the fourth day after the accident at the nuclear reactor the levels of radioactivity would tend to further decrease, but more slowly and with greater differences between them.

A colorimetric scale for practical and mnemonic use

A precise scale value for all levels of radioactivity on the ground after an accident of atomic reactor, as Chernobyl (Table IX), or a nuclear explosion of atomic explosion (Table XII) can be used for practical and mnemonic use. This colorimetric scale, in Table VIII, derives from the Nomogram (SEE figure 1) used for predicting radioactive Fallouts, and is described hereafter.

Table VIII shows a summary of the Fallout for a practical mnemonic use, with the various doses of radiation expressed in REM, as can be accumulated overall by an individual standing in the open, because these doses of radiation are referred as doses absorbed at a meter from ground level. Therefore an individual bending over or lying down will absorb a much higher dosage: if the dose at one meter = 1, then: a dose at 50 cm = 1 x 4; a dose at 30 cm = 1 x 11; a dose at 10 cm = 1 x 100; a dose at 1 cm = 1 x 10,000.

Table VIII – Colorimetric classification of Fallout from atomic explosion or nuclear power station (proposed by Author)

White Zone	x 1 (level near natural Background)
Yellow Zone	x 10
Orange Zone	x 50
Red Zone B	x 100
Red Zone A	x 300
Gray Zone	x 500
Black Zone B	x 1,000
Black Zone A	x 3,000

Table drawn up by the Author based on data partly taken from:
1. Glasstone C.D. *The effects of Nuclear Weapons*, Atomic Energy Commission, Rome 1959
7. Fowler J. Fallout: *le precipitazioni radioattive e il futuro dell'umanità*, Milan, Bompiani 1961
8. Dieta G. *Progetto Fallout, per sopravvivere il giorno dopo*, SugarCo Edizioni, Milan 1984

Simplified calculation systems help to predict the dose intensity on the ground in the various areas, after some time from the first measurements (SEE Figure 5: Two decay curves [[404]]).

The decrease in the radiation and therefore the intensity of the dose that can be estimated (in RAD/hour or RAD/month) can be calculated with two different systems, which allow for a fairly accurate prediction of the levels of radioactivity in the following days, weeks and months if used together.

The levels of radiation in the various radioactive zones from Fallout from nuclear power station could be the following (SEE Table IX).

However, it has been considered more useful to summarise in Table IX the intensity levels of the dose in RAD/hour, measured one meter from the ground, before and after the first 72-100 hours.

In this table the intensity levels of the dose are listed in RAD/hour, measured one meter from the ground, at different times after the fall of the Fallout, in the various zones of radioactive contamination, from the fourth day after the accident to the twelfth year.

Table IX/a: Anticipatory model of radioactive Fallout from nuclear power station within the first month (dirty Fallout)

Hot areas	Total *gamma* radiations at the beginning of the Fallout in RAD/hour	*Gamma* radiations after four days in RAD/hour	Total *gamma* radiations of the first four days in total RAD	*Gamma* radiations after thirty days in RAD/hour	Total *gamma* radiations from the fourth to the thirtieth day in total RAD
Black Zone A	60-70	15	3,000-15,000	12	6,330
Black Zone B	20-25	5	1,000-5,000	4	2,000
Grey Zone	10-12	2.5	500-2,500	2	1,000
Red Zone A	5-6	1.5	300-1,500	1.2	633
Red Zone B	2.5	0.5	100-500	0.4	200
Orange Zone	1-1.2	0.25	50-250	0.2	100
Yellow Zone	0.1	0.025	10-50	0.25	20
White Zone	0.01	0.002	1-5	0.02	2

Table IX/b: Anticipatory model of radioactive Fallout from nuclear power station from the first to the third month

Hot areas	*Gamma* radiations after two months in RAD/hour	Total *gamma* radiations from the first to the second month in RAD/month	*Gamma* radiations after three months in RAD/hour	Total *gamma* radiations from the second to the third month in RAD/month	*Gamma* radiations after four months in RAD/hour
Black Zone A	9.5	about 7,800	8.5	about 6,500	6.8
Black Zone B	3.2	about 2,600	2.8	about 2,100	2.3
Grey Zone	1.6	about 1,300	1.4	about 1,000	1.2
Red Zone A	1	about 780	0.85	about 650	0.7
Red Zone B	0.3	about 260	0.28	about 200	0.2
Orange Zone	0.15	about 130	0.14	about 100	0.1
Yellow Zone	0.03	about 25	0.02	about 20	0.02
White Zone	0.003	about 2	0.002	about 2	0.002

Table XI/c: Anticipatory model of radioactive Fallout from nuclear power station from the fourth to the sixth month

Hot areas	Total *gamma* radiations from the third to the fourth month in RAD/month	*Gamma* radiations after five months in RAD/hour	Total *gamma* radiations from the fourth to the fifth month in RAD/month	*Gamma* radiations after six months in RAD/hour	Total *gamma* radiations from the fifth to the sixth month in RAD/month
Black Zone A	5,500	6.8	4,500	5	4,000
Black Zone B	3,300	2.3	1,600	1.7	1,333
Grey Zone	1,100	1.15	900	0.85	650
Red Zone A	550	0.68	450	0.5	400
Red Zone B	330	0.23	160	0.17	133
Orange Zone	170	0.11	80	0.085	68
Yellow Zone	33	0.011	15	0.017	13
White Zone	3.3	0.001	1.5	0.001	1.3

Table XI/d: Anticipatory model of radioactive Fallout from nuclear power station from the seventh to the ninth month

Hot areas	Total *gamma* radiations from the thirtieth day to the sixth month in total RAD	*Gamma* radiations after seven months in RAD/hour	Total *gamma* radiations from the sixth to the seventh month in RAD/month	*Gamma* radiations after eight months in RAD/hour	Total *gamma* radiations from the seventh to the eighth month in RAD/month
Black Zone A	about 28,000	4.5	3,300	3.6	3,000
Black Zone B	9,500	1.5	1,100	1.2	1.000
Grey Zone	4,750	0.75	500	0.6	500
Red Zone A	2,800	0.45	330	0.36	300
Red Zone B	950	0.15	110	0.12	100
Orange Zone	about 470	0.075	about 50	0.06	50
Yellow Zone	about 100	0.015	11	0.03	10
White Zone	about 10	0.001	1	0.003	1

Table XI/e: Anticipatory model of radioactive Fallout from nuclear power station from the ninth to the eleventh month

Hot areas	*Gamma* radiations after nine months in RAD/hour	Total *gamma* radiations from the eighth to the ninth month in RAD/month	*Gamma* radiations after ten months in RAD/hour	Total *gamma* radiations from the ninth to the tenth month in RAD/month	*Gamma* radiations after eleven months in RAD/hour
Black Zone A	3	2,500	2	1,800	1.8
Black Zone B	1	830	0.7	600	0.6
Grey Zone	0.5	415	0.35	300	0.3
Red Zone A	0.3	250	0.2	180	0.18
Red Zone B	0.1	about 84	0.07	60	0.06
Orange Zone	0.05	about 42	0.035	30	0.03
Yellow Zone	0.01	about 8	0.007	6	0.006
White Zone	0.001	0,8	0.0007	0.6	0.0006

Table IX/f: Anticipatory model of radioactive Fallout from nuclear power station from the first to the second year and a half

Hot areas	Total *gamma* radiations from the tenth to the eleventh month in RAD/month	*Gamma* radiations after twelve months (1 year) in RAD/hour	Total *gamma* radiations from the eleventh to the twelfth month in RAD/month	*Gamma* radiations after thirty months (2 years and a half) in RAD/hour	*Gamma* radiations from the twelfth to the thirtieth month in total RAD
Black Zone A	1,350	1.5	1,200	0.75	12,000
Black Zone B	450	0.5	400	0.25	4,000
Grey Zone	225	0.25	200	0.12	2,000
Red Zone A	135	0.15	120	0.075	1,200
Red Zone B	45	0.05	40	0.025	400
Orange Zone	22	0.025	20	0.012	200
Yellow Zone	4.5	0.005	4	0.0025	100
White Zone	0.45	0.0005	0.4	0.0002	10

Table IX/g: Anticipatory model of radioactive Fallout from nuclear power station from the second year and a half to 25 years

Hot areas	*Gamma* radiations after sixty months (5 years) in RAD/hour	Total *gamma* radiations after 2 years and a half to 5 years in total RAD	*Gamma* radiations after 12 years in RAD/hour	Gamma radiations after 2 years and a half to 12 years in total RAD	*Gamma* radiations after 25 years in RAD/hour
Black Zone A	0.4	12,000	0.12	12,000	0.06
Black Zone B	0.13	4,000	0.04	4,000	0.02
Grey Zone	0.06	2,000	0.02	2,000	0.01
Red Zone A	0.04	1,200	0.012	1,200	0.06
Red Zone B	0.013	400	0.004	400	0.02
Orange Zone	0.006	200	0.002	200	0.01
Yellow Zone	0.0013	100	0.001	100	0.002
White Zone	0.00013	10	0.0002	10	0.0002

Using a Nomogram to predict a Fallout after an accident of atomic reactor (nuclear power station) as Chernobyl: calculating the extension of various radioactive zones on the basis of the estimated power of the atomic bomb and the relative wind speed

These estimates can be easily deduced from the Nomogram for predicting a Fallout, in Figure 1, with the explanation summarising use in Table X.

TABLE X – Constructing the Nomogram to predict Fallout

Border between Gray Zone and Black Zone	Distance indicated by Point C divided by 4
Border between Red Zone and Gray Zone	Distance indicated by Point C divided by 2
Border between Orange Zone and Red Zone	Distance indicated by Point C
Border between Yellow Zone and Orange Zone	Distance indicated by Point C multiplied by 2
Border between White Zone and Yellow Zone	Distance indicated by Point C multiplied by 4
End of White Zone	Distance indicated by Point C multiplied by 8

Table drawn up by Author

Basically, the following should be known:

1) the place of the atomic explosion (POINT A)
2) the quantity of the radioactivity released
3) the actual wind direction
4) the fictitious wind speed (POINT B)

This information should be available via radio within the first half hour after the accident.
Connect Point A to Point B with a line (FICTITIOUS WIND SPEED). The line will indicate Point C in the DISTANCE DOWNWIND column, which will show the distance from the Zero Point of the nuclear explosion, of the border between the Red Zone and the Orange Zone, expressed in kilometres.
The border between the Grey and Black Zones will be equal to a quarter of the value indicated by Point C.
The border between the Red and Grey Zones will be equal to half the value indicated by Point C.

The border between the Orange and Yellow Zones will be equal to double the value indicated by Point C.
The border between the Yellow and White Zones will be equal to four times the value indicated by Point C.
The White zone will extend 8 times as far as the value indicated by Point C.

This Nomogram is used in order to calculate Fallouts from nuclear explosions of atomic bomb on the ground.

According to an American study published about 25 years ago [[404]], isodose lines from a thermonuclear explosion entirely fissionable of about 1,000 kiloton could be compared with isodose lines from a severe accident at a civil nuclear power station.

In particular, the maximum accident at a nuclear power station would release 1.5 billion Curie, thus causing a "heavy" residual radioactive area of 68 km downwind of the nuclear power station (with wind of 24 km/h), as against a "heavy" residual radioactive area of 100-120 km caused by a nuclear explosion on the ground of 1,000 kiloton (again with wind of 24 km/h).

According to the NATO Nomogram of Figure 1, an isodose line at 100-120 km – from explosion on the ground of an atomic bomb of 1,000 kiloton with wind of 24 km/h – can be reduced to an isodose of 68 km downwind of the zero point (as calculated in the American study for an accident at a nuclear power plant causing the release into the atmosphere of 1.5 billion Curie) if a nuclear explosion on the ground of 300 kiloton with wind of 24 km/h is taken into consideration.

According to this study it is possible to consider the maximum accident at a civil nuclear reactor (with a consequent release into the atmosphere of 1.5 billion Curie) as equivalent to a nuclear explosion of 300 kiloton.

Extension estimates of point C after the Fallout of 1.5 billion curie with different wind speeds

Wind speed	*Point C, at a distance of..... from the nuclear power station*
100 km /h	*125 km*
80 km/h	*120 km*
70 km/h	*110 km*
60 km /h	*100 km*
50 km /h	*90 km*
40 km/h	*80 km*
30 km/h	*70 km*
25 km/h	*68 km*
20 km/h	*58 km*
15 km/h	*50 km*
10 km/h	*48 km*
8 km/h	*38 km*
6 km/h	*33 km*

Figures 6-A, 6-B, 6-C, 6-D, 6-E, 6-F show different pictures of radioactive Fallout, supposing a maximum accident of 1.5 billion Curie at the Krsko nuclear power station

Conclusion

Substantially, predictive estimates of radioactive Fallout which can be obtained using Nomogram 1 in Figure 1 will provide all the measurements of radioactivity. The colorimetric classification of the various areas, shown in Table VIII, will also be useful to understand the biological risk deriving from the residues of gamma radiation due to a great extent to Caesium 137, and to the residual contamination of agricultural land by Strontium 90, and the risk of inhalation of radionuclides alpha-emitters as Plutonium and Uranium, thus obtaining a long range picture of the dangers deriving from the cultivation of this soil (SEE Fifth Part).

FOURT PART

Contamination levels from local Fallout from nuclear explosion of atomic bomb: proposal for a colorimetric classification by means of a Nomogram to predict Fallout, with a practical explanation for use in emergency.

The effects of a nuclear explosion

There are basically four effects of a nuclear explosion: the blast, the shock wave, high-energy ionizing radiations and Fallout (local, tropospheric and stratospheric) [1-8].

The blast

It is 30 times brighter than the sun at midday [7], lasts a variable time (SEE Three Part) and is above all of an extremely high temperature which is lethal for those exposed to the explosion, even at tens of kilometers away (vaporization/ carbonization/extensive burns). The heat from the blast is so intense as to cause fires to break out on a vast scale and to render quite useless any Fallout shelters in large cities, where dangerous conditions for the formation of *'fire storms'* would be created: these are a physical phenomenon characterized by ground temperatures of many thousands of degrees Celsius, lasting many days. They are caused by the huge fires that would continue to burn for days on end inside the atomized area, continually fed by winds coming from outside the city where there are no fires. Even in nuclear Fallout shelters with hermetically sealed shutters and air filters, the 'chimney' effect might be felt: all the air in the shelter would be sucked out by the 'fire storm' killing all the occupants. In any case the high temperature, which would last for many days, would change the shelter into an oven, as has already been demonstrated by fire bombings in Tokyo, Dresden, Hamburg and Cologne during the Second World War [1-3,7].

The shock wave

This is extremely powerful, enough to flatten the entire historical center of a city: if only a small device were used, some tens of kilotons, equivalent to the first bomb dropped on Hiroshima (A-bomb, fusion only) or capable of destroying an entire metropolis (a medium power device, some hundreds of kilotons [H- bomb, fusion-fission], or a device capable of destroying an entire metropolis and all the surrounding suburbs (a highly powerful device of some thousands of kilotons (H-bomb fission-fusion-fission or dirty bombs) [1-3,7,8].

1,000 kilotons (kT) of explosive energy is equivalent to 1 megaton (MT) of explosive energy.

High-energy ionizing radiations

These are extremely strong (neutrons and gamma rays) lasting about one minute, with an effective range of 2 – 3 kms from the point of the explosion on a city. They are certainly fatal within a few days or weeks for any person who has survived the blast of the explosion, the shock wave or the fires but is within a radius of 2 – 3 kms from the point of the explosion (zero point) in the first few minutes of the explosion; even if he is protected by a shield structure at the front, he is not protected from "scattering", that is, the continual radiating flashes coming from the heart of the atomic stalk as it rapidly rises and lasting about a minute [1,8]

In the case of high altitude atomic explosions, these radiations also cause electromagnetic impulses [4,8] that seriously damage computers, telecommunication systems and almost all other instruments, especially transistorized ones, although valve systems or fiber optic systems are not affected. The effect is comparable to that of a bolt of lightning striking the instrument, with a rise time of nanoseconds even if, in the case of electromagnetic impulses from atomic explosions, the increase in the voltage is a hundred times faster, and for this reason present protection systems for electric and electronic instruments are too slow to be effective. In the framework of this paper this particular fact is important for the working of Geiger counters and radios: all instruments considered of vital importance for the subsequent functioning of emergency services for the civilian population.

Fallout

This is characterized by radioactive dust falling to earth. It is local, tropospheric and stratospheric; the latter occurs only in atomic explosions greater than 100 kilotons [5].

Local Fallout is characterized exclusively by an explosion occurring at or on ground level [1-3,5-8]; it comes from the thousands of tons of earth, rocks and other material which are fused or vaporized by the heat of the explosion and then mixed to about 200 types of radioactive isotopes [7], equal to about 50 grams for every kiloton of developed fissile energy [1,7], produced following the explosion and instantly fatal because of the high doses of gamma emissions irradiating from them. This detritus is carried high above the atomic mushroom cloud during its rising phase. At a high altitude (5-10 minutes after the explosion), the circle of fire cools and expands like an umbrella (stabilized atomic cloud) and the radioactive particles begin to fall, blowing for hundreds of kilometers downwind from the explosion (Figs.1, 7).

High altitude nuclear explosions, on the other hand, disperse radioactive isotopes over the whole latitude of the hemisphere (Tropospheric Fallout), going in a West-East direction in the Northern Hemisphere and in an East-West direction in the Southern hemisphere. About half of this Fallout falls back to earth every month [1] brought to the ground by rains and snow (Fallout more correctly termed rain-out); it falls over vast areas of the earth and oceans, like stratospheric Fallout, which is widespread all over the world, therefore falling again in the other hemisphere, at the rate of half every seven years [1]. These two types of Fallout (Rain-out) determine practically negligible local ionizing levels, even in the framework of a global thermal nuclear conflict [7]. This is because these types of Fallout fall to earth after weeks, months or years after the explosion, unlike local Fallout that is immediately fatal because it falls immediately within 24 hours and is 10,000 to 100,000 more radioactive [1] because it is rich in radioisotopes that decay rapidly. It is the effects of local Fallout that is the topic of this discussion.

An atomic mushroom cloud is the main characteristic of an explosion at ground level, or near the ground (with the formation of local Fallout) since it is characterized by an atomic stalk: a column of smoke which is very thick and dark, due to the materials from the earth which are thrown up into the cloud [1-3,5-7]. On the contrary, if there is an atomic explosion in the air at high altitude, there is no stalk. If there is a low-altitude atomic explosion in the air (but without creating local Fallout, because the fire does not reach the ground) an atomic stalk can form, but it is very thin and broken in parts since it only derives from the suction of surface earth caused by the explosion in the air; the danger, therefore, of local Fallout is negligible [1-3,5-7].

Local Fallout falls to earth, downwind of the point of the explosion (zero point), first with an atomic stalk and then with an atomic cloud too [1]. The latter is visible only in the first hours after an explosion, then it is no longer visible [1]. Therefore particular attention must be paid to the following statement: *a large part of local Fallout from an atomic cloud is practically invisible* [1]. It is thus necessary to use a Geiger counter continuously to check the environmental radioactivity, as it is described in this article, for practical purposes [1].

The effects of Fallout on man can be summarized thus [1-3, 5-8] :

1) *acute ray syndrome*: death within a few weeks or even days; from a clinical point of view the white blood cells, the red blood cells and the platelets in the bone marrow may stop producing completely (*Bone Marrow Death*); the gastro-intestinal system is seriously damaged (*Intestine Death*). In these two cases death occurs within a few weeks because of infection or hemorrhages. In the case of even higher doses of radiation, death occurs within a few days through the *'Collapse of the Central Nervous System*'.

5) *Delayed ray syndrome*: death occurs within 6-8 months, because of serious damage to the respiratory system.
6) *Leukemia or cancers*: death occurs over the succeeding years among a high percentage of the survivors.
7) *Genetic mutations*: there is a high rate of miscarriages and deformed babies.

The Fourth Part introduces a new practical system of evaluating the different levels of Fallout present in the territory after an atomic explosion at ground level. The colorimetric classification system, proposed by the author, has been studied by comparing the experimental data from the nuclear tests carried out by the USA in the 1950s and 60s [1,7], from which this classification proposal derives. It has been thought out substantially for the practical purpose of protecting the civilian population, based also on an Italian study from 1984 [8].

Annihilation Zone.

The real nuclear explosion zone is included inside this zone, identified by Zero Point, and by its corresponding limit zone, that is, the extensive area characterized by really severe mechanical and thermal damage caused by the explosion, with probable formation of Fire Storms, the size of which depends on the power of the nuclear device:

a) a tactical bomb (fission type, a few tens of kilotons), it completely destroys a city of small sizes.
b) a medium power bomb (fission-fusion:, some hundreds of kilotons), it completely destroys a city of average sizes.
c) an high power bomb (fission-fusion-fission, several thousand kilotons), it completely destroys a city of big sizes.

The Fallout then has a 'cigar'-type progress (SEE Nomogram of Figure 1 and the isodose curves in Figure 7), the extension of which depends on the explosive power of the bomb and the speed of the wind.

The Black Zone - This is the area immediately downwind of the Annihilation Zone, including the latter, where Fallout, coming from the atomic Stalk, would start to fall immediately. So by the Black Zone we mean the area where the intensity of the dose absorbed by the individual would correspond to: >4,500 REM in the first hour, followed by 15,000-20,000 REM in the first seven hours, to a total of about 30,000 REM within 1-3 days (20,000+10,000). For anyone extending their stay in these areas, there would be an added dose of about 10,000 REM from the 3rd day to the 17th day after the explosion (Table XII).

The Gray Zone - This is the area where Fallout, also arriving from the Stalk, would begin to fall starting from the first half hour after the explosion. Thus by the Gray Zone we mean the area of almost immediate radioactive Fallout, of which the intensity of the dose absorbed by the individual would correspond to: 1,000 REM in the first hour, followed by 4,000 REM in the following 7 hours to a total of 6,000 REM within the second and third day (4,000+2,000). For anyone staying longer in these areas there would be an added dose of about 3,000 REM from the third day to about the seventeenth day after the explosion (Table XII).

TABLE XII – Summary of local Fallout, for practical-mnemonic purposes, proposed by the Author. Gamma ray dose which can be accumulated by an individual, standing outside, in overall REM.

Zone	Arrival time of Fallout	Intensity of dose REM/hour at start of Fallout (*)	Accumulated dose in REM				
			First 7 hours after Fallout arrives	First 3 days after Fallout arrives	First 17 days after Fallout arrives	From 17th to 30th day	From 30th day to 6th month
Black	<30 m	>4,500	15-20,000	30,000	40,000	+1,200 (A) + 400(B)	+ 400 (A) + 160 (B)
Gray	30 m	1,000	4,000	6,000	9,000	+ 200	+ 80
Red	2 hours	450	2,000	3,000	4,000	+ 120 (A) + 40 (B)	+ 40 (A) + 16 (B)
Orange	3 hours	150	1,000	1,500	2,000	+ 20	+ 8
Yellow	5 hours	50	200	300	400	+ 4	+ 2
White	8 hours	5	20	30	40	+ 0.4	+ 0.6

(*) Initial Reference dose at start of Fallout (SEE also Table XIV)
Table elaborated by the Author according to data partly taken from:
1. Gladstone C.D. *The effects of Nuclear Weapons*, Atomic Energy Commission, Rome 1959
7. Fowler J. Fallout: *le precipitazioni radioattive e il futuro dell'umanità*, Milan, Bompiani 1961
8. Dieta G. *Progetto Fallout, per sopravvivere il giorno dopo*, SugarCo Edizioni, Milan 1984

The Red Zone - This is the area where Fallout would begin at least 2 hours after the explosion. Thus by the Red Zone we mean the area of radioactive Fallout in which the dose absorbed by the individual would correspond to: 400 REM in the first hour of Fallout (that is 3 hours after the explosion), followed by 2,000 REM in the following 7 hours (that is, 10 hours after the explosion), to a total of 3,000 REM within the second and third day (2,000+1,000). For those staying longer in theses areas there would be an added dose of about 1,000 REM from the third to about the seventeenth day after the explosion (Table XII).

The Orange Zone - This is the area where Fallout would begin at least 3 hours after the explosion. Thus by the Orange Zone we mean the area of radioactive Fallout in which the dose absorbed by the individual would correspond to: 150 REM in the first hour of Fallout (that is, 4 hours after the explosion), followed by 1,000 REM in the following seven hours (that is, 11 hours after the explosion) to a total of 1,500 REM within the first to third day (1,000+500). For those staying longer in these areas there would be an added dose of about 500 REM from the third to about the seventeenth day after the explosion (Table XII).

The Yellow Zone - This is the area where Fallout would begin at least 5 hours after the explosion. Thus by the Yellow Zone we mean the area of radioactive Fallout in which the dose absorbed by the individual would correspond to: 50 REM in the first hour (that is, 6 hours after the explosion) followed by 200 REM in the following seven hours (that is, 13 hours after the explosion) to a total of 300 REM within the second to third day (200+100). For those staying longer in these areas there would be an added dose of about 100 REM from the third to about the seventeenth day after the explosion (Table XII).

The White Zone - This is the area where Fallout would begin at least 8 hours after the explosion. Thus by the White Zone we mean the area of radioactive Fallout in which the dose absorbed by the individual would correspond to: 5 REM in the first hour (that is, 9 hours after the explosion) followed by 20 REM in the following seven hours (that is, 16 hours after the explosion) to a total of 30 REM within the second to the third day (20+10). For those staying longer in these areas there would be an added dose of about 10 REM from the third day to about the seventeenth day after the explosion (Table XII).

After the seventeenth day.

From the seventeenth day after the explosion the level of radioactivity would tend to decrease still more, but more slowly and with greater differences between them. Thus there would be a practical sub-division of the Black Zone into Black Zone A (the area of highest contamination, covering about 1/3 of the Black Zone) and Black Zone B (with lower contamination compared to Zone A). Similarly the Red Zone would be divided into Red Zone A (the area of highest contamination, covering about 1/3 of the Red Zone) and Red Zone B (with lower contamination compared to Zone A).

Table VIII shows a summary of the Fallout for a practical mnemonic use, with the various doses of radiation expressed in REM, as can be accumulated overall by an individual standing in the open, because these doses of radiation are referred as doses absorbed at a meter from ground level. Therefore an individual bending over or lying down will absorb a much higher dosage: if the dose at one meter = 1, then the dose at 50 cms = 1x4; a dose at 30 cms = 1x11; a dose at 10 cms = 1x100; a dose at 1 cm = 1x10,000.

Table XIII shows the physical characteristics of an atomic mushroom 10 minutes from the explosion, that is, as a stabilized atomic cloud [[363]]. This Table is useful to understand the similarities and differences between the different levels of explosive power developed by atom bombs (note the different heights and above all, the gradual asymmetry between the diameter and the thickness of the Cloud as the explosive power increases). With Table XII this is one of the most important, together with other Tables (VII-XVII) which are considered essential, because they can be used with the Nomogram for predicting Fallout in case of emergency.

Table XIII – Characteristics of the atomic mushroom, with the Cloud stabilized, after 10 minutes

Explosive power, In kilotons	Height of Cloud from ground in km a) from base	b) from summit	Thickness of Cloud in kms	Diameter of Cloud in kms	Arrival time of Cloud to ground
20,000	22	37	15	130	5 hours
8,000	17	31	14	80	4.5 hours
3,000	16	26	10	56	4 hours
1,000	13	21	8	35	3.5 hours
300	11	17	6	25	3 hours
80	9	14	5	12	2.5 hours
20	7	11	4	7	2 hours
10	6	9	3	5	1¾ hours
6-7	4.5	7	2.5	4	1½ hours
3	3	5.5	2.5	3	1 hour
1	2	4	2	2	¾ hour
0.3	1	1.5	0.5	0.5	½ hour

Table drawn up by the Author, based on data partly taken from Difesa N. Tabelle, Nomogrammi e Grafici, Scuola Unica Interforze difesa NBC, Rome, Cecchignola, 1980

Table XIII has 4 different considerations:

First consideration (the starting time of Fallout) - At first sight, the time at which the base of the atomic Cloud (the last column) falls would lead one to assume a certain lapse of time which would allow the population downwind of the Cloud to take shelter, above all in the case of an explosion of high power: but this contradicts what is reported in Table XII, concerning the time predicted for the arrival of Fallout in the Black Zone: Fallout which, to simplify terminology, we will call Black Fallout.

In reality, this apparent contradiction is resolvable considering that that which begins to fall immediately after the explosion, downwind from the Black Point, is the atomic Stalk of the mushroom cloud, with a 'hot' radioactivity, as hot as that or even hotter than that in the Cloud.

The fall-time of the base of the atomic Cloud has therefore only the function of better defining the dynamics of the Fallout's fall to earth, but it must not be thought that before this reaches the ground the radioactivity from Fallout has not already reached the ground because this would mean the atomic Stalk is not being taken into consideration.

Second consideration (colorimetric classification of Fallout) - According to this work, concerning the proposed classification of the different radioactive zones into Black, Gray, Red, Orange, Yellow and White Zones, it will also become clear that the progress of Fallout from the Stalk, and then from the Cloud, will give rise to a Fallout classifiable in terms of Black, Gray, Red, Orange, Yellow and White Fallout. However, it would be a mistake, in order to predict Fallout, to divide it into Fallout from the Stalk and Fallout from the Cloud.

The sixth column of Table XIII has, therefore, only a descriptive function, of little importance from a practical point of view, except to show the really big difference in area that Fallout can reach (SEE the Nomogram in Figure I) if it is caused by a low power explosion (20 kilotons), medium power (300 kilotons) and high power (20,000 kilotons): three different types of Fallout which begin to fall to the ground with the lowest part of the base of the Cloud (and no longer with the Stalk) respectively after 2, 3 and 5 hours after the explosion, but by now with a radioactive level of Red Fallout (2 hours after the explosion), Orange Fallout (3 hours after the explosion) or Yellow Fallout (5 hours after the explosion. It is therefore no longer characterized by Black or Gray Fallout, which are already present at ground level in the black Zone and the Gray Zone respectively, because of the radioactive Stalk which deposits these immediately on the ground.

It is, however, appropriate to put together both the components of Fallout (Stalk and Cloud) referring only to Table XII (column 2: the arrival time of Fallout) to know the initial values of radioactivity, which in their turn are the cause of the different levels of intensity of doses according to which, on the basis of the present work (Table XIV) the radioactive zones have been classified as Black, Gray, Red, Orange, Yellow and White.

One must therefore recognize the practical advantage of dividing the Fallout levels measurable in the first hours of radioactive Fallout into Black, Gray, Red, Orange, Yellow and White, because these allow us to understand better the level of danger of Fallout: a Fallout at the beginning of 150 RAD/hour is obviously less serious than a Fallout at the beginning of 450 RAD/hour.

It is, however, extremely useful to have a colorimetric classification of initial Fallout (Black, Gray, Red. Orange, Yellow or White Fallout) as shown in Table XIV, as a more valid simplification of the estimates of biological risks which come in the hours following an atomic explosion.

In Table XIV this question is summarized, in terms of practical use to decide on the steps to take to protect civilians.

Table XIV – Levels of Fallout at start of fall (*)

Time of arrival of Fallout after explosion	Intensity of dose RAD/hour at start of Fallout	Fallout level on Day After (24 hours after explosion) in RAD/hour	Resultant Zone Level
< 30 minutes (black)	>4,500 (black)	100	Black
> 30 minutes (gray)	>1,000 (gray)	20-25	Gray
2 hours (red)	450 (red)	10	Red
3 hours (orange)	150 (orange)	3	Orange
5 hours (yellow)	50 (yellow)	1	Yellow
8 hours (white)	5 (white)	0.1	White

(*) Initial Reference Dose at start of Fallout (SEE also Table XII)
Table drawn up by the Author based on data partly taken from:
1. Glasstone C.D. The effects of Nuclear Weapons, Atomic Energy Commission, Rome 1959
7. Fowler J. Fallout: le precipitazioni radioattive e il futuro dell'umanità, Milan, Bompiani 1961
8. Dieta G. Progetto Fallout, per sopravvivere il giorno dopo, SugarCo Edizioni, Milan 1984

Third consideration (the colorimetric classification of zones on the basis of Fallout) - The Day After is used for measuring the beginning of radioactivity on the ground, that is the day after and possibly exactly 24 hours after the explosion, because the period when Fallout is finally deposited on the earth is variable, and depends on two factors:
1) the diameter of the Cloud
2) fictitious wind speed.

This period of deposition is directly proportional to the diameter of the Cloud, but inversely proportional to the fictitious wind speed. In practice, knowing the diameter of the Cloud in kilometer, and the wind speed in kilometers per hour one can easily find the period of time which the atomic Cloud will take to deposit itself completely onto the ground. Obviously it is important to know, in approximate terms, the moment when the base of the Cloud touches the ground, as indicated in column 6 in Table XIII. From that precise moment the phase of depositing Fallout from the Cloud itself has begun (in addition to that from the atomic Stalk, which has already deposited). It is a period of time that can be very long, because of the diameter of the Cloud (SEE column 5 in Table XIII). For example, in the White Zone, where Fallout occurs just 8 hours after the explosion, if we estimate a very long time of deposition of the atomic cloud because of: :
a) the large diameter of the Cloud, because of the high power of the explosion (e.g. 20,000 kilotons)
b) very little wind (e.g. 5-6 km/h)

one can immediately obtain the data that Fallout starting from the lowest part of the Cloud would begin depositing at +5 hours: (N.B. therefore Yellow level Fallout according to the bottom of Table XIV), according to the sixth column of Table XIII (deposition beginning in the White Zone, and therefore White Fallout, at +8 hours, SEE Table VIII). But since the Cloud has a diameter of 130 kilometers (Table XIII), with a wind of from 5-6 km/h, it would take 130 divided by 8, that is 16 hours and a half, to deposit completely, still beginning from the moment when the base of the Cloud began to touch the ground (that is, +5 hours after the explosion), to a total of +25.5 hours. The first measurement of Fallout taken exactly 24 hours after the explosion (the Day After), could theoretically be considered optmum, given that the Fallout has been almost completely deposited in a situation where there is the most prolonged deposition on the ground imaginable (very high powered nuclear device with almost no wind). For practical purposes the confirming measurement should be put off to 72 hours, so that staff would be less exposed.

Fourth consideration (predicting a calculation of the intensity of the dose in the following months) - Simplified calculation systems help to predict the intensity of the dose on the ground in the different areas, at a distance of time from the first measurements taken on the Day After or on the third day (Table XIV).

The decrease in the radiation and therefore the intensity of the dose estimated (in RAD/hour) can be calculated with two different systems, which used together allow us to predict fairly accurately the levels of radiation in the following days, weeks and months.

First system: halving the radiation for every doubling in time - If at a certain number of hours after the explosion (for example +9) the intensity of the dose, expressed in RAD/hour, is equal, (for example) to 66 RAD/hour, after a number of hours double those mentioned above (therefore +2x9=18) the intensity of the dose, expressed in RAD/hour, will be half the value of that mentioned above (66 RAD hour), that is, 33 RAD/hour.

Another example: if at a certain number of hours after the explosion (for example: +20) the intensity of the dose, expressed in RAD/hour, is equal to, (for example), 50 RAD/hour, after a number of hours double those mentioned above (that is +2x20=40), the intensity of the dose, expressed in RAD/hour, will be half the value of that mentioned above (50 RAD/hour), that is 25 RAD/hour.

If we increase the number of passes, however, the numerical values that are obtained no longer reflect the real radioactive Fallout, therefore it is advisable not to do more than 2-3 passes. It is always necessary to start from an actual Geiger counter measurement, or calculated using the second system as reported below, based on the *Rule of 7*, which is much more reliable.

Second system: the rule of 7 - Radioactivity decays 10 times for every 7-fold increase in time (Table XV).

Table XV – decay of radiation with the Rule of 7

Reference time, expressed in hours after the Initial Reference Dose at start of Fallout has been measured (*)	Decay of Radioactivity
7 X 1 = 7 hours	1/10
7 X 7 = 49 hours (2 days)	1/100
7 X 7 X 7 = 15 days	1/1,000
7 X 7 X 7 X 7 = 3½ months	1/10,000

(*) measurement done at start of Fallout (SEE Tables XII and XIV). If measured at + 24 hours from explosion, multiply the result obtained by the corrective factor 45. If measured at + 72 hours from explosion, multiply the result obtained by the corrective factor 450.
Table drawn up by Author

From Table XV one can deduce that the initial radioactivity, measured at hour 1 (for example: 3,000 RAD) reduces by 10 times after 7 hours, becoming 300 RAD/hour. It reduces by 100 times after 7x7 hours (= 49 hours, that is, 2 days), becoming 30 RAD/hour. It reduces by a 1,000 times after 7x7x7 hours (= 15 days, that is, 2 weeks), becoming 3 RAD/hour. It reduces by 10,000 times after 7x7x7x7 hours (= 3 and a half months), becoming 0,3 RAD/hour.

This formula, if it is applied on the basis of outside measurements taken at different times from the two times indicated above (+24 hours or + 72 hours after the explosion), must be corrected by multiplication factors [364] not reported in this work. They are needed to obtain the initial reference doses at the beginning of Fallout (column 3 Table XII). The multiplication factors are equal to 45 (if the measurement is taken at +24 hours) or 450 (if the measurement is taken at +72 hours).

One can therefore state the following practical rules:

1) Measure the Fallout, at a meter from the ground, at exactly 24 hours from the atomic explosion. Then multiply the values x 45, and then begin with the rule of 7 (Table XV) or:
2) Measure the Fallout, at a meter from the ground, at exactly 24 hours from the atomic explosion. Then multiply the values x 450, and then begin with the rule of 7 (Table XV).

Vice versa, in the event of a lot of nuclear explosions at ground level, and not knowing the number of each atomic explosion or where it takes place, one can use Haaland's Nomogram [364] (SEE Figure 8). It is not reported in this work but it is useful because it helps us know the age of the Fallout (that is, how old it is with respect to the atomic explosion it comes from), on the basis of simple measurements, using a Geiger, of two separate values of radiation taken in the same place, at one meter from the ground, but at two different times, subtracting the smaller value from the larger one and then using Haaland's Nomogram which allows us to calculate the level of intensity of the dose in the following hours and days, without needing to multiply the values of radiation measured by the Geiger by other figures.

However it has been considered more useful to report in Table XVI, as a summary, the intensity levels of the dose in RAD/hour, measured one meter from the ground, within the first 72 hours after the last atomic explosion referred to, because it is easier to use practically and mnemonically. In Table XVII the intensity levels of the dose have been reported in milli-RAD/hour, measured one meter from the ground, at different times after the fall of the Fallout, in the different zones of radioactive contamination, from the seventh day after the explosion until the sixth month; these too are easy to memorize and therefore of practical use.

Table XVI – Levels of dose intensity in RAD/hour, measured at 1 meter from the ground, at different times after Fallout, in differe zones of radioactive contamination.

Zone	Levels of Fallout in RAD/hour					
	At start of Fallout (*)	Second hour of Fallout	7 hours after start of Fallout	(+24) Day After	+ 48 hours	+ 72 hours
Black	> 4,500	>3,000	450-500	100	45-50	10
Gray	>1,000	1,000	100	20-25	10	2
Red	450	300	50	10	5	1
Orange	150	100	15	3	1-2	0.3
Yellow	50	30	5	1	0.1	0.1
White	5	3	0.5	0.1	0.05	0.01

(*) Initial Reference Dose at start of Fallout (SEE also Table X)
Table drawn up by the Author based on data partly taken from:
1. Glasstone C.D. *The effects of Nuclear Weapons*, Atomic Energy Commission, Rome 1959
7. Fowler J. *Fallout: le precipitazioni radioattive e il futuro dell'umanità*, Milan, Bompiani 1961
8. Dieta G. *Progetto Fallout, per sopravvivere il giorno dopo*, SugarCo Edizioni, Milan 1984

Table XVII – Levels of dose intensity in milli-RAD/hour, measured at 1 meter from the ground, at different times after Fallout, different zones of radioactive contamination

Zone	Levels of Fallout in milli-RAD/hour					
	After 1 week	After 1 month	After 2 months	After 3½ months	After 6 months	After 2 years
Black	4,500	3,000	300	100	30-90	20
Gray	1,000	250	80	20-25	15	5-7
Red	450	100	30	10	3-9	2
Orange	150	30	8-10	3	1-2	1
Yellow	45-50	10	3	1	0.3	0.2
White	5	1	0.3	0.1	0.03	0.01-0.02

Table drawn up by the Author based on data partly taken from:
1. Glasstone C.D. *The effects of Nuclear Weapons*, Atomic Energy Commission, Rome 1959
7. Fowler J. *Fallout: le precipitazioni radioattive e il futuro dell'umanità*, Milan, Bompiani 1961
8. Dieta G. *Progetto Fallout, per sopravvivere il giorno dopo*, SugarCo Edizioni, Milan 1984

A colorimetric scale (SEE Table VIII) for practical and mnemonic use.

For all the Tables considered up to now (Tables VII-XVII), one can also assume, for practical and mnemonic use, a precise scale value for all levels of radioactivity on the ground after a nuclear explosion (Table VIII), identical to the table (Table VIII) for accident to nuclear power station . This colorimetric scale is derived from the Nomogram (Figure 1) used for predicting nuclear Fallout, and is described hereafter.

Using a Nomogram to predict Fallout of explosion nuclear of atomic bomb: calculating the extension of different radioactive zones on the basis of the estimated power of the atomic bomb and the relative wind speed

These estimates can be easily deduced by the Nomogram for predicting Fallout, in Figure I, with the explanation summarizing use in Table VIII and X. Basically, if we know the place of the explosion, the power of the explosion, the actual wind direction and the fictitious wind speed (information which should be available via radio within the first half hour after the explosion) we can connect Point A (the power of the explosion) with a line to Point B (fictitious wind speed). The line will indicate Point C in the distance downwind column, which will indicate the distance, from Zero Point of the explosion, of the border between the Red Zone and the Orange Zone, expressed in kilometers. In the case of an underground nuclear explosion (demolition atomic mines or laser bombs for "hard targets"), for depths near the surface, that is, not more than 10 meters below ground or 30 meters below water, Point C must be calculated as 2.5 times more than that shown on the Nomogram. Therefore (SEE the Nomogram in Fig. I and Table X):

- The border between the Gray and Black Zones will be equal to a quarter of the value indicated by Point C.
- The border between the Red and Gray Zones will be equal to half the value indicated by Point C.
- The border between the Orange and Yellow Zones will be equal to double the value indicated by Point C.
- The border between the Yellow and White Zones will be equal to four times the value indicated by Point C.
- The White Zone will extend 8 times as far as the value indicated by Point C.

Example n. 1: Estimate the downwind extension of Fallout from an atomic bomb of 60 kilotons, with a wind of 20 km/h

Calculation: Point C = 30 kms (SEE Nomogram Figure 1). Therefore:

- The border between the Black and Gray Zones: Point C (in kms) divided by 4 = 7.5 kms.
- The border between the Gray and Red Zones: Point C (in kms) divided by 2 = 15 kms.
- The border between the Red and Orange Zones: Point C (in kms): 30 kms.
- The border between the Orange and Yellow Zones: Point C (in kms) multiplied by 2 = 60 kms.
- The border between the Yellow and White Zones: Point C (in kms) multiplied by 4 = about 120 kms.
- End of the White Zone: Point C (in kms) multiplied by 8 = about 240 kms.

Example n. 2: Estimate the downwind extension of Fallout from an atomic bomb of 1,000 kilotons, with a wind of 25 km /h

Calculation: Point C = 100 kms (SEE Nomogram Figure 1). Therefore:

- The border between the Black and Gray Zones: Point C (in kms) divided by 4 = 25 kms.
- The border between the Gray and Red Zones: Point C (in kms) divided by 2 = 50 kms.
- The border between the Red and Orange Zones: Point C (in kms): 100 kms.
- The border between the Orange and Yellow Zones: Point C (in kms) multiplied by 2 = 200 kms.
- The border between the Yellow and White Zones: Point C (in kms) multiplied by 4 = 400 kms.
- End of the White Zone: Point C (in kms) multiplied by 8 = about 800 kms.

FIGURE 9-A, 9-B, 9-C, 9-D, 9-E, 9-F, 9-G: Estimate the downwind extension of Fallout from an atomic bomb in Milano, of 20, 100, 300, 1,000, 2,000, 20,000 kilotons, with a wind of 24 km/h

Estimating the power according to the duration of the atomic blast

The power of the explosion is detected by spy satellites, which on the basis of the duration of the blast (Table XI) provide the estimated power of the device. The duration can also be estimated on the ground by observers who have survived the explosion. On the other hand the psychological and physical shock when faced with such an event renders the reliability of the people involved highly debatable, even if they are far away from the mushroom cloud. Furthermore, the observation of the duration of the blast, even if this occurs a good distance away and therefore without immediate danger to life (for example: 80 kms) is nonetheless extremely dangerous because of the damage caused to the retina. The intensity of the light of the blast (30 times more than the sun at midday [[1,7]]) is identical for any energy it produces; it is only the duration that changes (Table XI).

Table XI – Duration of the atomic blast according to explosive energy

Duration of blast in seconds	Explosive power in kilotons
1	2.5
2	10
3	22
4	40
5	60
6	90
7	125
8	160
9	200
10	250
11	325
12	475
16	700
20	1,000
50	20,000

Table drawn up by the Author, based on data partly taken from “Difesa N. Tabelle, Nomogrammi e Grafici, Scuola Unica Interforze per la difesa NBC, Rome, Cecchignola, 1980

Estimating the power according to the shape of the atomic Cloud

From Table XIII it is useful to focus attention on columns 5 and 6 which show, respectively, the thickness of the Cloud and its diameter. Ignoring the size of the cloud, expressed in kilometers, which is in any case practically impossible to calculate the observer, when the atomic cloud has stabilized, that is 10 minutes after the explosion, will only have to observe the dimensional ratio between the thickness of the Cloud and its diameter, remembering these simple values:

- for explosive powers less than 3 kilotons, the two dimensions are equal;
- for powers up to 80-100 kilotons the diameter of the Cloud is about double that of its thickness:
- for powers of 300-1,000 kilotons, the diameter is four times more than the thickness;
- for powers up to 3,000 kilotons, the diameter is 5 times more than the thickness;
- for powers up to 8,000 kilotons, the diameter is 6 times more than the thickness;
- for powers up to 20,000 kilotons the diameter is 9 times more than the thickness

FIFTH PART:

Residual radioactivity from Caesium 137, Strontium 90 and Iodine 131, Uranium and Plutonium.

Comparisons of this residual radioactivity between Fallout from atomic bomb and Fallout from civil nuclear reactor

The aim of this section is to compare the Fallout from an accident at a nuclear power station (SEE also the third part) with the Fallout from an atomic bomb in order to know whether it is possible to estimate the quantities of Caesium 137 and Strontium 90 present in the various areas.

The Fallout from an atomic explosion is much more radioactive than that deriving from a nuclear power station. For an in-depth study SEE for example *Minerva Medica*, August 2002, Vol. 93, No. 4, pages: 227-273.

Table IX and XII show different levels of radioactivity in the various "hot" areas (Black, Grey, Red, Orange, Yellow, White Zone), from nuclear explosion of atomic bomb (Table XII) and from accident of nuclear power station (Table IX).

This paper will focus on the levels of radioactivity in the medium-long term, comparing the values of a Fallout from a nuclear power station (SEE Table IX, Figure 6-A, 6-B, 6-C, 6-D, 6-E, 6-F) with those from a Fallout from an atomic explosion on the ground, for example, in a big city, as Milano (SEE Table XII and Figure 9-A, 9-B, 9-C, 9-D, 9-E, 9-F).

Table XII highlights the very high dose intensity released by the Fallout induced by explosion of an atomic bomb on the ground, as against that deriving from a nuclear power station (Table IX). Afterwards, instead, in the medium-long term, the Fallout caused by an accident at the nuclear power station remains more radioactive.

From the seventeenth day after a hypothetical explosion of an atomic bomb on the ground, the levels of radioactivity would tend to decrease further, but more slowly and with greater differences between them. Thus there would be a practical sub-division of the Black Zone into Black Zone A (the area of highest contamination, covering about 1/3 of the Black Zone) and Black Zone B (with lower contamination compared to Zone A). Similarly, the Red Zone would be divided into Red Zone A (the area of highest contamination, covering about 1/3 of the Red Zone) and Red Zone B (with lower contamination compared to Zone A).

Table XII shows a summary of the Fallout from atomic bomb, proposed by the author, for a practical mnemonic use, with the various doses of radiation expressed in REM, as can be accumulated overall by an individual standing in the open, because these doses of radiation are referred as doses absorbed one metre from ground level. Therefore an individual bending over or lying down will absorb a much higher dosage: if a dose at one metre = 1, then: a dose at 50 cm = 1 x 4; a dose at 30 cm = 1 x 11; a dose at 10 cm = 1 x 100; a dose at 1 cm = 1 x 10,000.

Table VII and Figure 5 shows comparisons among the different levels of radioactivity of the two types of Fallouts (nuclear explosion of atomic bomb and accident to nuclear power station, considering the highest contaminated zone as the reference "hot" area, i.e. the Black Zone A.

First of all, we will consider the quantities of Strontium 90 and Caesium 137 deriving from nuclear explosions of atomic bomb on the ground. Then, we will analyse the contamination from Caesium 137 and Strontium 90 also in the case of a Fallout caused by an accident at a civil nuclear reactor, considering the terrible disaster of Chernobyl as example.

Substantially, the predictive estimate of radioactive fall which can be obtained using the Nomogram in Figure I will provide all the measurements of radioactivity foreseen in the first 6 months. The colorimetric classification of the different areas, shown in Table VIII, will also be useful to understand the biological risk deriving from the residues of gamma radiation due to a great extent to Cesium 137, and to the residual contamination of agricultural land by Strontium 90; we can thus obtain a long range picture of the dangers deriving from the cultivation of this soil. There follows a description of the risk estimates keeping in mind that the calculations are approximate.

Table XVIII – Contamination at ground level by Cesium 137 after an atomic explosion

Hot Zones	Cesium 137 at ground level	Gamma emission from Cesium 137	
	Micro/Curie 10 dm^2	Milli-RAD/hour at 1 meter from ground level	RAD/month at 1 meter from ground level
White Zone	0.03	0.03	0.02
Yellow Zone	0.3	0.3	0.2
Orange Zone	1.5	1.5	1
Red Zone B	3	3	2
Red Zone A	9	9	6
Gray Zone	15	15	10
Black Zone B	30	30	20
Black Zone A	90	90	60

Table elaborated by the Author according to data partly taken from:
1. Gladstone C.D. *The effects of Nuclear Weapons*, Atomic Energy Commission, Rome 1959
7. Fowler J. Fallout: *le precipitazioni radioattive e il futuro dell'umanità*, Milan, Bompiani 1961
8. Dieta G. *Progetto Fallout, per sopravvivere il giorno dopo*, SugarCo Edizioni, Milan 1984

Cesium 137

Around the sixth month radioactivity is thought to be almost all due to Cesium 137, which could therefore be considered the parameter for measuring the contamination from Fallout dust, according to Table XVIII.

In this last Table, on the basis of various American estimations [1,7] the dose of radiation expressed in milli-RAD/hour, refers to one meter from the ground. Therefore an individual lying on the ground will absorb a much higher dose. Again in Table XVIII one can see that the level of radioactivity from Cesium 137, foreseen in the White Zone (0.03 milli-RAD/hour) is higher than the level of natural (Background) radioactivity currently present in the world [38] and is equal to about 0.015 milli-RAD/hour, or even less, as in North Italy (0.008 milli-RAD/hour).

As will be noted, the schematic division of the Fallout in these colorimetric plans are principally of practical use, with easy data to remember. In this sense the second column of Table XVIII has been completed with measurements in micro-Curie/10 dm^2 of land, and not in nano-Curie, Becquerel or any other measurements, for the simple reason of making the data as similar as possible (in fact they have been rounded up) to those in column three of the same Table, which are expressed in milli-RAD/hour.

The values shown in the Table have been applied by the author, on the basis of values of Cesium 137 in Black Zone A (850-900 Curie/km^2), deduced on the basis of three considerations:

1) American calculations in the 1950s and 60s gave an approximate estimation at the sixth month of Fallout of about 60 RAD/month, almost all deriving from Cesium 137 [[7]].
2) American calculations in the 1950s and 60s considered that half the dose absorbed came from Cesium 137 situated within a range of 10 m from the Geiger positioned at one meter from the ground [[7]].
3) The quantity of Cesium 137 on the ground is thought to be equivalent to that of Strontium 90, on the basis of work done in 1959, where the quantity of Cesium 137 produced by the explosion was 6%, and that of Strontium 90 5% [[6]], for every 50 g of radioactive isotopes deriving from fission [[1,6,7]]. The concentrations of Strontium 90 calculated by the Americans were equal to about 75-780 Curie/km^2 for the most contaminated areas [[7]], and they were therefore considered credible for estimating local Fallout.

A calculation was then made to verify the correlation between the concentrations of Cesium 137 on the ground expressed in micro/Curie/10 dm^2 (second column, Table XVIII), and the gamma intensity of the same resulting radio-isotope (third column, Table XVIII), looking for the amount of Cesium 137 present within a range of 10 m in Black Zone A, and then correlating it with half the ionizing dose of Cesium 137 estimated at one meter from the ground by the Americans in 1961 [[7]] equal therefore to 30-32 RAD/month, that is, equal to 45 milli-RAD/hour. Given that in Table XVIII the estimated amount of Cesium 137 in Black Zone A, within an area of a 10 m radius (31,415 dm^2), is equal to 0.282 Curie (author's estimate) and supposing that the whole area were completely decontaminated (in practice impossible), and that all the Cesium 137 were put in one place, therefore making it similar to a punctiform source, and supposing that a Geiger were positioned at a distance of one meter, one could therefore estimate that the real gamma dose at a distance of one meter, of all the Cesium 137 previously distributed in that area of a ten meter radius, according to the formula of Constant Specific Gamma of the desired radioisotope (in this case Cesium 137) multiplied by its own Emission Fraction. One would find that the final value found (70 milli-Roentgen/hour) is very near to the value previously shown in the third column in Table XVIII, and foreseen for Black Zone A.

In fact, the Constant Specific Gamma of Cesium 137 is equal to 0.3 Roentgen/hour/1m/Curie [9], and the Emission Fraction of Cesium 137 is equal to 0.84 [[365]].

Therefore 1 Curie of Cesium 137 will be equal to 0.3 Roentgen/hour/meter. Multiplying this value by the following Emission Fraction of Cesium 137, equal to 0.84, we find that 1 Curie of Cesium 137 gives 0,25 Roentgen/hour/meter.

Therefore 0.282 Curie of Cesium 137 (Black Zone A within a 10 m radius) will be equal to 0.07 Roentgen/hour/meter: a value which goes well with those theoretically predicted and reported in Table XVIII.

These estimates, referring to Cesium 137, should be considered approximate, however.

Considering that Cesium 137 dilutes very little in the earth, one can substantially state that, on the basis of Table XVIII, if the ground is not decontaminated, the residual radioactivity from Cesium 137 will reduce by a half only about every 30 years, which would take us up approximately by one level of color in Table XVIII for every halving period (30 years for Cesium 137).

For example, after 120 years, a piece of land on the radioactive level Black A will be equal to level Red B; a piece of land at Gray level, after 90 years will become an Orange Zone. These estimates are theoretical, however, because they are based on the hypothesis that no substantial alterations occur, caused by atmospheric agents or by decontamination programs carried out by man.

In reality, it can be estimated that a certain percentage of radioactivity will go out of the most contaminated areas, affecting those less contaminated in the course of subsequent decades.

There are, however, no predictable studies of the hydro-geologic type for our national territory, especially concerning the most important agricultural areas such as the Po Valley, Central Italy and the Apulia plateau.

Strontium 90

The system of classification proposed in this work (Table VIII) also works well to measure the radioactive concentration of pure beta emission isotopes; it is therefore useful in the case of radio-nuclides that are particularly serious for the food cycle of the population, such as Strontium 90 (Tables XIX-XX).

If we refer again to the American predictions, already cited, for Strontium 90 concentration at ground level following a thermal-nuclear global conflict [[7]], these concentrations were considered variants from 10 to 3,000 times the level derived from Fallout of more than 200 experimental atomic explosions during the 1950s and 60s. They corresponded in the USA to about 25 milliCurie per km^2, equal to 10 units deposited in the skeleton of an average American child (1 Unit of Strontium 90 is equivalent to $1x10^{-12}$ Curie of Strontium 90 per gram of Calcium): these 10 Units of Strontium 90 were considered to be equal to about 6 REM of total irradiation foreseen for the subsequent 70 years (about 2 REM in 25 years [[7]]). Those works considered as negligible the percentage of Strontium 90 which would be eliminated from the skeleton in the following decades, and of little relevance the further accumulation of Strontium 90 in adulthood. Therefore, this irradiating dose was considered a possible future cause of leukemia, with a number of cases of between 0.2 and 0.6 per 100,000 cases for every REM accumulated in the subsequent 70 years, and a smaller percentage of bone cancers.

According to the author, these values should be modified on the basis of worse results from UNSCEAR from 1988 [[21]]. They raised the values to 8.5 of cases of leukemia within 25 years for every REM accumulated by 100,000 people, with the addition of 5 cases of bone cancer within 50 years and 15 cases of Multiple Myeloma also within 50 years (Table II).

These worse values, reported in Table II; refer to instantaneous exposure to gamma radiation, however, and not to chronic exposure to Strontium 90 beta rays, which deposits itself in the bones and stays for the 70 years following absorption: therefore the values referring to the percentage of leukemia, reported in Table XIX, should be slightly modified. Similarly, this should also apply to the rise of bone cancers in the population, calculated over a 50 year period of time.

On the basis of American studies [[7]] and on what is reported in Table II, concerning UNSCEAR values from 1988 [[21]], one would estimate in any case, in the absence of more precise data, that each Unit of Strontium 90 must give the bone marrow 2 REM in 25 years, 4 REM in 50 years and 6 REM in 70 years.

Strontium 90 is probably the most dangerous radio-nuclide of all those produced by an atomic explosion, because this is easily dissolved and absorbed by the gastrointestinal system, differentiating it from almost all other radioisotopes. In an adult, where only 5% of the skeleton tends to renew itself with new calcium, with the possibility therefore of assimilating Strontium 90 too (because it is very similar to calcium), one finds the accumulation of this radio-nuclide can be considered negligible. Vice versa, children develop quickly: from the first to the fifth year their skeletal weight increases by 20% a year [7]. The nutrition they receive is therefore crucial: a diet based on cereals would result in an incredibly high percentage of this radioisotope in children (Table XX). Vegetables would be dangerous too: assuming that the presence of Strontium 90 in the soil is equal to 1, a diet based only on vegetables could give higher estimates than those, already serious, reported in Table XIX, as can be demonstrated by comparisons from the 1950s which had documented accumulations of Strontium 90 130 times higher in the bones of rats than those of the same radio-nuclide contained in plants and the surrounding soil.

Table XIX – Levels of Fallout from Strontium 90 at ground level. Relative units accumulated in children, and % of tumors estimated

Hot Zones	Ground level Strontium 90 Micro/Curie/ 10 dm^2 (♣)	Units of Strontium 90 absorbed with diet (♦)	Leukemias In 25 years from 2 REM/Units of Strontium 90 accumulated by 100,000 children (♣)	Bone tumors in 50 years from 2 REM/Units of Strontium 90 accumulated by 100,000 children (♣)	Multiple myel. in 50 years from 2 REM/Units of Strontium 90 accumulated by 100,000 children (♣)
Present level	0.0025 (♣)	10 (♣)	17	10	30
White	0.025	100	170	100	300
Yellow	0.25	1,000	1,700	1,000	3,000
Orange	1.2	5,000	8,500	5,000	15,000
Red B	2.5	10,000	17,000	10,000	30,000
Red A	7.5	30,000	50,000	30,000	90,000
Gray	12.5	50,000	All	50,000	All
Black B	25	100,000	All	All	All
Black A	75-80	> 300,000	All	All	All

(♣): in Table XIX this is estimated at 15 Units. In Japanese children it was estimated at around 50 Units [7].
(♦): One Unit of Strontium 90 is equivalent to $1x10^{-12}$ Curie of Strontium 90 per gram of Calcium. It is estimated that 1 Unit depo REM in 25 years, 4 REM in 50 years, 6 REM in 70 years [7].
(♠): UNSCEAR in 1988 21 increased its estimates to 8.5 cases of leukemia within 25 years for every REM accumulated by each of 10 people, with an additional 5 cases of bone tumor within 50 years and 15 cases of Multiple Myeloma, again within 50 years (SEE Tab These values refer, however, to instantaneous exposure to gamma radiations, and not to chronic exposure to beta rays from Strontium 70 years, as researched in this study.
Table elaborated by the Author according to data partly taken from: Fowler J. Fallout: *Le precipitazioni radioattive e il fu dell'umanità*, Milan, Bompiani 1961 and from: UNSCEAR 1988 "*United Nations Scientific Committee on the Effects of Ato Radiation,* 1988", *Sources, Effects and Risks of Ionizing Radiation*, United Nations, New York, 1988.

Table XX – Strontium 90 assimilated in the diet of an average American in 1958

Food	Quantity of Calcium absorbed in a year, in grams	10^{-12} Curie of Strontium 90 found in 1 gram of Calcium	Total Units of Strontium 90 (*) by food
Meat	20	5	100
Dairy products	233	7.8	1,818
Potatoes	22	12.2	268
Fruit and Vegetables	80	14.5	1,160
Cereals	18	125	2,250
Total	373	164.5	5,594

(*): One Unit of Strontium 90 is equivalent to $1x10^{-12}$ Curie of Strontium 90 per gram of Calcium. American studies concluded that of the 5,500 Units of Strontium 90 contained in 373 grams of calcium consumed in the diet in one year, 15 Units would be deposited in the skeleton of the average American (not reported whether adult or child).
Table elaborated by the Author according to data partly taken from: Fowler J. *Fallout: le precipitazioni radioattive e il futuro dell'umanità*, Milan, Bompiani 1961, page 91.

Table XXI - % of accumulation in foods of Strontium 90 able to be assimilated in a population with a diet totally lacking in cereals, fruit, vegetables and dairy products, and with potato consumption increased threefold.

Food	Quantity of Calcium absorbed in a year, in grams	10^{-12} Curie of Strontium 90 found in 1 gram of Calcium	Total Units of Strontium 90 by food
Meat	20	5	100
Potatoes	66	12.2	805
Total	86	17.2	905

Table elaborated by the Author according to data partly taken from Table XIX and XX.

As regards cows milk, it must be added that as the fodder turns into milk there is a certain discrimination between Calcium and Strontium 90 by the cow, but the percentage of Strontium 90 which gets into the milk is nonetheless very high: babies should therefore always be breast fed, because a woman, being adult, has little Strontium 90. Any dairy products should be eliminated from her diet. The milk itself, the crops grown in contaminated areas, the fruit and the green leaf vegetables should guarantee the child a diet free from Strontium 90. Vice versa, as regards dairy cows, they should not be put out to pasture for many decades (except in the White and Yellow Zones), but should only be fed on fodder coming from soil with a low Strontium 90 content (perhaps the Orange Zone, but definitely the Yellow and White Zones). Furthermore all children should have a supplement to their diet of tablets of alginate of Calcium or Sodium: a natural polysaccharide used in the confectionery industry today, which has shown that it can reduce from 50% to 80% the absorption of Strontium 90 by the intestine [6,8,366]. Dolomite, a calcium compound made up with 40% of magnesium carbonate has also been proposed [8]. It is of course useful to integrate the diet with vitamins, mineral salts and anti-oxidants from herbal therapy origins.

The ratio of accumulation of Strontium 90 between cereals on the one hand and all other foods, including milk, is 10 to 1 (Table XIX). This, therefore, makes a diet of grain impossible for man. Probably, the most suitable energy-giving substitute for cereals is the potato, because its accumulation of Strontium 90 is 10 times less, even if it is still high (Tables XX and XXI), because it is similar to that of milk, fruit and vegetables.

Overall evaluation of Cesium 137, Strontium 90 and other radio-nuclides

The seriousness of the environmental damage on the ground from Cesium 137 and Strontium 90 is due to their long period of physical half-life (28 years for Strontium 90 and 30 years for Cesium 137). Both enter the human food chain (Tables XVIII-XXI) [1,6,7,26,27] but they differ from each other in different ways, which need different protection techniques.

Unlike Strontium 90, Cesium 137 is not cumulative in the organism, because about a half is eliminated over 0.5-6 months [1,6,7]. For this reason it is a lot less dangerous in the long term than Strontium 90. It is, however, still dangerous because it is a *gamma* emitter. Thus Cesium 137 is dangerous even if it is on the outside of an organism, unlike Strontium 90 (the latter can cause leukemia or bone cancers only if it is taken in with the diet, because it is a *beta*-emitter, Tables XIX XXI). The threat posed by Cesium 137 is therefore difficult to quantify as in the case of Strontium 90. It can be defined in some way, supposing that it is in a state of equilibrium, in the sense, that is, that Cesium 137 is dangerous for the population only because of its concentration in the ground, whatever precautions are taken to eliminate it from the diet, precautions that one can consider substantially useless (unless the soil can be decontaminated to such an extent that it is equivalent to a Yellow or Orange Zone). The dangers of Cesium 137 are the following:

1) it causes tumors in any organ, because it is everywhere in the organism and it can also cause damage from the outside (gamma radiation can carry about 40 m);

2) it causes genetic mutations in descendants, because it is also present in the testicles and it can also cause damage from the outside (gamma radiation can carry 40 m).

The final difference between these two radio-nuclides lies in the different ways they accumulate in the soil: Strontium 90 penetrates deeply to a depth of more than 30 m, while Cesium stays on the surface: it is thus possible to eliminate it using seedlings with short roots such as grass. Vice versa, with regard to the decontamination of soil from Strontium 90, fertilizing the soil with a calcium-based fertilizer, carried to the limits of tolerability for agricultural land, reduces the absorption of Strontium 90 by the roots of the plants, by only a half [7].

With regard to cultivated foods, potatoes do not absorb Cesium 137 (Table XX), even if they absorb a quantity of Strontium 90 equivalent to about 10% of that absorbed by cereals [7], a fact, which, according to the author, makes the risk of the accumulation of Strontium 90 in the bones (through eating potatoes) negligible, probably completely negligible in the Orange, Yellow and White Zones, and perhaps even in the Red, but only if the earth is not turned. Furthermore, the soil should be decontaminated quickly, using grasses suitable to reduce both the radio-nuclides in the soil before Strontium 90 does any deeper and makes the soil in the Red Zone unusable even for the cultivation of potatoes (in preparation: *'the cultivation of potatoes in areas contaminated by Fallout'*).

The problem of cereals [7] is a serious one because they assimilate both Cesium (Table XVIII) and Strontium (Table XIX) equally well, reaching, in the case of the latter, very high levels.

Cows milk, too, has high levels both of Cesium [6,7,25-27] and of Strontium [6,7] because the cows feed on grass (short roots), and green leaf vegetables which are full of Fallout. Unless it is possible to feed the cows in the barn with uncontaminated fodder and water, it is better not to drink milk in the areas up to and including the Orange Zone, where it is possible to eat potatoes.

The consumption of vegetables, green leaf vegetables and fruit should be forbidden under any circumstances except, perhaps, in the White and Yellow Zones. Fresh vegetables are very important for their anti-oxidant action and their vitamins (thousands of herbal-chemical factors). Some root vegetables, such as carrots, could be used as substitutes and above all the intense cultivation of brown seaweed along the less contaminated coasts, (it would then be dried and made into tablet form). There is a fair amount of Cesium 137 in meat, but the concentration varies a lot according to the animal and the place where it usually grazes. Meat, on the other hand, is not an important source of Strontium 90, but if the bones of the animal are used to make stock for soups, if they are boiled for a long time or cooked in a pressure cooker, then a certain amount of Strontium will pass into the food. Therefore, the consumption of meat or fish can be considered of very little danger, even if they are contaminated with Cesium 137 because of its almost even distribution in the organism rather than concentrations in important points. Vice versa the consumption of liver should be avoided because it is rich in long life radioisotopes (Strontium 90, Manganese 54, Cobalt 60, Zinc 65, Ruthenium 106, Barium 144, Plutonium 241, Cerium 144, Promethium 147, Praseodymium 147, Uranium 238, Radium 226, Samarium 151) as was already shown in Japan in the 1950s [6].

In the event of a possible exposure to Iodine 131 in the Acute and Sub-Acute Period, it may be useful to keep available tablets of potassium iodide, to be given especially to children.

Iodine 131

The irradiation from the inside of the thyroid due to Iodine 131 does not significantly increase the risk of developing thyroid cancers, but the number of individuals exposed to Iodine 131 during the childhood for medical purposes is too low to express a certain judgement on the issue [28]. The minimum latent period between the exposure to radiations and the diagnosis of thyroid cancer is about 5 years, but the effects of radiations persist for decades [28-30].
The risk of developing a thyroid cancer is maximum 20-30 years after exposure, remains high for about 20 years and then slowly decreases.
The younger the individual at the moment of exposure, the higher the risk of developing thyroid cancer: after 20 years of age, the risk is very low or even zero [29,31].
These data – largely confirmed by other scientific literature – show higher radiosensibility of the thyroid in children and teenagers as against in adults [30,32].
The risk of developing thyroid cancer increases in case of exposure to 10 REM doses and it depends on doses.
No reliable data are available for doses lower than 10 REM. Thyroid cancers caused by radiations are almost all well differentiated (papillary and follicular-papillary).

In the Chernobyl nuclear accident, radioactivity doses affecting thyroid were measured after the accident in Ukrainian and Belarusian children and teenagers and they ranged from less than 12 RAD to more than 1,000 RAD, with a median dose of 30 RAD.
About 1% of the children were exposed to a dose of more than 500 RAD.
The number of thyroid cancers was therefore very high [32], from about 0.07-0.3 cases out of 100,000 individuals in paediatric age (similarly to western countries) to 2.5 cases out of 100,000 individuals in paediatric age, with an incidence peak 7 years after the disaster, i.e. 1993.
In the most contaminated areas, the incidence of thyroid neoplasias in paediatric age was 20-60 times higher than previous years. The highest incidence was registered in the youngest subjects – aged less than 7 years – at the moment of exposure. Most of the children who developed a thyroid cancer were less than 1 year old when the accident occurred.
The average latent period between irradiation and diagnosis was definitely shorter (4 years) as against that seen in other thyroid tumours induced by radiations.
Also in adults there was an increase – almost twofold –in thyroid neoplasias during the years after the disaster.
There also was an increase in benign diseases – such as autoimmune thyroiditis, multinodular goiter. In the event of a possible exposure to Iodine 131 in the Acute and Sub-Acute Period, tablets of *potassium iodide* could prove useful, especially for children [367].

Plutonium and Uranium

About 14,000 American soldiers, First Gulf War veterans, died in the last few years because of lymphomas, lung tumours and leukaemias caused by the inhalation of Plutonides and Uranides [379-380].

This fact let people dramatically reconsider the dangerousness of Uranide-234/235/238 and Plutonide-238/239/240 leaked by a Fallout from a nuclear power station and an irresponsible use of so-called "Depleted Uranium" both for civilian and military purposes [512-519].

Also Uranium-238 is one of the 200 radioisotopes which make the effects of a Fallout on the civilian population extremely dangerous for human health. However, even if the natural Uranium-238 is a radionuclide with a very long decay and therefore potentially present in the global ecosystem for a very long period, it is not in the least comparable with metallic Uranium 238 (uranium obtained by man in the form of UO_2 as Fuel: *Uranium dioxide, manufactured ceramic pellets*), and with Plutonium, which on the contrary can be considered together with Caesium-137, Strontium-90 and Iodine-131 one of the most important – and the fourth most dangerous – radionuclide which needs to be considered in case of a Fallout from a nuclear power station and from an atomic explosion on the ground.

Plutonium and other similar transuranic elements are dangerous because they enter the food chain through fruit, vegetables, shellfish, fish, meat, grain, legumes, milk, etc. These radionuclides have a structure similar to that of the above-mentioned Strontium-90 and Caesium-137 and closely simulate the biochemistry of Calcium, Potassium and other chemical elements necessary for human biochemistry. Fortunately their absorption percentage is much lower than that of Strontium-90 and Caesium-137. However, *alpha* emissions of their radiations make them from 5 to 20 times more dangerous than Strontium-90 or Caesium-137 also with the same amount of RAD (Gray) or Curie (Becquerel) emitted.

According to other data, Plutonide-238/239/240 and other transuranic elements could be dangerous especially because they can be inhaled into lungs. Precisely the amount of Plutonium absorbed through inhalation is about 10 times higher than the amount of Plutonium absorbed through ingestion ([372]). In particular, as far as Plutonides are concerned, it was demonstrated that al least 15% of the substances deposited in the lung alveoli reach the lymphatic system (Hodgkin lymphoma and Non-Hodgkin lymphoma), 5% go into the blood stream, thus reaching almost all tissues and organs. 45% of this 5% settle into bones (cancers and bone sarcomas) and affect the bone marrow (leukaemias, multiple myeloma), further 45% settle in the liver and the rest 10% are excreted by kidneys. The rest deposited in the alveoli cause lung cancers [[373,374]].

Plutonium assimilation percentage is at least 10 times higher than that occurring through water or food at the gastroenteric level: according to the data collected by the ICRP in 1972, only 0.003% of Plutonium ingested through food is assimilated by the intestine.

Table XXII: Current amounts of transuranic radionuclides contained in the human body (in not contaminated areas)

alpha-emitting radionuclide	femto-Curie absorbed (per gram of Calcium)
Uranium-238	8-100
Radium-226	4-100
Lead-210	60-320

From "*Exposures from the uranium series with emphasis on Radon and its daughters*." NCRP. Report No. 77

Data from Chernobyl [[370]] allowed to estimate its concentration on the ground in the different areas of contamination. The level of Plutonium-239/240 resulted to be about 1,000 times lower than that of Caesium-137 and Strontium-90.

Unfortunately, concentrations of Plutonium-241 on the ground, though not measured, should be very similar to those of Caesium-137 and Strontium-90, i.e. 1,000 times higher than those of Plutonium-239. Actually, according to Soviet authorities, the leak from Chernobyl reactor was of 6,000 Tera-Becquerel of Plutonium-241, as against a total of 34 Tera-Becquerel of Plutonium-239 and about 40 Tera-Becquerel of Plutonium-240 [[370]].

These data should be reconsidered in the light of the almost imminent use of so-called "depleted Uranium" (containing also plutonium isotopes) both for military purposes (depleted Uranium anti-tank bombs) and civilian applications (in order of dangerousness: inertial counterweights for aeroplane wings and tail rudders [370-500 kg for a Boeing 747, 300 kg for a DC-10], building industry in general, locks of security safes, ship keels, rock drills, engine spark plugs, engine flywheels, microwave ovens, microphones, telephones, earphones, televisions, airbag sensors, underwater snorkels, shots for sporting guns, golf clubs, fishing rods, etc…).
In particular, it must be underlined that although Uranium is a metal, it is pyrophoric, i.e. it tends to burst into flames in contact with oxygen and at high temperatures, thus releasing Plutonium isotopes and other radionuclides [[382, 512-519]].

"Depleted" Uranium is produced in two different ways:
1) enrichment of Uranium-235, where Uranium-238 is partially depleted by Uranium-235, which is used for other purposes and passes from a normal concentration of 0.7% to a final concentration of 0.2%
2) reprocessing of atomic waste after exhaustion of nuclear fuel used to make nuclear power stations work: after a year of functioning, in a nuclear power station 0.5% of Uranium-238 turns into Plutonium-239. After separating the waste, 0.1-0.2% of the above-mentioned 0.5% remains Uranium-238. Modern chemistry is not able to further purify the waste and then completely eliminate all Plutonium-239 [[512-519]].

Supposing that only 20% of the depleted Uranium used today to produce conventional weapons (anti-tank bombs) and/or for civilian building, and/or for civilian aviation, and/or for other civilian purposes has gone out of the reprocessing method and is polluted with Plutonium-239, Plutonium-238, Plutonium-234, Plutonium-240, Uranium-235, Radium-226, Lead-210, Uranium-236, Radium-222, etc., the following considerations can be made:

1) It was estimated that out of about 3,000 tons of "depleted" Uranium used during the first Gulf War at least 2-6 kg of Plutonium were dispersed in the ground, about a half (1-3 kg) as aerosolised nanoparticles, causing environmental contamination conditions similar or worse than those of the most contaminated areas of Chernobyl, i.e. 3-4 Becquerel of Plutonium-239/m^2 within 25 km from the nuclear power station (Grey and Black Zone).
2) In the areas where depleted Uranium weapons were used – Iraq, Afghanistan or former Yugoslavia, Plutonium concentration in the ground might be higher. Actually, according to the U.S. Senatorial Commission, the first Gulf War caused the death of 14,000 American veterans from cancer, lymphomas, leukaemias or other malignant tumours and permanent disability of other 320,000 veterans.

These data make it absolutely clear that depleted Uranium is extremely dangerous (above all because of the Plutonium contained), in every kind of situation:
1) Fallout from nuclear explosions of atomic bombs on the ground;
2) Fallout caused by an accident at a nuclear power station, as happened in Chernobyl;
3) Use of depleted Uranium conventional weapons (Iraq, Afghanistan, former Yugoslavia);
4) Use of depleted Uranium for civilian purposes (locks of security doors, civilian aviation, etc., …)

Plutonium came then into the limelight immediately after the end of the first Gulf War of 1992 and of wars in the Balkans (1991-1999), when the great use of depleted Uranium – probably containing Plutonides-238/239/240) as well – caused an until then unknown effect regarding ("nuclear" or "conventional") Fallouts: the *splashing* effect, i.e. when radioactive particles (the most dangerous are those of Plutonium-238/239) resuspend in the atmosphere because of the wind or rain (differently from the phenomenon known as *wash out*, when the rain drags radionuclides to the ground and that of *rain out*, when radionuclides are dragged to the ground in the form of microdrops, which act as condensation nuclei and are carried by the clouds over long distances before falling to the ground as snow, rain or hail).

In order to understand the extreme dangerousness of Plutonium and other *alpha*-emitting radionuclides, such as those of depleted Uranium, it is necessary to make the following considerations (SEE Table XXIII).

Table XXIII : Plutonides and Uranides

alpha-emitting radionuclide	Radionuclide physical Half-Life (in years)	Source weight (from 1 nano-Curie)	Energy in MeV of emitted Hellion	RAD/year of 1 nano-Curie		
				1 micro-metro	**10** micro-metri	**20** micro-metri
Uranium 238	4,5 x 10E9	33 gram (^) 3,3 milligram (*)	4,2	54	13	1,6
Uranium 235	7 x 10E8	5 milligram (^^)	4,4	58	14	1,8
Uranium 234	2,45 x 10E5	3,2 microgram (°)	4,8	60	20	4
Radium 226	1620	1 nano-gram	4,8	60	20	4
Plutonium 239	24,000	16 nano-gram	5,1	76,5	33,3	11,8
Plutonium 238	86	57 pico-gram	5,6	82,4	36	12,6

From "*Exposures from the Uranium series with Emphasis on Radon and its Daughters. Recommendations of the National Council on Radiation Protection and Measurements", Issued March 15, 1984; page 66.*

(^) Natural Uranium, present in weak traces in uraniferous rocks, where its concentration is about 33 nano-Curie (1.23 E3 Becquerel) of Uranium-238 per 1 kg of rocks (Hendee W.R.: *Health Effects of exposure to low-level-Ionizing Radiation*, pages 366 (Nuclear Power Generation).

(*) Metallic uranium obtained by man in the form of UO_2 (Fuel: *Uranium dioxide, manufactured ceramic pellets*), where its concentration is much higher, nearly 100%, i.e. about 0.3 mille-Curie/kg of metallic bar.

(^^) Metallic uranium obtained by man in the form of UO_2 (Fuel: *Uranium dioxide, manufactured ceramic pellets*), where its concentration is much higher, similar to that of Uranium-238.

(°) From "*Dose factors, dose-to-source ratios, and uranium isotope mass and activity abundances assumed for estimating exposures from DUE-containing products*."

The biological effect of *alpha* radiations on human tissues requires a special treatment.
Alpha radiations (Hellions) have a range of a few dozen microns and 1 RAD is equal to the energy deposited in 1 gram of biological tissue (too big for the range of Hellions). It can therefore be assumed the activity expressed in Curie to be constituted by millions of alpha-emitting microsources.
It can therefore be assumed that this 1 nano-Curie of alpha-emitting radioisotopes is uniformly distributed in a volume of 1 cubic centimetre, 1 gram heavy, constituted by 1 billion healthy human cells, each cubical, with a side of 10 microns and a volume of 1,000 cubic microns, without any empty space between them.

As these are *alpha* radiations, the RAD (Gray) must be converted into REM (Sievert) because of the Relative Biological Effectiveness or R.B.E., which ranges from 5 to 20 for these radionuclides.

As far as this radionuclides is concerned, its effective emission range of hellions is 20 microns. The volume irradiated by one micro-source will be of 34,000 cubic microns, i.e. 34 struck cells, each with a volume of 1,000 cubic microns. It can be assumed that microsources – uniformly distributed in the hypothetical network of one gram of human tissue, which is constituted of 1 billion cells with a side of 10 microns – are about 34,000,000 so as to "cover" each cell with their own *alpha* emissions; in other words, the above-mentioned volume (34,000 cubic microns, i.e. 34 struck cells), with the result of 1 RAD uniformly distributed in 1 gram of human soft tissue, constituted of 1 billion healthy cells.
The radioactivity of each of these microsources will then be about 34 atto-Curie (1,3 micro Becquerel).

At this point, it can be confirmed that these microsources are extremely dangerous. Their dimensions expressed in weight are shown here, on the basis of the previous Table.

Table XXIV: Plutonides and Uranides

alpha-emitting radionuclide	Radionuclide physical Half-Life (in years)	Source weight (from 1 nano-Curie)	Source weight (from 34 atto-Curie)	Amount of radionuclides necessary to reach the same dangerousness as Plutonium 238, which is considered as reference quantity
		33 gram (^) 3,3 milligram (*)	1,12 micro-grams (^) 0,1122 nano-grams (*)	585.000.000 585.000
Uranium 235	7 x 10E8	5 milligram (^^)	0,17 nano-grams (^^)	88.500
Uranium 234	2,45 x 10E5	3,2 microgram (°)	0,108 nano-grams (°)	56.000
Radium 226	1620	1 nano-gram	0,033 pico-grams	18
Plutonium 239	24.000	16 nano-gram	0,54 pico-grams	280
Plutonium 238	86	57 pico-gram	1,92 femto-grams	1

(^) Natural Uranium, present in weak traces in uraniferous rocks, where its concentration is about 33 nano-Curie (1.23 E3 Becquerel) of Uranium-238 per 1 kg of rocks (Hendee W.R.: *Health Effects of exposure to low-level-Ionizing Radiation*, pages 366 (Nuclear Power Generation).

(*) Metallic uranium obtained by man in the form of UO_2 (Fuel: *Uranium dioxide, manufactured ceramic pellets*), where its concentration is much higher, nearly 100%, i.e. about 0.3 mille-Curie/kg of metallic bar.

(^^) Metallic uranium obtained by man in the form of UO_2 (Fuel: *Uranium dioxide, manufactured ceramic pellets*), where its concentration is much higher, similar to that of Uranium-238.

(°) From "*Dose factors, dose-to-source ratios, and uranium isotope mass and activity abundances assumed for estimating exposures from DUE-containing products*."

Table XXIV shows the great difference between natural uranium, whose dangerousness is relative, and metallic uranium, whose dangerousness is almost the same as Plutonium 239.

Furthermore, it is clear that Plutonium 238 is extremely dangerous. To underline is the amount of different radionuclides necessary to reach the same dangerousness as Plutonium 238, which is considered as reference quantity measured in nano-Curie and not in emitted or absorbed radiation (RAD or REM).

Note: Radium 226 can be simply measured from the outside of the body, according to its characteristic gamma-emission of 188 and 262 KeV, i.e. a gamma constant of 835 milliRoentgen/h/metre [375].

Limits of dangerousness of *alpha*-emitting radioisotopes

In the past – as reported by the NCRP 1971 – possible tolerability limits with no risks for people were estimated to be around 1x10E-5 micro-Curie of *alpha*-emitting radioisotope per square centimetre, as against *beta*-emitting radioisotopes, whose limit was estimated to be about 1x10E-4 micro-Curie per square centimetre. For example, 0.8 nano-Curie/ cm2 (8 x 10E-4 micro-Curie) of Phosphorus 32 (*beta*-emitting) emits alone 15 REM a year [374].
On the basis of the above Tables, the estimate is considered by the author to be unreliable.

Similarly, the estimated security limits of *alpha*-emitting radionuclides present in the air are considered to be completely wrong.
According to American studies, the concentration of Plutonium should have not exceeded 0.03 nano-gram/cubic metre of air (0.003 nano-Curie/cubic metre of air) in the air and a total amount of 0.6 micro-gram in the human body, i.e. 0.04 micro-Curie totally absorbed.
But these data are at lot of times higher than the amounts of Plutonium-239 shown in Table XXIV, which are able to emit about 13 RAD/year, also taking into consideration the subsequent conversion into REM (i.e. 130 REM/year, with an R.B.E. of 10).

Both Plutonium and Uranium are very dangerous, especially if inhaled into lungs in the chemical-physical form of oxides (UO_2, PuO_2), as they remain in the lung alveoli and also in the thoracic lymph nodes forever. Only a small part is eliminated from the liver through faeces and from kidneys through urine. Single monomers of Plutonium or Uranium – with an initial diameter of 0.01 microns – in the body tend to aggregate to other monomers of Uranium or Plutonium, constituting even polymers with a diameter of one micron or more. Lung washing did not achieve good results, not even in association with intravenous infusions of sodium bicarbonate (1.4%) [377] or other chelation substances, administered also intravenously, such as CaDTPA, NaDTPA, ZnDTPA [374].

From a medical point of view, assuming that Uranium or Plutonium have been absorbed by the human body and have deposited in the skeleton or an inner organ, where they cannot be taken away, it can be simply concluded that the quantity sufficient to cause cancers or leukaemias will be about 1 nano-Curie of Uranium and/or Plutonium and/or other *alfa*-emitting radionuclides present in the lungs and/or in the liver and/or in the skeleton.

It will be not possible to precisely estimate the concentration of Plutonium-239, and/or Plutonium-238, and/or Uranium-234, and/or Uranium-235 and/or Uranium-238, since the exact percentage of these radionuclides within the "depleted Uranium" is not known: for example in the case of accidents, such as safe locks burst into flame, or crashes due to technical problems or pilot's errors of large commercial 747 aeroplanes (tons of which are manufactured using "depleted Uranium"), or in the case of conventional wars (Afghanistan, Iraq, former Yugoslavia) using grenades or missiles.

However, the precise amount of Plutonium-239 and those considered to be the most dangerous could be discovered in patients contaminated by these mixtures of radionuclides, by exploiting the good percentage of *gamma* emissions of Uranium-235 (about 0.2%) and a tomograph with a gamma chamber at 186 KeV.

By knowing theoretical values of ground contamination from Plutonium-239, shown in Table XXV, the *splashing* effect, with resuspension of Plutonium-239 to air and inhalation in the lungs, could be estimated together with the risk of lung cancer, lymphoma or leukaemia.
The only true starting data – which were experimentally determined by Soviet authorities using analysis instruments and contained in their paper mentioned in the bibliography [370] regard Plutonium-239 in Grey Zone, i.e. 3 kilo-Becquerel/square metre (7-10 nano-Curie/square decimetre).
Radioactivity estimates in less radioactive zones (Red, Orange and Yellow Zone) are therefore only presumptive.
The catastrophe of Chernobyl caused the dispersion of 6,000 Tera-Becquerel of Plutonium-241 – 2,000 more than Plutonium-239 (34 Tera-Becquerel) and Plutonium-240 (40 Tera-Becquerel).
However, its importance is relative because of its half-life (13 years).
The Table XXV shows the contamination values from Plutonium-239 around Chernobyl, offering the basis for a general study.

Table XXV: contamination values from Plutonium-239 around Chernobyl

Soviet contamination LEVELS	Plutonium-239 on the ground	Plutonium-239 on the ground	
	Kilo-Becquerel/m^2	nano-Curie/dm^2	Equivalent Zone (colorimetric scale)
LEVEL 0	6-8	15-20	BLACK
LEVEL 1	3-4	7-10	GREY
LEVEL 2	2	5.4	RED
LEVEL 3	1	2.7	ORANGE
LEVEL 4	0.2	0.5	YELLOW
LEVEL 5	0.02	0.05	WHITE

SIXTH PART:

Fallout caused by an accident at a nuclear power station: the disaster of Chernobyl

The nuclear reactor of Chernobyl released about 81 million curie – about 3,000 Peta-Becquerel – during the first ten days following the accident, i.e. from 26th April to 6th May 1986.

In the following months, the total leakage of radioactive materials was about 10,000 Peta-Becquerel, i.e. about 270 Mega-Curie.

Within a radius of 30 km around Chernobyl – an area of about 3,000-4,000 km^2 – 4,400 Tera-Becquerel of Caesium-137, 4,000 Tera-Becquerel of Strontium-90 and 32 Tera-Becquerel of Plutonium-239/240 [[370]] were measured.

Altogether about 10,800 Peta-Becquerel, i.e. 270 Mega-Curie [[370]], were released throughout the world. They were constituted by:

85,000 Tera-Becquerel (2.3 Mega-Curie) of Caesium-137 (4,400 Tera-Becquerel within a radius of 30 km from the nuclear power station).

10,000 Tera-Becquerel (270 kilo-Curie) of Strontium-90 (4,000 Tera-Becquerel within a radius of 30 km from the nuclear power station).

54,000 Tera-Becquerel (1.46 Mega-Curie) of Caesium-134 (amount released within a radius of 30 km from the nuclear power station unknown)

1,760 Peta-Becquerel of Iodine-131.

6,000 Tera-Becquerel (162 kilo-Curie) of Plutonium-241 (amount released within a radius of 30 km from the nuclear power station unknown).

30 Tera-Becquerel (810 Curie) of Plutonium-239 (a small amount within a radius of 30 km from the nuclear power station, in particular 3-4 kilo-Becquerel/m^2 within a radius of 30 km).

42 Tera-Becquerel (108 Curie) of Plutonium-240 (a small amount within a radius of 30 km from the nuclear power station, in particular 3-4 kilo-Becquerel/m^2 within a radius of 30 km).

Other less dangerous substances:
1,150 Peta-Becquerel (30 Mega-Curie) of Tellurium-132
115 Peta-Becquerel (3 kilo-Curie) of Strontium-89
240 Peta-Becquerel (6.5 kilo-Curie) of Barium-140
196 Peta-Becquerel (5 kilo-Curie) of Cerium-141
116 Peta-Becquerel (3 kilo-Curie) of Cerium-144
73 Peta-Becquerel (2 kilo-Curie) of Ruthenium-106
168 Peta-Becquerel (4.5 kilo-Curie) of Ruthenium-103
196 Peta-Becquerel (5 kilo-Curie) of Molybdenum-99
168 Peta-Becquerel (4.5 kilo-Curie) of Zirconium-95
95 Peta-Becquerel (2.5 kilo-Curie) of Neptunium-239
6,500 Peta-Becquerel (170 Mega-Curie) of Xenium-133

Total: 10,880 Peta-Becquerel (270 Mega-Curie)

Soviet authorities used the following scheme of radioactive levels (SEE Table XXVI) and measured the radioactivity in Kilo-Becquerel/m^2 for Caesium-137, Strontium-90 and Plutonium-239/240.

Table XXVI Ground contamination from Caesium-137, Soviet measurements in Chernobyl

	Distance from the nuclear reactor of Chernobyl, in km	Caesium-137 on the ground		
		Kilo-Becquerel/m^2	Contaminated surface in km^2	Evacuated people
LEVEL 1	25-30	1,500-5,000	3,000	100,000 people
LEVEL 2	48-50	600-1,500	7,000	270,000 people
LEVEL 3	100	185-555	30,000	580,000 people
LEVEL 4	200	37-185	125,000	4 million people
LEVEL 5		3.7-37	Russia. Europe	

Table formulated by the author on the basis of Soviet data (TCHERNOBYL, *Evaluation de l'impact radiologique et sanitaire*. Mise à jour 2002 de Tchernobyl: Dix ans déjà) SEE bibliography No. 370

The author has converted these data into the old measurement units, i.e. *micro-Curie/dm*^{2} (SEE Table XXVII), in order to compare these data with those produced in his predictive estimates of Fallout from an atomic explosion [[371]].

Table XXVII Ground contamination from Caesium-137, Soviet measurements in Chernobyl

	Distance from the nuclear reactor of Chernobyl, in km	Caesium-137 on the ground	Caesium-137 on the ground		
		Kilo-Becquerel/m^2	Micro-Curie/10 dm^2	Contaminated surface in km^2	Evacuated people
LEVEL 1	25-30	1,500-5,000	4-20	3,000	100,000 people
LEVEL 2	48-50	600-1,500	1.5-4	7,000	270,000 people
LEVEL 3	100	185-555	0.5-1.5	30,000	580,000 people
LEVEL 4	200	37-185	0.1-0.5	125,000	4 million people
LEVEL 5		3.7-37	0.01-0.1	Russia. Europe	

Data concerning ground contamination from Caesium-137 and Strontium-90 after an explosion of an atomic bomb on the ground are here shown. They were published by the author on "*Minerva Medica*" in 2002 [[371]] : SEE Table XIII (for Caesium-137[[371]]) and Table XIV (for Strontium-90 [[371]]).

It can be said that the levels of radioactive contamination from Caesium-137 (and Strontium-90) used by Soviet authorities (SEE Tables XXVI and XXVII) substantially coincide with the Grey, Red A, Red B, Orange, Yellow and White Zones of the Nomograms presented in this work (SEE Tables IX, XI, XIII and XIV). These refer to the effects caused by a Fallout from an atomic explosion [[371]], which have been partially shown in the present paper as well.

Table XXVIII shows the comparison between the two systems for evaluating contaminated areas, considering Caesium-137 as reference point.

Table XXVIII: comparison between Table XIII [371] and table XXVII (this work) as far as Caesium-137 is concerned

Soviet contamination LEVELS	Caesium-137 on the ground	Caesium-137 on the ground	
	Kilo-Becquerel/m^2	Micro-Curie/dm^2	Equivalent Zone (colorimetric scale)
LEVEL 1	1,500-5,000	4-20	GREY
LEVEL 2	600-1,500	1.5-4	RED
LEVEL 3	185-555	0.5-1.5	ORANGE
LEVEL 4	37-185	0.1-0.5	YELLOW
LEVEL 5	3.7-37	0.01-0.1	WHITE

Table formulated on the basis of Table XIII [371] and Table XXVII of this work

Therefore, it can be said that the level 1 determined by Soviet authorities – which reached up to 25-30 km from the nuclear power station of Chernobyl, covering an area of about 3,000 km^2 – substantially coincides with the Grey Zone of the Nomograms presented in this work, which refer to the effects of Fallout from an atomic explosion (15 micro-Curie/dm^2). The lowest value of Caesium-137 measured in this level-1 area was 1,500 Kilo-Becquerel/m^2 (equal to about 4 micro-Curie/10 dm^2 in our Tables) and the average highest value registered in this area (5,000 Kilo-Becquerel/m^2) could be considered equivalent to about 20 micro-Curie/dm^2, i.e. a level slightly higher than the Grey Zone (Black Zone B).

At this stage, if the amount of radionuclides released by the nuclear power station of Chernobyl from 26th April to 6th May 1986 (81 Mega-Curie) and the contaminated areas are known, it is theoretically possible to consider the accident of Chernobyl as equivalent to the power of a nuclear bomb of 15 kiloton exploded on the ground with a wind of *25* km/h.

According to the Nomogram of Fig. 1, Point C (the isodose line between Red Zone and Orange Zone) is equal to 50 km downwind of the Chernobyl power station.

On the basis of Tables VIII, IX and X, it is possible to obtain the different areas of Fallout:

Calculation: POINT C = 50 km (SEE Nomogram Fig. 1). Therefore:

The border between Black and Grey Zones: POINT C (in km) divided by 4 = 12 km
The border between Grey and Red Zones: POINT C (in km) divided by 2 = 25 km
The border between Red and Orange Zones: POINT C (in km): 50 km
The border between Orange and Yellow Zones: POINT C (in km) multiplied by 2 = 100 km
The border between Yellow and White Zones: POINT C (in km) multiplied by 4 = about 200 km
END of the White Zone: POINT C (in km) multiplied by 8 = about 400 km

Data from Chernobyl (SEE Table XXVII) show a good correlation between real contamination data and the theoretical data presented here, provided that 81 Mega-curie is considered equivalent to a nuclear explosion of an atomic bomb of 15 kiloton and the contamination on the ground has been carried by a wind of *25* km/h.

On the other hand, all the radioactivity released by the nuclear reactor of Chernobyl – thus *also* including the radioactivity after 6th May 1986, many months after the accident – is equal to 270 mega-Curie, 81 of which released on between 26th April and 6th May 1986, when helicopter bombing with sacks of boron 10 ended. So the total dose released would be equivalent to the explosion of a nuclear device entirely fissionable of about 50 kiloton.
However, also in this case the extension of the different zones of the Fallout (Black, Grey, Red, Orange, Yellow and White Zones) is similar to that shown above, provided that there is a wind blowing at less than 18 km/h.

SEVENTH PART:

The Testament of Chernobyl

Passing time makes us more and more distant from that Saturday of April 1986, when the silence of an Ukrainian night, as warm as in summer, was rent by the sound of an explosion which echoed back to every corner of the world. From that moment, the word "*Chernobyl*" entered without being translated into the vocabulary of every language, thus becoming the symbol of the atomic disaster.

When such a disaster occurs, the human mind drags up the past, maybe with the desire to understand what could be done to prevent it from happening again.
Finally today, after many years, a number of things have been clarified.

Water-cooled graphite reactors (RBMK) installed in the four blocks of the nuclear power station of Chernobyl had until then proved to be absolutely safe. The very new reactor of the fourth block – used for four years only – had always worked properly. From a technical point of view, due security measurements had been taken.

Unfortunately, the human factor had not been taken into consideration and played a fatal role in that night of April.

It is known that the night preceding the 26th of April, at the beginning of normal maintenance works, run-out tests on one of the turbogenerators were performed. During the preparation of these tests and at the beginning of their performing, some security systems of the reactor were disabled and the alarm display on the control board was stopped, thus breaking the strict security rules set. That led to an uncontrollable situation where the power of the reactor increased without any chance to regulate it.

A significant increase in temperature and insufficient cooling caused the breaking of some hollow spaces, thus influencing Zirconium-steam and other exothermic reactions.
The pressure of the Hydrogen-steam mixture in the watertight compartment increased so much as to cause the first explosion, which occurred at twenty-four minutes past one of that terrible night.
After a few seconds, the second and more catastrophic explosion occurred, which completely destroyed the reactor hall and ejected fragments from the nuclear core of the exploded reactor.

According to the report by A. K. Mikeev, Chief of the General Direction of the Fire Brigade of the Soviet Union, the situation was the following:

"The first explosion occurred at 24 minutes past one of that night, followed after a few seconds by the disaster of nuclear reactor No. 4, which burst into flames.
Highly radioactive and incandescent pieces of the reactor were scattered on the unroofed fourth block and on the auxiliary building, falling then on the ventilation system and the roof cover of the machinery hall, thus causing more than thirty other small fires.
Inside block No. 4, five more fires broke out at different levels, both in the reactor room and in the machinery room. Flames rapidly spread through the roof cover of the next third block as well, where reactor No. 3 was still working normally. Fire was therefore a threat to cable conducts and then to the entire control and protection system of the plant.
Damaged oil pipes and short circuits of electrical cables also caused the fire of the machine close to one of the turbogenerators. This area was particularly dangerous because of the presence of

high-capacity oil tanks placed next to each turbine and the great proportions of the machine itself, which made the fire spread very rapidly.
The first fire-fighting squad, composed of 17 men, two units and three fire extinguishing vehicles, led by lieutenant Vladimir Pravik, arrived at the reactor site five minutes after the explosion. Another five minutes later, a fire-fighting squad led by lieutenant Victor Kibenok came to their aid. This team was from Pripiat, a town situated only 2 km away from the nuclear power station".

There were 28 firemen, all told, a derisory number of men given the extent of the disaster. However, they were perfectly trained in their task: actually, about a month and a half before, on 5th March, main and secondary rapid-reaction squads had conducted a normal fire drill right at the Chernobyl nuclear plant and proved to be adequately reliable.
Thanks to these hard-trained units, which were real military squads, the disaster of Chernobyl did not cause the leak of billion Curies, thus preventing the fire of the fourth block from spreading through all four nuclear reactions.

During the following 20 minutes, Leonida Telyatnikov directed the fight against the fire, coordinating the operations of the other fire-fighting units arriving in the meantime from Pripiat, Chernobyl (18 km away) and other towns. One of these squads came from as far as Kiev and is reported to have covered 150 km in less than an hour and a half. Firemen arrived in waves and substituted those of the first waves, who were already contaminated by radiations, and then were themselves replaced by other fire brigades coming from farther places.
According to official figures, before the livid dawn of that day, more than 240 firemen were replaced by different arriving waves, until they succeeded in extinguishing the flames at about five o'clock of that tragic Saturday morning.

However, the first 45 minutes of the accident were the most crucial, and decided the result of the operations.

Citing A. K. Mikeev's report again:
"During the first minutes, the fire extinguishing vehicles were rapidly linked to fire hydrants and through pipes to the dry columns of fire protection systems; mechanical ladders allowed the firemen from Pravik and Kibenok to climb onto the roof of the machinery hall and the auxiliary block. Further pipes replaced the inner water piping of the station, which had been damaged by the explosion. Fixed hydrants threw fire extinguishing substances on accessible fires beginning from the ground level, thus cooling the metal bearing structures in order to prevent further collapses of the buildings, which were already seriously damaged.
Firemen with hand-hydrants located the main and most dangerous fires on the roof of the machinery hall and in the auxiliary building and managed to extinguish all fires.
But then the most critical situation arose in the machinery hall of the fourth block, which had been demolished by the two explosions and was situated at a height of 70 m: part of the roof over the reactor being destroyed, bearing structures had been deformed by the shock wave; toxic smokes coming from the roof cover in flames spread through the entire fire, covering dozens of square metres.
Accesses to the next block, on the site of the auxiliary building, were dangerous as well."

It is difficult to imagine what consequences would have followed the propagation of the fire and the destruction of the roof cover over the third reactor if the small squad led by lieutenant Pravik and that led by lieutenant Kibenok had not prevented the fire from spreading, by fighting over what remained of the fourth block in the thick and radioactive smokes coming from the nuclear power station and at more than 70 m of height, while their dosimeters and the shrill whistle of their Geiger counters showed by then intolerable levels of environmental radioactivity.

Besides, if even only one roof tile of the third block had fallen onto nuclear reactor No. 3 beneath, …

The fact remains that for more than an hour and a half a handful of men fought against the fire, while being exposed to intolerable levels of radioactivity, at more than 70 m of height, on burning structures falling down.

Lieutenant Vladimir Pravik and other five men are reported to have been the first victims.
By dying they succeeded in putting out and extinguishing the most dangerous fires.

At ten past two of that night the last fires on the machinery hall roof were extinguished, and so were the flames at other levels twenty minutes later.

At this point the first external emergency squad arrived, the one which had been coming from Kiev and covering more than 150 km in less than ninety minutes.

Chernobyl has not been the only accident where the human factor brought the salvation of many people instead of a nuclear disaster: on many occasions, civilian and military applications of the atom almost changed the course of events catastrophically and forever.

For example, at about midnight of 25th September 1983, in a secret bunker on the outskirts of Moscow, Stanislav Petrov, colonel of the Red Army and head of the Soviet Satellite Early Warning Centre saw his control board indicating that four American ICBM nuclear missiles ("Minuteman" model) had been launched in only three minutes and were headed towards the Soviet Union.
However, nobody thought about a computer error.
It was the period of the Cold War: after the terrible Cuban missile crisis between Kennedy and Khrushchev in 1962, the two superpowers timidly got closer through the use of an emergency telecommunication system, called "Red Telephone", which should have prevented international political crises from causing a terrifying Third World War due to a chain of political and diplomatic events, as happened in 1914, when the First World War broke out.
But nothing or next to nothing had been done to avoid a nuclear war by technical mistake.

And that night, colonel Stanislav Petrov, 42, had to take the decision which until then had been a nightmare in his head, i.e. executing what military rules ordered to do in that case.
The control board confirmed the almost simultaneous launch of four huge intercontinental strategic missiles, each of them theoretically armed with three independent re-entry thermonuclear warheads of 170-335 nominal kilotons (Minuteman 3) and probably heading towards Moscow.

The M-10 computer – able to process more than 10 million operations per second – was directly connected via radar to the *Cosmos* first-alert satellites and nothing suggested an error in the satellites or in the M-10 computer.

As is widely known, after the introduction of the intercontinental solid-propellant ICBM missiles in the sixties and seventies, the so-called "nuclear limbo" had become shorter. It was no longer possible – as was the case in the fifties – to call back the atomic bomber pilots during the flight – lasting some hours – before reaching their objectives and stop a nuclear war broken out by mistake.

After the introduction of solid-propellant intercontinental missiles, ICBM missiles of both superpowers could hit their objectives within less than 30 minutes, thus reducing to less than twenty minutes the reaction time necessary for both parties to survive a surprise nuclear ICBM attack and keep the 3-C systems (Communication-Command-Control) active in case of a reprisal nuclear attack after the explosion of enemy missiles.

After suffering an attack, a reprisal from underground missile pads, among thermonuclear mushroom clouds caused by recent enemy bombing, would have constituted a significantly less aggressive attack as against one launched before the impact of the enemy missiles, i.e. ten-fifteen minutes after the report of the *first launch* by the enemy. Which is what appeared to have happened at that moment…

At that terrible moment, nothing could also exclude the launch of other American missiles – such as manoeuvering re-entry *Trident Delta 5* missiles – from other places, in particular from the "*Ohio*" American nuclear submarines, which were immersed under the Arctic polar ice pack, just outside Russian territorial waters.

Furthermore, despite the oncoming American nuclear attack, nobody knew whether the hundreds and hundreds of *Frontovaya Aviatsiya* bombers stationed in Siberia would manage to take off and gain height in order to follow scheduled courses before their air bases were destroyed by the American thermonuclear bombing, to then pass the American positions from where the first attacks had come to engage in a no-return mission beyond the *Pine Tree Line* and – at a very low altitude – the *Mid-Canada Line*, skimming the tops of the trees… finally reaching the skies of big American cities and dropping their H-bombs of thousands kilotons after gaining a height of 16,000 m over the condemned city to not be sucked down by the nuclear mushroom that would open beneath them after few instants, like a monstrous, huge white flower…

Finally, nuclear submarines of the Soviet fleet, which were immersed in the depths of the Pacific and Atlantic, would launch their nuclear missiles, which despite their imprecision would still be able to destroy the few American cities still standing…

Everything would die, forever, under the mushrooms of the Apocalypse in Asia, Europe and America. Everything would be devastated by huge fires extending over thousands of kilometres, originated in the *Fire Storms* of the atomized cities and in the *Fire Hurricanes* caused by the conflagrations among several *Fire Storms*, which would lash entire continents, from one coast to the other, bringing death where the effects of nuclear bombs had not arrived yet…

This scenario would have led to the use of thousands and thousands of nuclear warheads, which were jealously kept by both rivals in a high number of secret bunkers and were ready to be used on the "War Day", a terrible circle of hell which would mark the end of the Third World War…
And it would have been the end.
For everyone.

Nobody could have stopped the war that colonel Stanislav Petrov was witnessing in its first phase because the "*nuclear limbo*" was too short.

On that terrible night at the end of September 1983, the entire Soviet ICBM system ((580 SS11, 60 SS13, 150 SS17, 308 SS18, 300 SS19) was immediately put on the alert. However, the order to launch was not given yet. A chain of events led to the switching on of the indicator lights inside the nuclear suitcase of Secretary General of the Union of Soviet Socialist Republics, Yuri

Vladimirovich Andropov, by that time old and ill. Nobody could know how he would react after being hastily woken up in the middle of the night and told that four American ICBM missiles had just been launched from the American coast, probably heading towards the Command-Control-Communication centres of Moscow with a view to destroying the Soviet highest political and military authorities and having time to bomb the entire Soviet ICBM missile net and the *Frontovaya Aviatsiya*, with all its atomic bombers still on the ground, and finally the submarine naval bases.

But then someone noticed something odd…

During the few minutes before waking up the Soviet leader, it was essential to see the four American missiles actually flying over the Arctic Circle, in order to check that the M-10 computer was really right.

Very-high definition photos taken by the *Cosmos* satellites – continuously shown on displays and observed 24 hours a day – actually *did not* show any object flying over the Arctic Ocean.

But the alarm of four American ICBM missiles launched against the Soviet Union had already been given.

General Yuri Votintsev, who headed the ABM antimissile defence in Moscow, was told that an "extraordinary accident" had occurred: the M-10 computer had provided wrong data.

Marshal Ustinov, the Soviet Union minister of defence, was immediately informed about what was happening and in particular of the error made by the M-10 computer.

The Soviet leader Yuri Vladimirovich Andropov, who would have had to decide whether to start the Third World War in a strange night at the end of September in 1983, was not woken up in his residence.

This "extraordinary accident" was reported by the newspapers [[520]] only ten years later, in May 1993, when the Berlin Wall had already been pulled down and the Cold War had already become history, with all its frightening ghosts.

However, those dark years, threatened by the terror of the atomic war, left a terrible heritage: the Chernobyl sarcophagus and its thirty kilometres of contaminated land, where there are trees that have turned completely white and contain red chlorophyll, strange flowers with unseen colours, giant insects, poor animals and human beings reduced to monsters by ionizing radiations...

In Chernobyl, there is the most abominable grass of the world, of a legendary dark colour, dry, thin and resistant, bending under the shoes and getting up, crooked and hard.
Old farmers came back to live in the forbidden villages of the Grey and Black Zones. They see the grass and say that everything is as before, also the colour.
But the grass has the evil of this land inside, the invisible sentence of Chernobyl.
The animals that have pastured on these meadows are now becoming deranged in their DNA, in their genetics, and show devastated and deformed bodies.

A man going around the country, dressed in his white suit of modern atomic scientist, measures the environmental radioactivity by using the sinister ticking of his small Geiger counter and has to submit to the enormousness of the unknowable because what is born here, now, in the *Sovkhozes*, shows the horror of a violated nature which has been forever destroyed down to the most inner, hidden and secret alchemy of genetic magic. The horror of a DNA that God had created perfect and man has destroyed and is not able to repair. Men, like monkeys, are only able to mimic – in their white gowns of modern geneticists – the secret alchemy that over 700 million years of Evolution led Life to self-replicate in the perfect magic of a DNA which was the mirror and the proof of the absolute greatness of the Unknowable…

The following was written by Ezio Mauro and published by the Italian daily "*La Repubblica*" on 15th February 1989, about twenty years ago:

"Vladimir Kolinko told unheard stories about deformed animals born in the *Sovkhozes*, disabled by radiations, about sick children, irradiated shepherds who died in mass of lip and mouth cancer. Together with the director and friend Igor Skliarevsky, he returned to the countries of Norodiceskij, Khristinovka and Matejki to secretly take pictures and record declarations.
In the Ukrainian contaminated country, dying animals are born, as well as deformed beings, unseen creatures, brought into the world surrounded by the radioactive cloud and the nuclear dust which covers fields and waters.
These creatures are Chernobyl monsters and after seeing them you cannot help asking yourself when the man's turn will arrive…
Today there are genetic mutations, the most expected and terrible: nothing will ever be as before.

Yet, the Nadoriceskij region, in the district of Ghitornskaja, lies outside the "*Opasnaja Zona*", the Dangerous Zone officially comprising a thousand square kilometres around the Chernobyl plant. Here, in the villages and in the state farms of Nadoriceskij, you live in the great ambiguity of an *after-bomb* life, which is bound to be normal by decree, even though small daily rules and Government recommendations reveal a constant suspect of abnormality.

Everyone knows that on 26th of April 1986 the wind blew from the East.
Radioactivity has arrived here from Chernobyl, and is still here.

The report and the video taken by Kolinko and Schkliarevski precisely document the level of radioactive contamination and provide names and details: for example, in the country house of Pavlina Struzkaja, the contamination level is nowhere less than 0.2 milli-Roentgen/hour and reaches 2 milli-Roentgen/hour near the entrance, whereas the level of the natural ground in Kiev is 0.014 milli-Roentgen/hour.
The document denounces that, according to the vice-president of the Academy of Sciences, Leonid Ilyn, small amounts of radiations can have significant effects, modifying bioelectric activity and causing biochemical changes.
Most of all, the text certifies that doses of 4.4 micro-Curie of Caesium-137 or 0.4 micro-Curie of Strontium-90 can cause important alterations in the human body.

Today, Kolinko's document is the first to reveal data collected at the medical station of Norodiceskij: 35% of the population of the entire region absorbed a dose from 1 to 2 micro-Curie of Caesium-137; 4% a dose from 3 to 5 micro-Curie; other 4% a dose varying from 5 to 10 micro-Curie.

More than 23,000 people live in this region.
Those in charge of the public health service maintain that there are no problems, because Norodiceskij is out of the "*Opasnaja Zona*", and that is enough.

Children's enlarged thyroids are officially caused by water and nothing else. But according to the report, more than half the children of the region suffer from pancreas diseases, serious ones in many cases.
Furthermore, the doctors working in the area informally advise young married couples not to give birth to children.
And most of all – according to the report – cancer cases have doubled in just one year. "*It is a fact*", says Anatoli Melnik, Regional Prime Secretary of the Party: "*our doctors notice an increase in the number of chronic diseases, as well as further worsening of patients' conditions during the postoperative course*".

Doctors perform periodic clinical tests, above all in children, but overall results are not known", says Vladimir Kolinko. He also maintains: "*still, some conditions should be alarming... Once arrived at this zone, I saw very contaminated meadows still with flocks out to pasture. In July, three shepherds of those flocks died of mouth cancer. In October also the other three shepherds died, in the same way and because of the same disease*".

Kolinko entered by force this area of terror and gave evidence of that. But all around, nobody knows what is really happening, between the desire for normality and the naturalness of those who adopted habits belonging to life before the nuclear reality.

The form of the "*Opasnaja Zone*", with a radius of about 30 km, is like a hand indicating something to the left. Contamination levels were higher in the north-east and – by following a sort of empirical map showing "dirty" and "clean" villages – the Ukrainian government allowed people aged more than 50 to return and live in their own homes in a region to the south of the cursed area, with lower irradiation levels.
But old people returned everywhere, by breaking barbed wires and laws. They sow and farm, milk and harvest. According to the rules, it is not allowed to pick mushrooms in a wood and berries in another. *"However, only a civil servant in Moscow",* says Menik, Secretary of the Party, "*can make such a ridiculous distinction between clean and dirty zones".*

Radiation dust moves with the wind, in the rivers after raining, and with the movements of cattle. Today, the main danger is that radionuclides may enter the human body through the food cultivated in these zones. "*There is no point in pretending*", says Kolinko: "*clean products coming from other regions are scarce and – despite the doctors' prohibitions – people often drink the milk of their cows, eat what they produce, above all fruit and vegetables, and sometimes the meat of animals they refuse to sell to the state*".

When you enter the "Petrovski" *Kolkhoz* a real tour through the atomic disaster begins. The animals of Norodiceskij were again used as guinea pigs and the future of the country land around Chernobyl will be worse than the last three years.
A countrywoman of the *kolkhoz* holds in her arms a small pig and shows it to Kolinko, Schkliarevski and their camera: "*Its head seems that of a frog*", she says, "*instead of the eyes it has something never seen before, without pupils*".
Piotr Kudin, the veterinary doctor of the *kolkhoz,* is not surprised: "*This is one of the many monsters that usually die just after the birth. This one continues to live*".
Kolinko explains that these animals belong to the second conception generation. "*I saw creatures that I thought could never exist, without head, chest, often without anus and legs. And then those eyes without eyes, pigs with the eyes of frogs, in enormous orbits*".

The small "Petrovski" *kolkhoz*, with its 350 bovines and 87 pigs, is an empirical test which reveals the terrible reality of the Ukrainian country. According to the report, during the five years before the

Chernobyl disaster, only three malformation cases were registered among pigs, whereas all calves were completely normal. A year after the explosion of the Chernobyl reactor, statistics became terrifying: 64 monsters were born among animals, i.e. 37 pigs and 27 calves. During the first 9 months of 1988 they became even worse: 41 deformed pigs, 35 malformed bovines. "*Calves sometimes have no head or legs, no ribs or eyes. Pigs have malformed heads*".

Piotr Kudin, the veterinary doctor of the *kolkhoz*, is facing the horror alone.
"*Scientists of the Research Institute for Agricultural Radiology in Kiev are not interested in our farm*", she says: "*they came, watched some animal corpses and went away after saying that the reasons for the malformations could be hundreds and there is no evidence of a direct relation to radioactive contamination*".

However, according to Kolinko's report, the logic and statistics show that the reason of these malformations is only one: "*Animals pasture and eat in our fields, which are contaminated by radionuclides*".

The dark grass of Chernobyl seems to bring that evil to the surface, the evil the ground had to absorb, in an uninterrupted cycle of a nuclear disaster that cannot be stopped.
Today that grass frightens the State, because the *Gorkomatom* gave the all-clear for the video-documentary of Kolinko and Schkliarevski and maybe the Soviet Union will be allowed to see it, whereas "*Moskovskie Novisti*", one of the most important newspapers of the "*Glasnost*" of the leader Gorbachev, breaks the silence and has announced that it will publish Kolinko's report.
That grass frightens if there is a plan to asphalt and cover everything, thus burying under the tar streets and courts, meadows and farmyards, in the last mutation of Chernobyl towards the resignation of those obliged to understand that from that day life has changed forever.

The fact remains that farmers continue to get up early, as the false Ukrainian normality wants.

They go out of the *Sovkhozes*, where the monsters just born wail before dying.

They work on the grass of the fields and use their tractors while closed in the hermetic cabins they were obliged to buy by law at 1,400 rouble each.

Then they cut trees and gather wood, because there is no gas heating.

At home, they will wash the wood before burning it, thus breathing the heat.

Then, at night, they will bury the ashes in the fields of Chernobyl, as state decrees and the fear want, after three years...

OCTAVE PART

After Chernobyl: from the atomic bomb to the genetic bomb: the threat of Genetically Modified Organisms

Biotech, or biotechnology, applied to plants comes from the research on recombinant DNA carried out in the Seventies.

The special nature of GENETIC RECOMBINATION – the basis of the technique used to modify the DNA – relies on the use of special "viral mosaics" which are able to modify the DNA. Among these, the most known and used mosaic is the CaMV (*Cauliflower Mosaic Virus*): a "viral mosaic" which is not able to survive without its host cell. It is a real viral parasite used by GMO Multinationals during the last ten years in order to modify numerous plants and produce food for men or animals.

GENETIC RECOMBINATION attracted attention in the genetic research institutes during the '70s and '80s.

However, at the beginning, scientists were very cautious in the use of these techniques, recognizing the risks of severe genetic pollution in plants and animals, in bacteria and above all in men: at that time, the term "*genetic bomb*" was introduced, drawing a parallel between the artificial GENETIC RECOMBINATION caused by man and the genetic modifications caused by the same ionizing radiations of the "*atomic bomb*" in the DNA of animal and vegetable cells, a bomb that had been already tested less than 30 years before in Hiroshima and Nagasaki.

Cancer is a degenerative disease caused by a lack of vitamins and poisoning from chemical substances present in food. One can estimate the number of vitamins and pro-vitamin substances present in natural plants commonly used as food by humans as more than 13,000 – 15,000 types.
The introduction into modern agriculture of Genetically Modified Organisms (GMOs) is an unjustified and very dangerous alteration of what Evolution has produced in plants over hundreds of millions of years:
plants on which the subsequent biochemical evolution of superior complex animal organisms has been based, culminating with the advent of mammals in the last 65 million years and then with the arrival of Man.
Therefore the delicate biochemical balance of the human race depends on plant species remaining integral, just as evolution created them, because the health of every one of us is based on the biochemical human cell, and this depends, through the complexity of the DNA, on the use of thousands of vitamins and of the herbal-chemical compounds present in nature.

Plants are complex organisms as well, they are the fruit of hundreds of millions of years of biological evolution: every genetic modification caused in plants by Man (with radiation such as Chernobyl, or with retroviruses such as presently used in GMO), however small that modification is, will cause damage, irreparable damage which often cannot be seen, because man only knows a limited number of safe vitamins and pro-vitamin substances.

However, there are tens of thousands of vitamins and other substances present in plants, and it is these which are responsible for the correct working of the biochemical human complex and the human genome (DNA).

To (supposedly) achieve greater agricultural production today we resort to changing the genetic patrimony of natural plants, with the aim of:

1) changing their structure,

2) making them sterile (thus farmers have to buy new seeds every year),

3) patenting the transformation induced and

4) re-selling the thus obtained product all over the world.

Actually it has never been demonstrated that GMO cultivations produce a larger amount of products. In fact, some independent scientific studies carried out by ISIS proved quite the opposite.

Furthermore it can be affirmed that there is a substantial equivalence between:

1) the genetically modified product (GMO)

2) and that obtained by selecting genetic characteristics (that is by means of naturally crossbreeding plants as has been done by man over the course of thousands of years).

However, this "substantial equivalence" cannot be sustained because:

1) the natural crossbreeding of plants uses natural seeds of the same species, while genetic manipulation (GMO) crosses all barriers, and introduces genes from other types of vegetable species or even bacteria, viruses and animal genes.

2) in fact the majority of genes used in genetic engineering come from living species which have never been a part of the human food chain and actually come from DNA not of plants but of animals, bacteria or viruses and/or transgenic retroviruses.

EIGHT immediate threats can therefore be identified:

FIRST POINT: ***The impoverishment of vitamin and pro-vitamin complexes in the plants***

SECOND POINT: ***genetic mutations of plants and the subsequent alteration of human biochemistry***

THIRD POINT: ***the failure of the anti-cancer diet***

FOURTH POINT: diseases induced by transgenic viruses

FIFTH POINT: ***intoxication by poisons synthesized from transgenic plants***

SIXTH POINT: ***danger of worldwide famine due to "TERMINATOR" technology***

SEVENTH POINT: ***transgenic pollution of natural plants***

EIGHTH POINT: ***the irreversible disappearance of the genetic inheritance of natural plants***

FIRST POINT OF THE THREAT OF GMOs:

The impoverishment of vitamin and pro-vitamin complexes in the plants

The deliberate attempt to deactivate the natural substances contained in the plants is very serious: in this way fresh fruit and vegetables – greatly impoverished of many vitamins – can be carried over long distances and long periods of time because their oxidation does not take place.

These vitamins are able to enter into complex enzymatic mechanisms inside mammals' DNA, inducing the APOPTOSIS (suicide) phenomenon in these mammal cells if they are suffering from infections or above all CANCER or LEUKAEMIA.

This deliberative vitamin impoverishment will ensure commercial profits and represents a serious act of deliberate damage inflicted on the Ecosystem by means of GMOs.

Fresh plants contain thousands of vitamins which are able to activate our immune system against germs, viruses or tumour cells, or even to induce apoptosis (cell suicide or programmed cell death) in tumour cells.

Amounts of vitamins needed to induce apoptosis in a certain number of tumour cells in the laboratory without damaging healthy human cells are really very small.

Several studies from medical and scientific literature, almost all in PDF format [[405-505]], show the actual ability of these vitamins to induce APOPTOSIS in the cancerous cell line considered. Amounts needed are measurable in: micromoles (i.e. micromoles/litre, i.e. nanomoles/millilitre, i.e. picomoles/microlitre).

SECOND POINT OF THE THREAT OF GMOs:

Genetic mutations of plants and the subsequent alteration of human biochemistry

Because of the introduction of foreign genes (for example from animals, bacteria, viruses and retroviruses) into the DNA of plants, an alteration in the normal genomic sequence of the plant occurs, with the appearance of new proteins and/or the loss of other proteins of a genomic sequence.

Therefore new substances similar to natural vitamins have appeared, but which actually have enzymatic and biochemical characteristics different to natural ones, and therefore introduce changes in their component of biochemical activity on the human genome, once they have been introduced through food.

There is therefore the potential risk of new diseases of an "artificial" type, caused by the genetic manipulation (GMO) of vegetable organisms, genetically polluted by new vitamin-like molecules with inductive effects on the human DNA and on its complex biochemistry which are totally unknown, but probably heralding serious damage given the extreme complexity and hence vulnerability of the human DNA.

For example, the only test on a long-term basis (24 months) carried out by an Italian research group demonstrated that GMOs may modify some internal organs. Feeding mice with the famous maize *Roundup Ready* changed the structure and the functioning of their liver, pancreas and testicles cells. [[395]]

A second study was conducted by Pusztai [[396]]: he found out that mice fed with transgenic potatoes showed damage to organs, thickening of the small intestine and scarce brain development.
Potatoes were genetically modified in order to contain lectin, which makes plants resistant to pesticides.

A third study was carried out by Prescott [[397]], who analysed GMO peas.

A fourth study was made by Dr Irina Ermakova in Russia, at the Institute of Higher Nervous Activity and Neurophysiology of the Russian Academy of Sciences (RAS) in Moscow.
During the experiment, doctor Ermakova added GM soy flour to the food of female rats two weeks before conception, during conception and nursing.
In the control group were the rat females that were not added anything to their food.

"For the study, the scientists used GM soy flour in a diet for female rats two weeks before and during conception, and after birth. Three groups of rats were assigned a different diet each: a control group received no soy, the second group received GM soy flour, and the third group received conventional soy flour. The scientists counted birth and death after the offerings. Three weeks after birth, the death rate of the baby rats was counted for each group.
It was found that both the conventional soy and the GM soy did not affect the number of baby rats each mother produced. However, the death rates of baby rats in three weeks after birth were drastically different. The death rates for the control, the group raised by mothers on a GM soy diet, and the group raised by mothers on a conventional soy diet were 6,8 percent, 55,6 percent and 9 percent respectively. The results indicate that conventional soy did not have a negative effect on the death rate, while a GM soy diet increased the death rate by a factor of eight.
Also, 30 percent of the babies in the GM soy group had an abnormal weight of less than 20 grams
The morphology and biochemical structures of rats are very similar to those of humans, and this makes the results we obtained very disturbing"

Irina Ermakova, told the NAGS press office

THIRD POINT OF THE THREAT OF GMOs:

The failure of the anti-cancer diet

As already demonstrated by Gerson [[505-510]] and other authors, many substances contained only in fruit and biologically grown raw vegetables are able to induce the IMMUNE CASCADE against tumours, detoxification and the particular phenomenon of apoptosis (suicide) of diseased cells making it unnecessary to conduct difficult and expensive research.

153 patients suffering from the worst form of cancer known (melanoma) followed Dr Gerson's anti-cancer diet [[511]], and after 5 years the percentage of recovery varied from:
70-90% (if the tumour was localized)
to 40-70% (if the tumour had metastasized),
provided that the patients had not previously undergone chemotherapy.

On the contrary, using chemotherapy the percentage of recovery from melanoma after 5 years is 6% or – according to other sources – is zero per cent [[403]].

In the latest study of MORGAN, based on more than 270,000 patients undergoing CHEMOTHERAPY, this zero survival value is confirmed even in the case of:
cancer of the pancreas, sarcoma, womb cancer, cancer of the prostate, bladder cancer, kidney cancer, and multiple myeloma. This percentage goes up to 1% in case of: stomach and colon cancer; about 2% in case of breast or lung cancer; 3-5% in case of rectum cancer; 4-5% in case of brain cancer; 5% in case of esophagus cancer; 9% in case of ovary cancer; 10% in case of NON-Hodgkin lymphoma; 12% in case of cervical cancer; about 40% in case of testicular cancer and Hodgkin lymphoma.

The explanation of the effectiveness of these vegetarian diets lies in: not consuming food containing all the potential factors which promote cell growth, **in particular** AVOIDING **the simultaneous consumption (1-3 hours) of ALL 9 essential amino acids (Valin, Isoleucin, Leucin, Lisin, Metionin, Hystidine, Tryphtophan, Phenylalanine, Treonine).**

These should not be taken simultaneously as through them cancer cells can build PROTEINS, i.e. other ill cells.

The intake of the following substances must also be avoided: **nucleic acids, vitamin B12 and folic acid** (as they cause the DNA replication of the cancer cell).

In the past,…before the GMO era, this rule was very simple to respect: the foods which contained all of these were of animal origin (meat, fish, eggs, yeast, milk, cheese, butter…).

Both Gerson and other authors (including Chinese and Indian medicine) forbade the consumption of these foods for at least a year.

A vegetarian diet, based only on fruit and vegetables, cereals and legumes, was, thus, the winning diet.

However, cereals and legumes are rich in ESSENTIAL AMINO ACIDS and thus their use in cancer therapy by many other Western, Chinese and Indian schools of natural medicine might seem surprising.

The success of these therapies, which are so distant from each other as far as the THEORY is concerned but are so similar in the effectiveness against CANCER, can be explained by the modern BIOCHEMISTRY: *NO* CEREALS and *NO* LEGUMES, taken singularly, contained ALL 9 essential amino acids.

These foods, however, if consumed together at the same meal determined the assimilation of all 9 amino acids.

The human body can thus synthesize PROTEINS and build cells – cancer cells.

Comparing these new therapies, it is clear that it is ABSOLUTELY FORBIDDEN to eat CEREALS + LEGUMES together, i.e. pasta (or polenta, or bread [even if unleavened] or rice) + legumes, because according to the modern BIOCHEMISTRY there would be the integration of the 9 essential amino acids (8 of them are contained in cereals and the other one, i.e. Lisin, is contained in legumes ; 8 of them are contained in legumes and the other one, i.e. Metionin, is contained in cereals) with a similar nutritional effect as that obtained from eating meat (after all, once a plate of pasta and beans was called … "poor man's meat").

Today, however, because of the introduction on the market of cereals, legumes and other vegetables which have been genetically modified (GMO), many of these foods contain ALL the essential amino acids [[398]], effectively rendering cancer NO LONGER curable in the way it is described in this study and according to the therapy of Gerson and many other authors.

FOURTH POINT OF THE THREAT OF GMOs:

diseases induced by transgenic viruses

The transgenic viruses with which genetically modified organisms (GMO) are created today enter into the DNA of the plant, modifying it in a way which is unknown to us.

These viruses are supposed to lie dormant but there is nothing to prevent them from reactivating themselves in a manner similar to the well known RNA tumour viruses (Oncornaviruses) or DNA tumour viruses (both inducers of leukaemias, sarcomas, carcinomas, gliomas...).

These viruses can also be the carriers of new diseases or diseases similar to syndromes whose dynamics are unfortunately very little understood (AIDS, Mad Cow Disease, etc…), and whose origin is still very vague (perhaps transgenic viruses?).

There is ample bibliography on viruses used in GMOs.
(SEE chapter 8 of the E-Book "Thousand Plants against Cancer without Chemo-Therapy" http://www.thenhf.com/about_us.html; http://www.mednat.org/cancro/nacci_english.pdf):

It is well known that CaMV (*Cauliflower Mosaic Virus*) is used today in the replication of retroviruses introduced in the plants by GMO multinationals in order to modify their DNA (GMO plants).
This virus is active both in angiosperms and gymnosperms, i.e. in all plants.

This virus is used by GMO multinationals to modify genetically plants because it contains particular *promoters*, which are "motors" which drive genetic activation.

CaMV has two *promoters*: **19S and 35S.**
Of these two the **35S** promoter is most frequently used by multinationals.

The **35S promoter** is a DNA sequence of about 400 bases (units of genetic sequence of four different molecules: Adenine, Cytosine, Guanine or Thymine).

The CaMV promoter is preferred above other potential promoters used by GMO multinationals to modify plants because it is not influenced by the different conditions of vegetable cell tissue types and thus it can act.

Unfortunately it is able to penetrate and replicate in animal cells, including mammalian and human cells, as demonstrated by Vlasak in a study published in 2003. Vlasak [383]
These artificial pararetroviruses are created and used by multinationals to modify the DNA of plants. They are similar to *retroviruses* already present in nature, such as: HIV retrovirus of AIDS, HUMAN LEUKAEMIA retrovirus, Hepatitis B retrovirus [384].
According to scientific literature, CaMV is closely related to the virus of human hepatitis B and AIDS. [385,386]

Using CaMV in plants eaten by humans and/or animals can be very dangerous and hazardous because of the GENETIC RECOMBINATION of DNA chromosomes in the plants. This can lead to the recombination of the 35S promoter itself with the DNA of the person or animal that has eaten fruit, vegetables, pasta or GMO soya containing these pararetroviruses.

Through GENETIC RECOMBINATION, the viruses can also include cell genes present in the animal that has previously eaten that GMO plant. These can reach the man who has eaten that animal causing totally unknown genetic effects.

One the most likely consequences is the outbreak of **cancers** and **leukaemias**.

Genetic modifications to progeny can be another consequence.
In these cases, the DNA system would be disrupted as happens in the case of exposure to ionizing radiations.

However, differently from ionizing radiations, there would be also the risk of new infectious diseases.

NEW INFECTIOUS DISEASES: it has been demonstrated that the CaMV genes incorporated into the plant (canola) chromosomes recombine with infecting viruses to produce new, much more virulent diseases.

This experimental model concerning the safety of transgenic plants containing viral genes such as CaMV was presented by Gal in a study published in 1992 [[387]].

About recombination between CaMV and viruses involving the promoter see also Vaden's paper published in 1990 [[388]].

Other scientific studies demonstrated that recombination of these retroviruses may take place either between DNA and DNA or RNA and RNA, thus creating new viral infections.
[[389]].

Similar related experiments suggest that altered plants may cause deadly diseases, as shown by Greene in 1994 [[390]]

Very dangerous viral DNA chains produced by normal RNA viruses are frequently propagated in the vegetable environment (GMO plants) using the CaMV 35S promoter to drive the production of RNA viruses which otherwise could not propagate in the plant DNA. From here they could pass to the animal DNA (man included) or in the bacteria or viruses DNA [[391]].

In conclusion: promoters recombine with the infecting viruses to produce virulent new diseases.
CaMV viruses and its promoters **19S** and **35S** may incorporate genes from the host plant or animal or bacterium DNA – or even from a DNA virus – creating virulent new diseases [[392, 399,400,401]].
In case of a DNA virus, CaMV can recombine with insect DNA viruses, thus propagating in the insect cells. [[393]]
As a consequence, it is likely that by eating tomatoes genetically modified with CaMV (recombined for example with hepatitis B viruses) a large number of people could create a SUPERVIRUS able to propagate in plants commonly used as food and in insects – such as mosquitoes – and then reach the man [[399]].

There are some natural retroviruses which are able to cause leukaemia, lymphomas, sarcomas or breast cancer in animals and human beings (from chapter 8 of the E-book "*Thousand Plants against Cancer without Chemo*".)

They are very dangerous and a casual recombination with the **promoter 35S** of *Cauliflower Mosaic Virus* is very likely to happen once GMO plants are introduced in the animal or/and human diet.

Search for GMO retroviruses in human tumours

It is the author's view that research should be conducted in patients suffering from tumour, to check any possible hybridation between the polysomal RNA (of suspected GMO viral origin, probably related to the modified Oncornavirus used in GMO plants to produce food) obtained from human tumours of patients who have eaten GMO food, and the DNA created in laboratory with reverse transcriptase from Oncornaviruses which have been modified to produce GMOs.

Note: all this, however, requires access to restricted, maybe patented information on retrovirus models used by GMO multinationals and modifications they made before putting GMO plants on the market.

It is much more difficult to find the specific tumour DNA viruses used by GMO multinationals to modify the DNA of commonly eaten plants, since these DNA viruses (Poxviruses, Herpesviruses, Papovaviruses, Adenoviruses) – differently from GMO Oncornaviruses – cannot be found in the serum or in the urine of patients.

It has nevertheless been demonstrated that a very specific and small part of messenger-RNA remains in the cytoplasm of mammalian tumour cells infected and modified by these tumour DNA viruses. This part of messenger-RNA does not exist in normal cells nor in tumour cells infected with other DNA viruses.

It is necessary, then, to verify the possible hybridation between this RNA-messenger – of suspected GMO viral origin, i.e. produced by a DNA virus modified to produce GMO foods – obtained from the cytoplasm of tumour cells in patients who have eaten GMO food, and the DNA created in laboratory with the same DNA viruses modified to produce GMOs.

Also in this case, access to restricted, maybe patented information on retrovirus models used by GMO multinationals and modifications they made before putting GMO plants on the market is needed.

If the hybridation takes place, thus creating a radioactive (^{32}P) hybrid DNA, it will show the presence of viral DNA sequences in the modified cells [[521]] .

Secret information

Nowadays multinationals are spreading "classified" GMOs all over the world, whose modification is not known as is protected by industrial secrecy.

Not having this information, no analyses and controls are possible.

This is a matter of grave concern as these GMOs are produced in the USA and in other countries where they are not kept separate from GMO-free products and so the exportations can be contaminated.

What should be done?

First of all, it is necessary to ask the Istituto Superiore di Sanità (Italian Health Institute), the Istituto

Zooprofilattico (Animal Disease Control Centre) in Rome, the Ministry of Agriculture and the European Commission for information and launch a parliament enquiry.

The European Commission is favouring the authorization of GMO foods in Europe, in order to avoid a complete block of importations from the USA.

It amounts to say since GMOs are in any case imported secretly, it is better to accept them in Europe so that maybe they can be controlled…

But a stronger political action in virtue of the precaution principle of Maastricht Treat is very likely to prevent GMOs from being licensed and any industrial “secrets” about genetic manipulations from being hidden.

In fact this “secret” information could regard not only the imported products but also the seeds…thus causing an irreversible and indiscriminate contamination of the European agriculture.

FIFTH POINT OF THE THREAT OF GMOs:

intoxication by poisons synthesized from transgenic plants

Chronic poisoning of foods caused by the toxic substances in insecticides which are used on plants to make them resistant to parasites such as *Bacillus touringiensis*, with a likely consequent increase in cancers, miscarriages, genetic mutations in descendants, Acquired Immunodeficiency Syndromes, degenerative diseases and diseases caused by toxic substances, etc.

For example, it has been demonstrated that GMO maize causes lesions in the oral cavity of sheep and ruminants.

A study published in 2003 [[402]] showed that eating GMO maize damages the oral cavity wall and is associated with inexplicable death in experiment animals: sheep and ruminants.

SIXTH POINT OF THE THREAT OF GMOs:

danger of worldwide famine due to "TERMINATOR" technology

Passing to natural "indigenous" species of wheat, rice, sweet corn, potatoes, legumes, because vegetables themselves cannot reproduce themselves the normal way due to "TERMINATOR" technology; this is caused by cross pollination, and it also causes irreversibly the loss of natural vegetables that are nowadays used as food by humans, as these will be polluted by the transgenic genes coming from transgenically cultivated areas (GMO) where "TERMINATOR" technology is used.

Therefore there is a potential menace of global famine in the future, something that cannot be controlled, as the world will not have sufficient quantities of wheat, rice, sweet corn, legumes, the way they are in nature, or in any case not of the "NON-TERMINATOR" kind.

SEVENTH POINT OF THE THREAT OF GMOs:

transgenic pollution of natural plants

The transmission to "indigenous" natural species of artificial toxic substances such as *Bacillus touringiensis* or others by means of cross pollination, with a potential threat also to the plants and herbs used today in herbal remedies, because the latter will also become polluted by the transgenic genes coming from the agricultural areas devoted to transgenic cultivation (GMO).

EIGHTH POINT OF THE THREAT OF GMOs:

the irreversible disappearance of the genetic inheritance of natural plants

The gradual and irreversible disappearance of biological diversity, that is of the normal, natural flora. This phenomenon is already taking place in the USA as a consequence of modern cultivation practises, which prefer transgenic monoculture (GMO) to differentiated cultivation techniques. Transgenic cultivation will pose a serious threat to those areas which are rich in biodiversity (natural genomes): the transgenic flow which will go from modified plants to natural plants will be inevitable when the numerical ratio between areas cultivated with artificial plants exceeds the areas of natural plants, thus causing the irreversible loss of a great part of the natural genetic patrimony of all the plants existing in the world: at present there are about 442,000 species already classified out of an estimated total of 600,000 – 800,000 species.

In short:
Numerous plants have already disappeared during the last few years because farmers have abandoned natural plants to adopt artificial plants, that is, genetically modified plants, because they are uniform in their genome and they yield high production (but are poor in vitamins). They are intrinsically sick (because they are incapable of surviving without pesticides), they are made sterile for economic reasons, and finally they are genetically manipulated to resist to insects and other animals because they themselves are capable of producing poisons, i.e. toxic substances which are eaten by farmyard animals and so passed on to man.

Even in the forests genetic variety is threatened today by the loss of habitat, not only caused by incorrect deforestation practices, but also by the contamination of the genetic patrimony (which has adapted to local situations) by hybrids created by large seed companies which produce GMOs.

Transgenic products *per se* therefore aim at underlining the unilaterality of monocultures, which lead to the disappearance of the natural genetic inheritance existing from hundreds of millions of years.
In a not so distant future, all the varieties of plants – used as food or not – which are typical of a region or country will not exist any more.

Environmental genetic contamination induced by hybrids created by large companies producing GMO seeds – which inevitably will cross with varieties present in nature – will cause the irreversible loss of the natural genetic inheritance and of all particular features gained by the plant genome during the long processes of adaptation to the different environmental situations.

Even natural environments such as forests are seriously threatened by this loss. Substantially the very foundations of the human Biochemistry – the human DNA – are threatened today by the reckless use of these artificial plants, without any possibilities of regaining a genetic inheritance of more than 440,000 classified species out of 600,000-800,00 estimated species. Most of these will disappear within few hundred years because of genetic damage caused by man.

Agro-alimentary Multinationals (GMO, Biotech)

For some years we have been witnessing the birth of multinationals which define themselves as "science of life multinationals", which are active in the pharmaceutical market, agri-business (seeds and pesticides) and the veterinary business.

They are, in themselves, different sectors, but they are linked by the use of biotechnology (GMO) to produce their products.

These multinationals are using unscrupulous and aggressive economic strategies: since the beginning of the 90s they have been working towards buying companies, even large companies.

One of these, *Monsanto*, within the space of a few years has acquired *Asgrov*, *Agracetus*, *De Calb*, and *Cargill* investing 10 billion euros.

Another big group, *Dupont*, has acquired *Pioneer*, investing about 8 billion Euros.

These investments do not seem to have any economic logic: they pay much more for the companies than their actual value, as if they were trying to eliminate a potential competitor rather than obtain a short term economic result.

Alongside the acquisitions we also have the mergers: *Ciba Geigy* and *Sandoz* created *Novartis* (with a turnover of 20 billion euros in the year 1997-98).

From the merger of the French company *Rhone Poulenc* and the German company *Hoechst* we have the new company *Aventis*.

Still within this context, *Syngenta*, the first worldwide agrochemical group was founded in October 2000. It is the result of a merger between the Swiss company *Novartis* (a company well-known for producing medicines for chemotherapy) and the Anglo-Swedish company *Astra-Zeneca* (a company also well-known for producing medicines for chemotherapy), and will have a turnover of about 8 billion euros. *Monsanto*, after its merger with *Pharmacia & Upjohn*, a large pharmaceutical industry (this too is well-known as a producer of medicines for chemotherapy) now concerns itself only with agriculture, with a turnover which in 2000 reached 5.5 billion dollars.

The current situation stands thus: a few multinationals (*Syngenta*, *Monsanto*, *Novartis*, *Dupont* and *Aventis*) have 25-30% of the seed market (but more than 90% of the transgenic seed market) and behind these big groups there is a plethora of smaller companies which makes one think that this trend can only get stronger in the future, since medium size companies cannot compete with these big groups. The objective seems clear: to convert the traditional seed market into a biotechnical one, i.e. GMO. But the worrying fact is that we find the same names in the field of pesticides, where the same companies control 55% of the market, and in the pharmaceutical field where the *same* companies play a dominant role.

Chemical-pharmaceutical Multinationals (Big-Farma)

The history of the chemical-pharmaceutical multinationals is incredible because of their rapid development, and today they are connected to the agro-alimentary sector in an extremely dangerous way.

The chemical-pharmaceutical industry started in Europe in the second half of the nineteenth century: in many cases they were dyeing industries which, moving away from basic chemistry, moved towards the new and more promising fields of specialized chemistry in key economic fields.

Before the Second World War, a powerful international pharmaceutical cartel developed in Germany. It controlled global pharmaceutical companies and chemical plants and was active in 93 countries, representing a powerful economic and political force in each of them. It was known as I.G. Farben.

It would become the main supporter of Hitler's chemical production during the years of war, offering products such as high explosives, toxic gases and the ignominious *Zyklon-B*, the lethal substance used by Nazis in the death camps.

In 1928, however, before the outbreak of war, the American monopolist manufacturer John D. Rockfeller had merged his international empire in America with I.G. Farben, creating the largest and most powerful pharmaceutical cartel ever seen.

The Military Nuremberg Tribunal established in 1946/47 that the Second World War would not have taken place without this petrochemical cartel called *I.G. Farben*.

As a consequence of the sentence passed by the Tribunal, *I.G. Farben* was divided into *Bayern*, *BASF* and *Hoechst*, and some executives were condemned for initiating a war against international law, genocide, the exploitation and looting of private and public properties in foreign countries and other crimes against humanity.

The events leading to the war and linked to this powerful cartel are reported in Joseph Borkin's *The Crime and Punishment of IG Farben*.
After the war, Germany, with its three large companies *Bayer*, *Hoechst* and *BASF* (which encouraged the rise of Hitler's national socialism), played an important role. So did Switzerland, which, in Basle, saw the founding and the development of companies *Ciba*, *Sandoz* and *Roche* – all of which later spread throughout the world.

But it was in the 1990s that the really big mergers started: in 1989, in the United Kingdom two big pharmaceutical companies merged to form *Smith Kline-Beecham*: later they merged with *American Home* (with an annual turnover of about 25 billion euros).

In 1993 the Swedish company *Pharmacia* bought the Italian company *Farmitalia-Carlo Erba*, then it merged with the American company *Upjohn* in 1995, and then again with *Monsanto*, before being bought by *Pfizer* which had previously bought the American company *Parke Davis*.

In 1995 there was the *Glaxo-Wellcome* merger (with an annual turnover of about 14 billion euros).

In 1998 *Smith-Kline-Beecham* (with an annual turnover of 62 billion euros) merged with *Glaxo-Wellcome* (with an annual turnover of about 90 billion euros) to make an annual turnover of more than 150 billion euros.

In the meantime the English company *Imperial Chemical Industries* merged with the Swedish company *Astra*, forming the company *Astra-Zeneca*.

These mergers have continued among the same companies operating in the same field: *Sandoz* and *Ciba Geigy* (Novartis, 1996), *Astra-Zeneca* (1998).

These huge companies have not been founded for the good of patients but out of the need to create monopolies and hence ever bigger profits.

Latest data:
June 2002: *Aventis* was taken over by *Bayer*. This allowed *Bayer* to enter the sector of GMO seeds. The merger brought to the foundation of *Bayer CropScience*, which is composed of three main commercial groups: *Crop Protection*, *Bio Science* and *Environmental Science*.

June 2005: *Sementis* was taken over by *Monsanto*.

The perverse alliance

One can thus affirm that the two cardinal points of the economy and the life of the individual, agriculture and pharmaceuticals, are substantially under the control of a few multinational groups.

CONCLUSIONS

We are faced with a choice: accepting biochemical modifications of plants leading to immense damage to human health or taking a stand together with the democratic institutions of our society against GMO and chemo-pharmaceutical multinationals, which in their perverse alliance are responsible for the reckless invasion of GMOs all over the world.

The solution is simple but there are only four months left to prevent GMOs from causing an IRREVERSIBLE event, as Prof Altieri rightly defined it:

1) Total ban on GMO cultivation
2) Total ban on experiments in the fields (risk of horizontal genetic transfer)
3) Promotion of organic farming (it produces a higher yield)
4) Defence of bio-diversity, in particular with the re-establishment of the freedom to exchange seeds.

If this does not take place, the world will need to consider the possibility of a SECOND NUREMBERG TRIALS, this time not with 4 allied judges – American, English, French and Russian – but 4 German judges instead…

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Curriculum vitae of the author

Giuseppe Nacci was born in Triest (Italy) on 26th February 1964.
He graduated in medicine at the University of Triest in the academic year 1990-1991. He specialized in Nuclear Medicine in Milan in 1996, and while there participated in the first experiments on man of oncological Radio-Immuno-Therapy with Yttrium 90 and Monoclonal Antibodies at the Scientific Institute San Raffaele and the European Oncological Institute.

In October 1998 he took up the position of Director of the Regional Sanitary Service at the Inland Revenue of Friuli Venezia-Giulia.

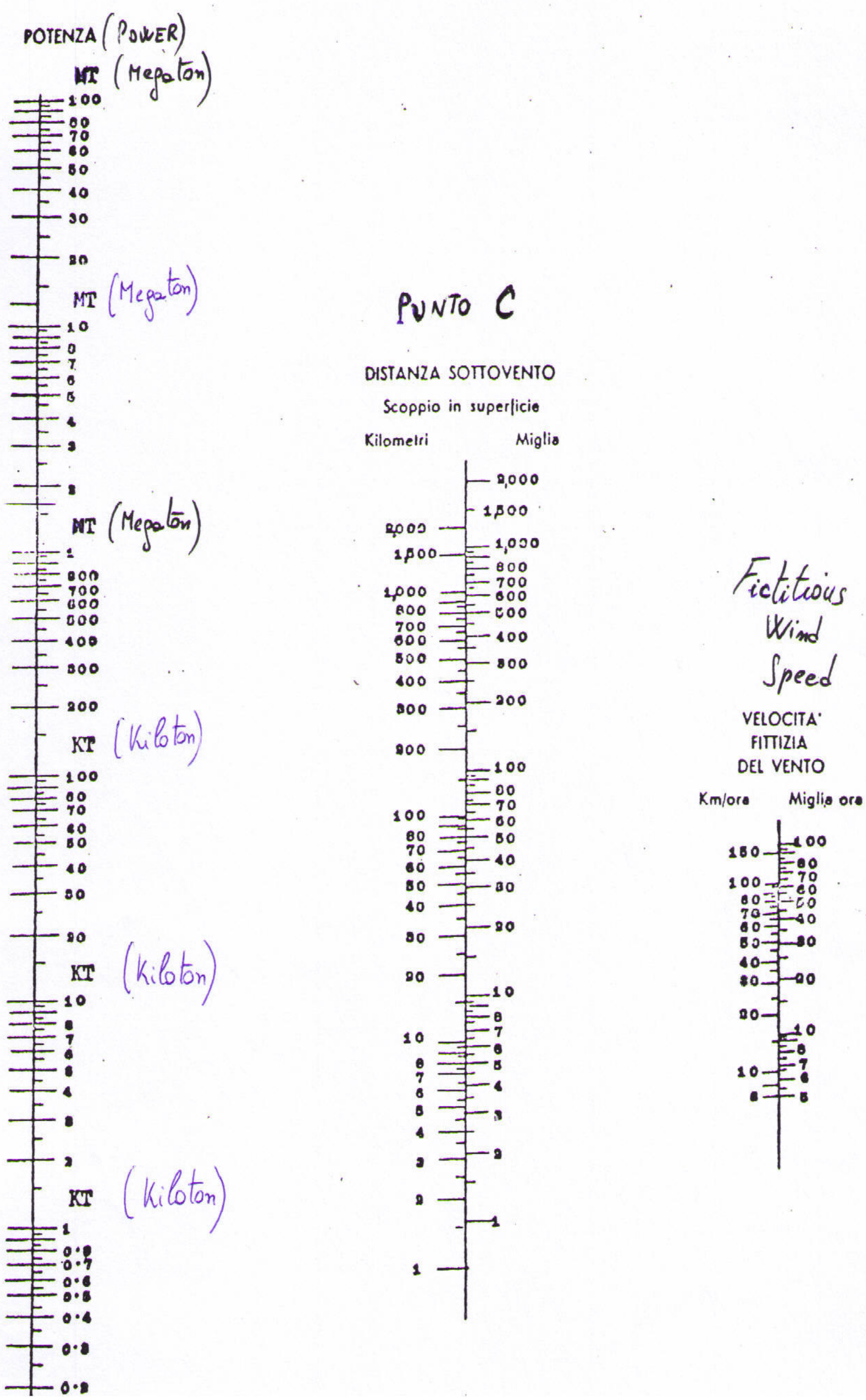
After having filed the patent of his industrial invention "*Synthesis and Use of biotin-DTPA-Gadolinium 157, 159 for radio-therapy*" (No. 01313103, class A61K051), he published "*Therapy of tumors with Gadolinium 159 in Nuclear Magnetic Resonance*", 760 pages, Callerio Onlus Foundation, published by "Italo Svevo" publishing house of Triest, May 2000 (only Italian version).

In October 2006 he published the book "Diventa Medico di Te stesso" (*Become your own doctor*)" (www.macrolibrarsi.it/libro.php?cid=1&sid=115&lid=11913).

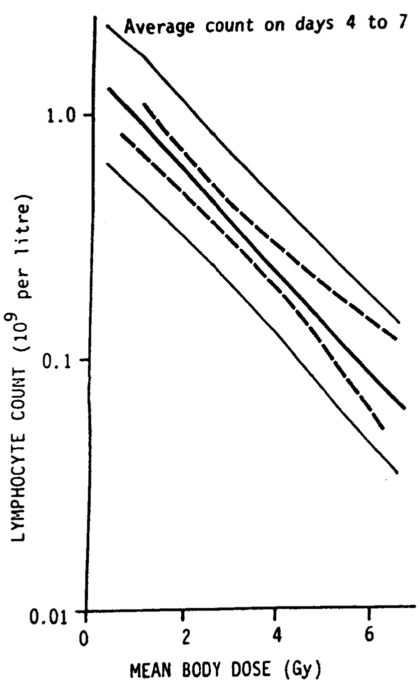
In January 2007, this book was awarded the following prize: "*Best scientific book of year 2006*", given "*motu propriu*" and unanimously (www.mednat.org/The-best-book_Nacci.gif) by the Board of Councillors (www.mednat.org/Miglior-libro_Nacci.gif) of the *Verein zur Foerderung der Forschung Mare Nostrum – Research Institut* (*Association for Promotion of Research Mare Nostrum*) in Wildon (Graz) Austria.

From October 2008 it's Project Manager Environment & Health
of " V.F.F. Islandhopper Viribus unitis "
http://technologies.ew.eea.europa.eu/technologies/pollut_mngt/waste/innovative-management-waste/mare_nostrum/

Fig. 1 – Nomogram for predicting Radioactive Fall-out (local Fall-out): Since the power of the explosion is known, in kilotons (KT), and the Fictitious Wind Speed, Point C can be identified on the middle line:
The nomogram is taken from: Difesa N: Tabelle, nomogrammi e grafici, Roma, Cecchignola: Scuola Unica Interforze per la Difesa NBC, 1980



Figs. 2, 3. – Estimate of the total gamma dose absorbed (x-axis), according to the haematic-lymphocyte count (y axis). Average lymphocyte count between day IV and VII (y-axis). The x-axis shows the estimated total dose in Grays absorbed (1 Gray = 100 RAD). 3) Minimal lymphocyte count between day I and day VIII (y-axis). The x-axis shows the total estimated dose in Grays absorbed. Figures taken from Guskova AK: *Acute radiation effects in victims of the Chernobyl nuclear power plant accident*. In: Sources, Editor. Effects and Risks of ionizing Radiation. United Nations Scientific Committee of the Effects of Atomic Radiation, UNSCEAR, 1988, page. 617. Report Fig. IIA.



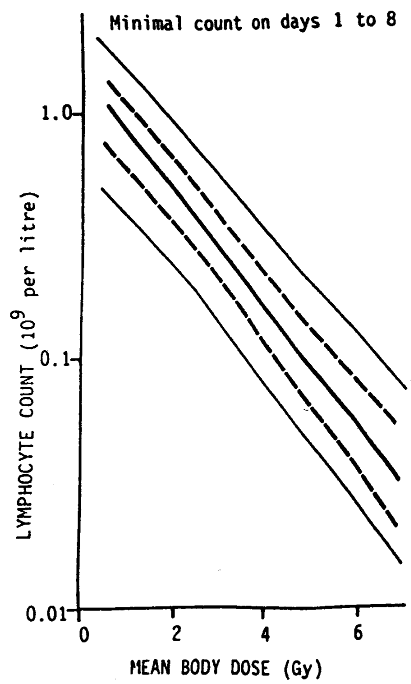
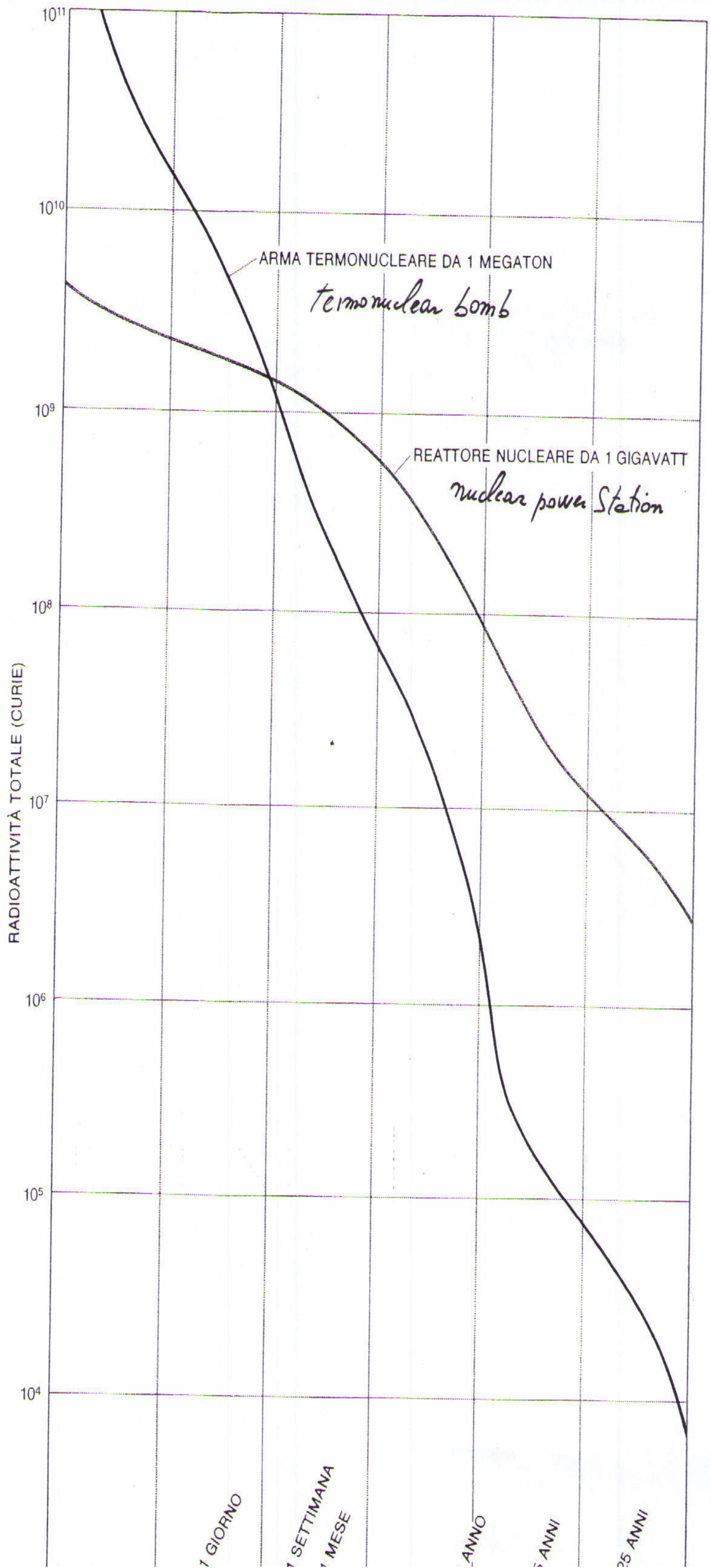
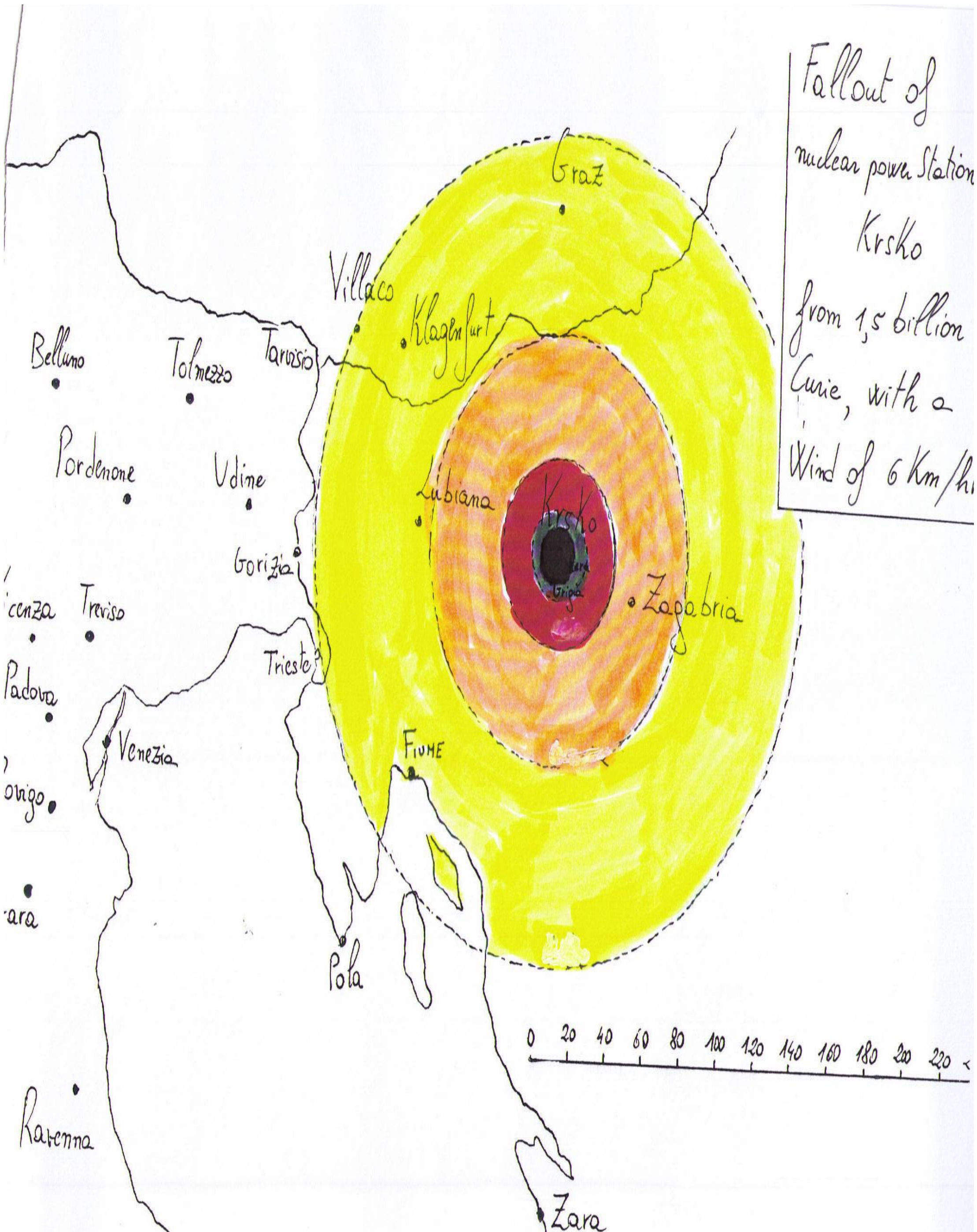


Fig. 5:
Two
Decay
Curves

Giorno : day
Settimana : week
mese : month
anno : year
anni : years
Tempo : Time
ore : hours




Fallout of
nuclear power Station
Krsko
from 1,5 billion
Curie, with a
Wind of 6 Km/h
Graz
Villaco
Klagenfurt
Belluno
Tolmezzo
Tarvisio
Pordenone
Udine
Lubiana
Krsko
Grigia
Gorizia
icenza
Treviso
Zagabria
Trieste
Padova
Venezia
Fiume
ovigo
ara
Pola
Ravenna
Zara
0 20 40 60 80 100 120 140 160 180 200 220

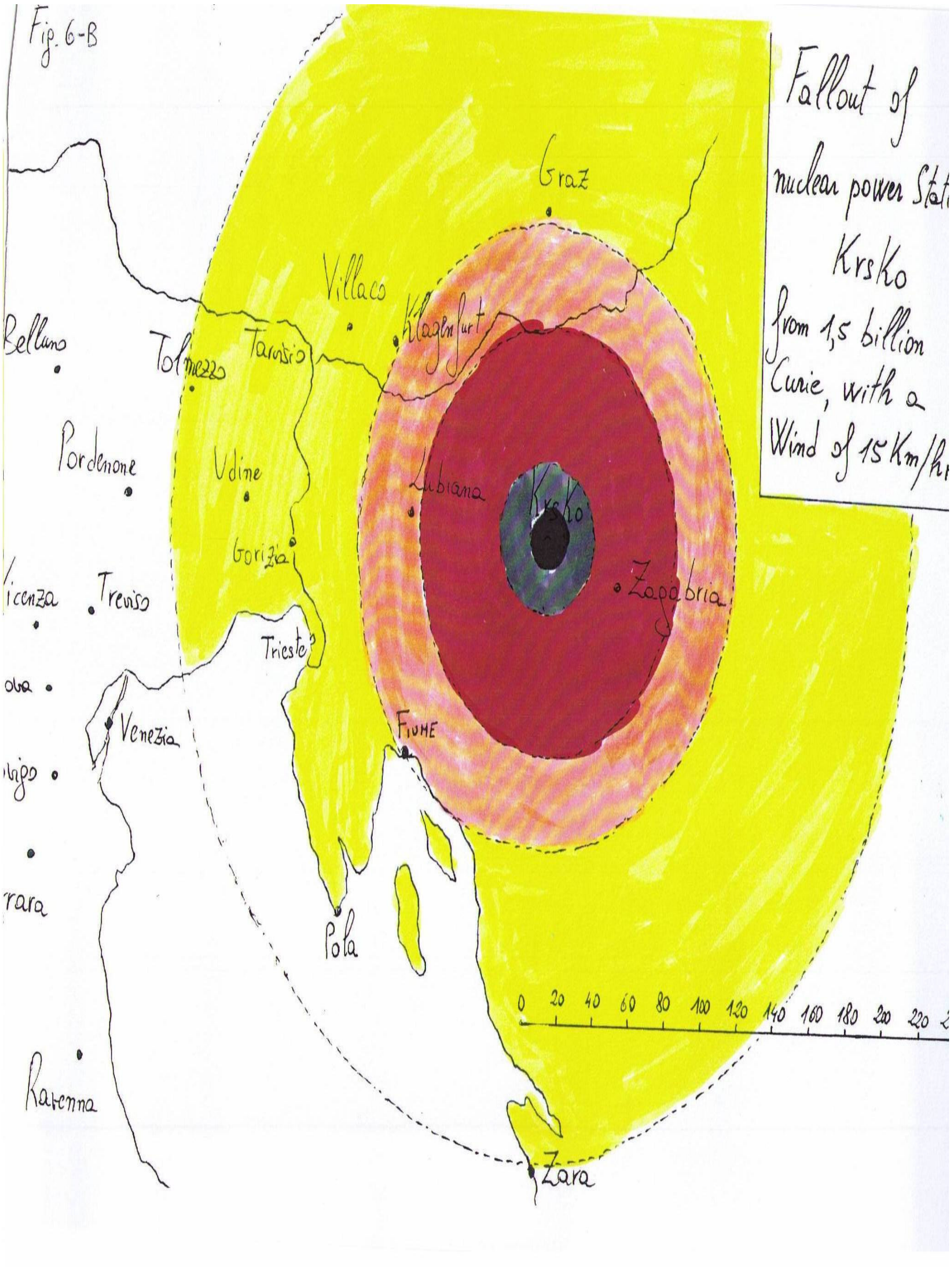


Fig. 6-B
Fallout of nuclear power Stati
KrsKo
from 1,5 billion Curie, with a Wind of 15 Km/h
Graz
Villaco
Klagenfurt
Bellano
Tolmezzo
Tarvisio
Pordenone
Udine
Lubiana
KrsKo
Gorizia
Zagabria
Vicenza
Treviso
Trieste
Venezia
Fiume
Pola
Ravenna
Zara
0 20 40 60 80 100 120 140 160 180 200 220


Fallout of nuclear power Station KrsKo from 1,5 billion Curie, with a Wind of 30 Km/hr
Graz
Villaco
Klagenfurt
Belluno
Tolmezzo
Tarvisio
Pordenone
Udine
Lubiana
KrsKo
Gorizia
Zagabria
Treviso
Trieste
Venezia
Fiume
Ferrara
Pola
Ravenna
Zara
0 20 40 60 80 100 120 140 160 180 200 220

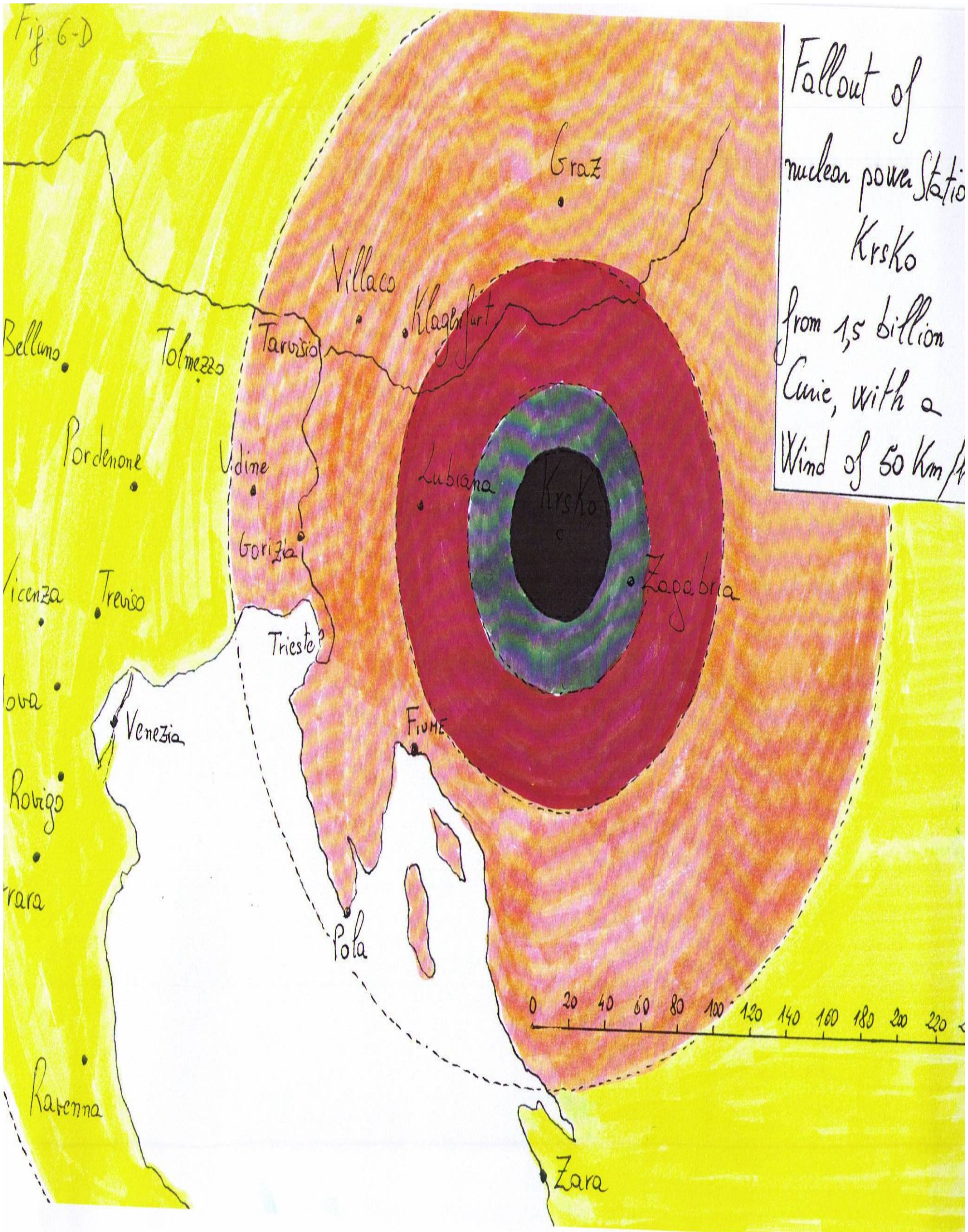


Fig. 6-D
Fallout of nuclear power Station Krsko from 1,5 billion Curie, with a Wind of 50 Km/h
Graz
Villaco
Klagenfurt
Tarvisio
Belluno
Tolmezzo
Pordenone
Udine
Lubiana
Krsko
Gorizia
Zagabria
Vicenza
Treviso
Trieste
Venezia
Fiume
Rovigo
Pola
0 20 40 60 80 100 120 140 160 180 200 220
Ravenna
Zara

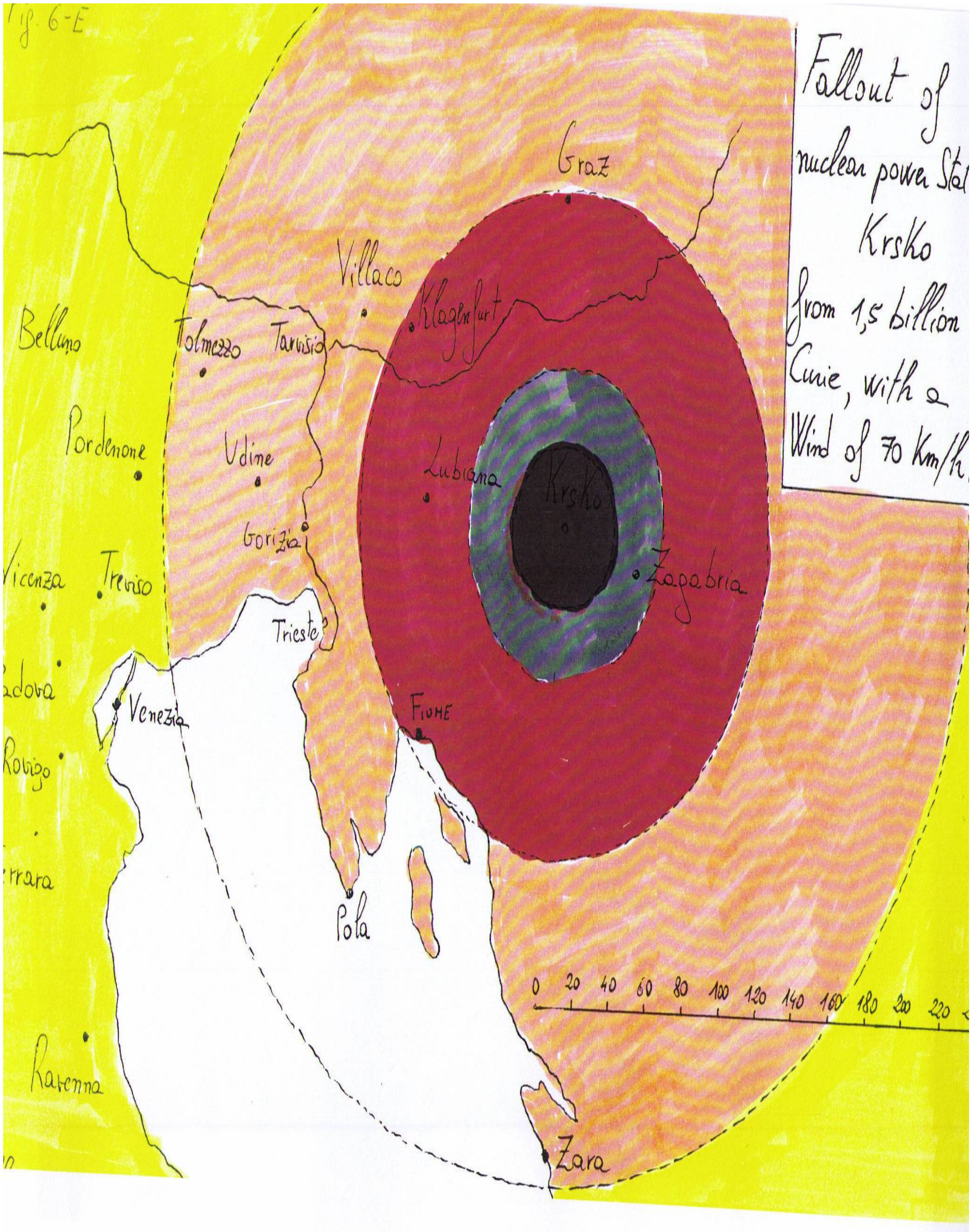


Fig. 6-E
Fallout of nuclear power Stat
Krsko
from 1,5 billion Curie, with a Wind of 70 Km/h
Graz
Villaco
Klagenfurt
Belluno
Tolmezzo
Tarvisio
Pordenone
Udine
Lubiana
Krsko
Gorizia
Zagabria
Vicenza
Treviso
Trieste
Padova
Venezia
Fiume
Rovigo
Ferrara
Pola
0 20 40 60 80 100 120 140 160 180 200 220
Ravenna
Zara


Fig. 6-F
Fallout of nuclear power Station Krsko from 1,5 billion Curie, with a Wind of 100 Km/h.
Graz
Villaco
Klagenfurt
Tarvisio
Tolmezzo
Pordenone
Udine
Lubiana
Krsko
Gorizia
Zagabria
Treviso
Trieste
Venezia
Fiume
Pola
Zara
Ravenna
0 20 40 60 80 100 120 140 160 180 200 220

Figura 7: linee di isodose da *Fall-out*, tracciate rispettivamente ad ore + 1, +6, +18 da esplosione atomica da 1 megatone (MT) (1.000 chilotoni) al suolo, con Velocità fittizia di vento di 23 Km / h.

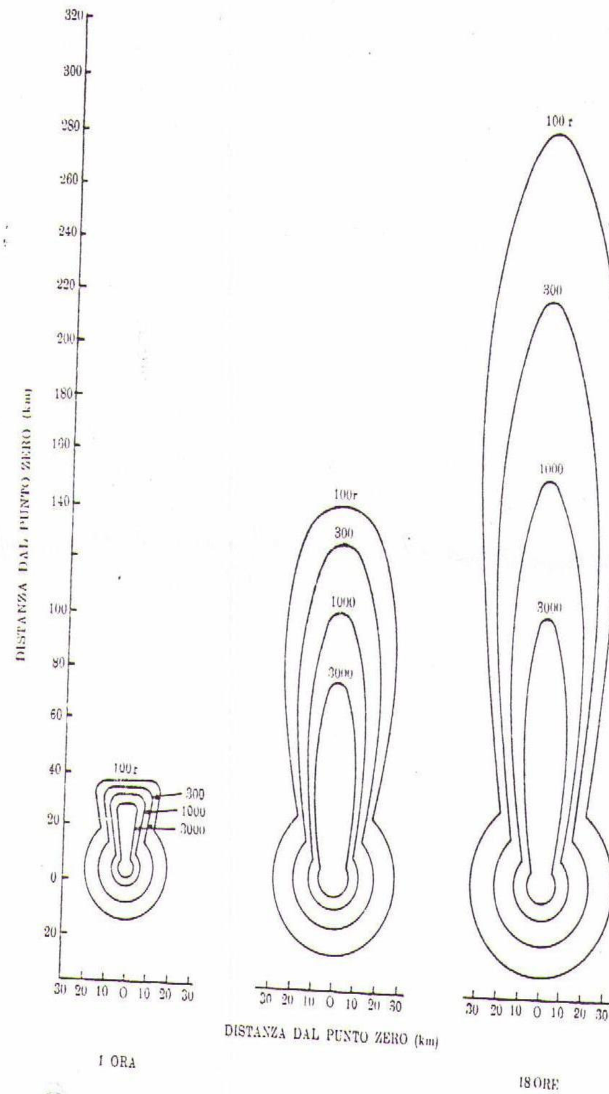


Fig. 7 - Linee isodose ad 1, a 6 ed a 18 ore dopo l'esplosione in superficie di una bomba a fissione di energia dell'ordine del Mt (velocità del vento efficace 23 chilometri all'ora).

Fig. 8 Haaland

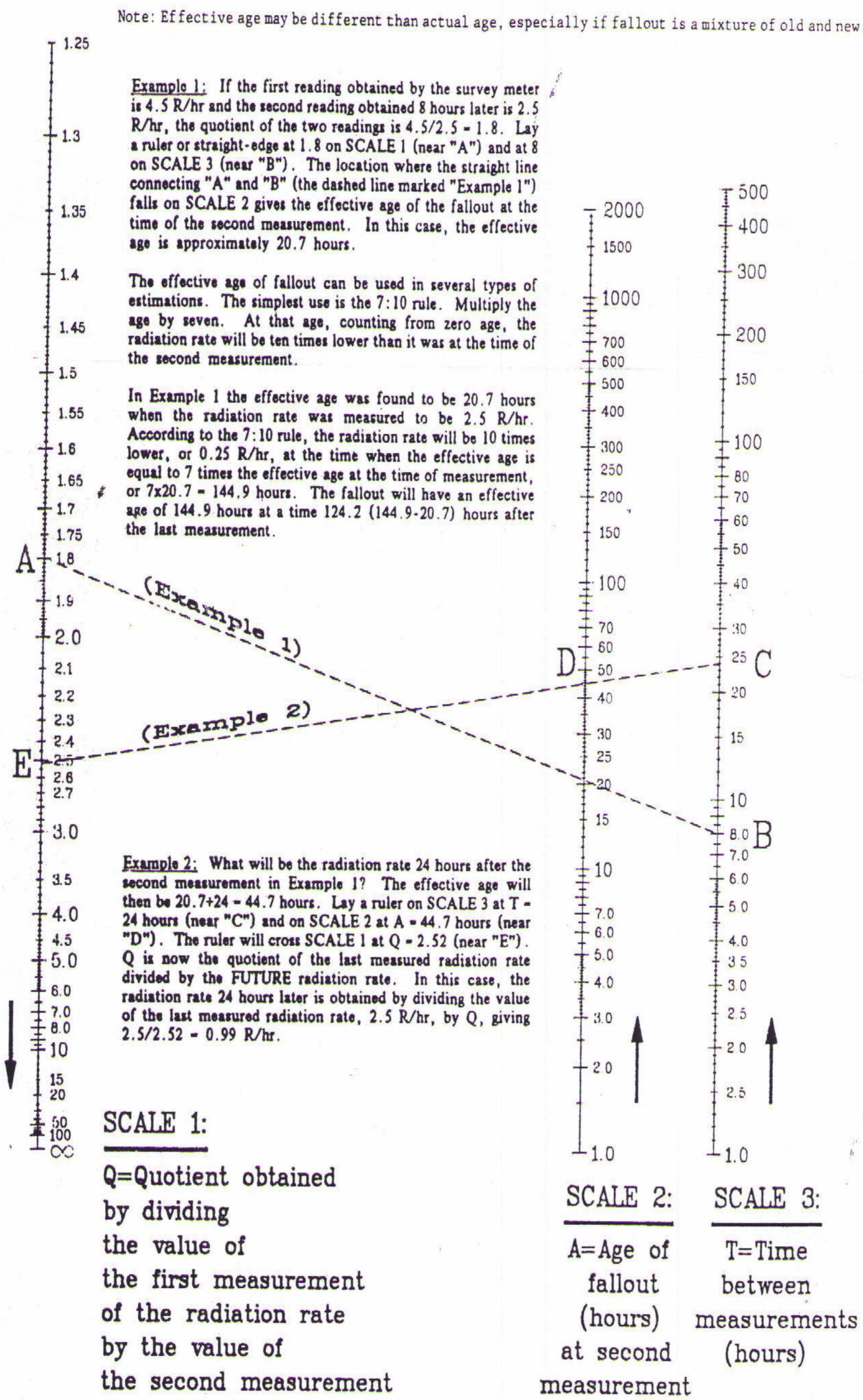
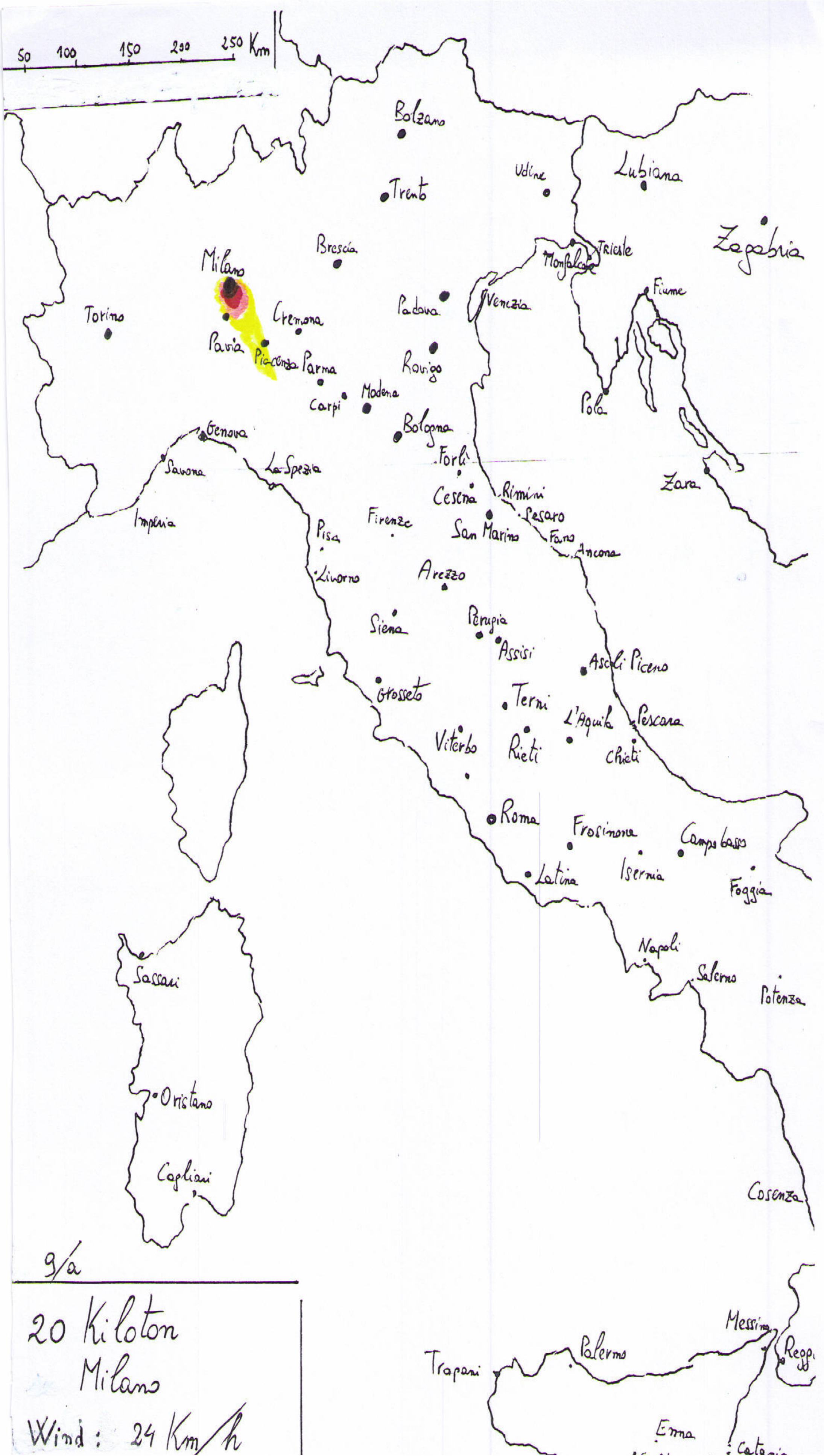


Fig. 1. A nomogram for determining the effective age of fallout and predicting future radiation rates. The examples of the nomogram text are provided for self-instruction for potential users of high-range U.S. civil defense survey meters, which are all calibrated in units of roentgens per hour. Because Scale 1 involves the quotient of the radiation measurements, the nomogram is independent of the radiation units used. Values obtained from the nomogram are valid for any pair of radiation rate measurements, whether provided in becquerels, centigrays per hour, grays per hour, milliroentgens per hour or roentgens per hour.



50 100 150 200 250 Km
Bolzano
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Brescia
Milano
Torino
Cremona
Padova
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Rovigo
Modena
Carpi
Bologna
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Genova
Savona
La Spezia
Forlì
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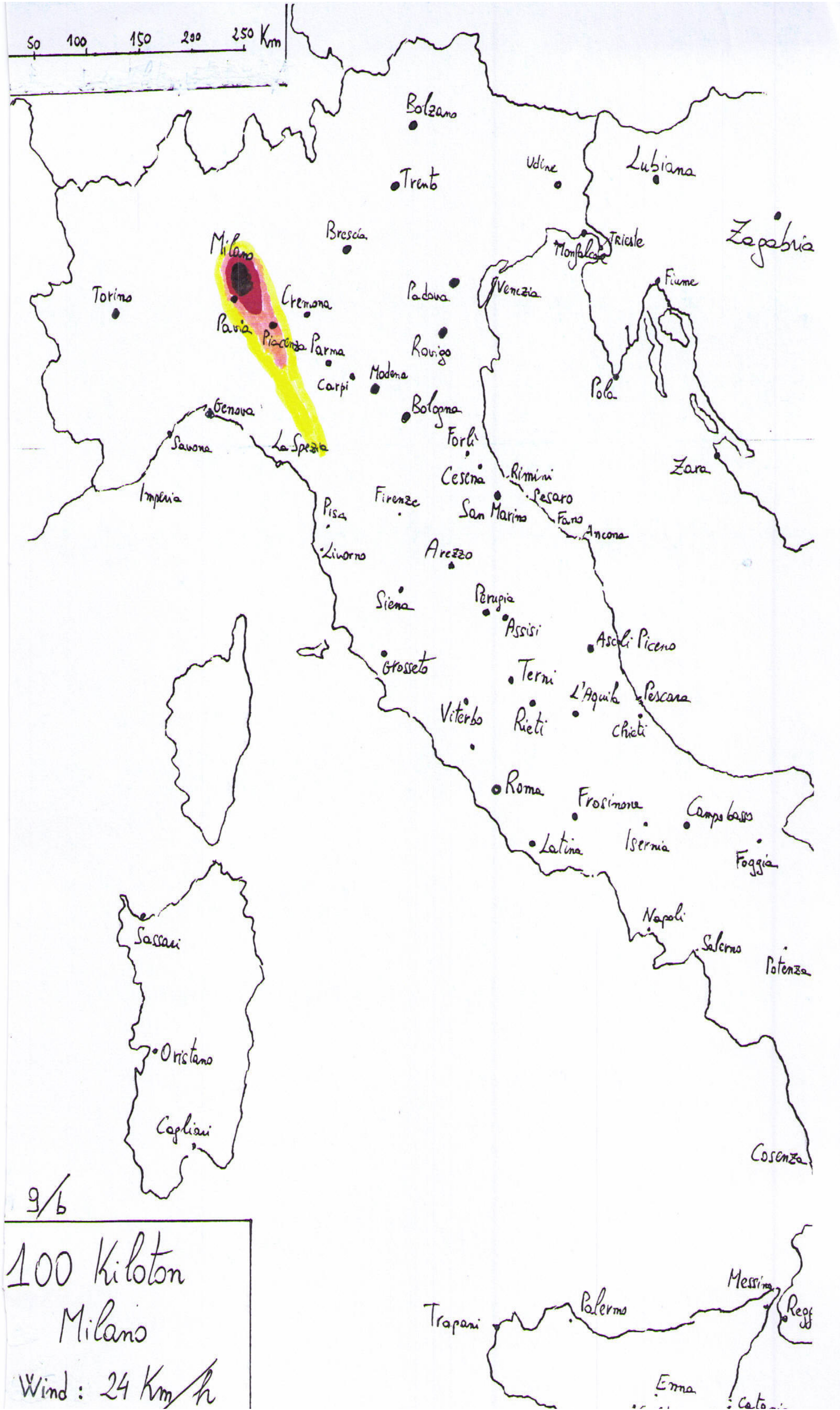
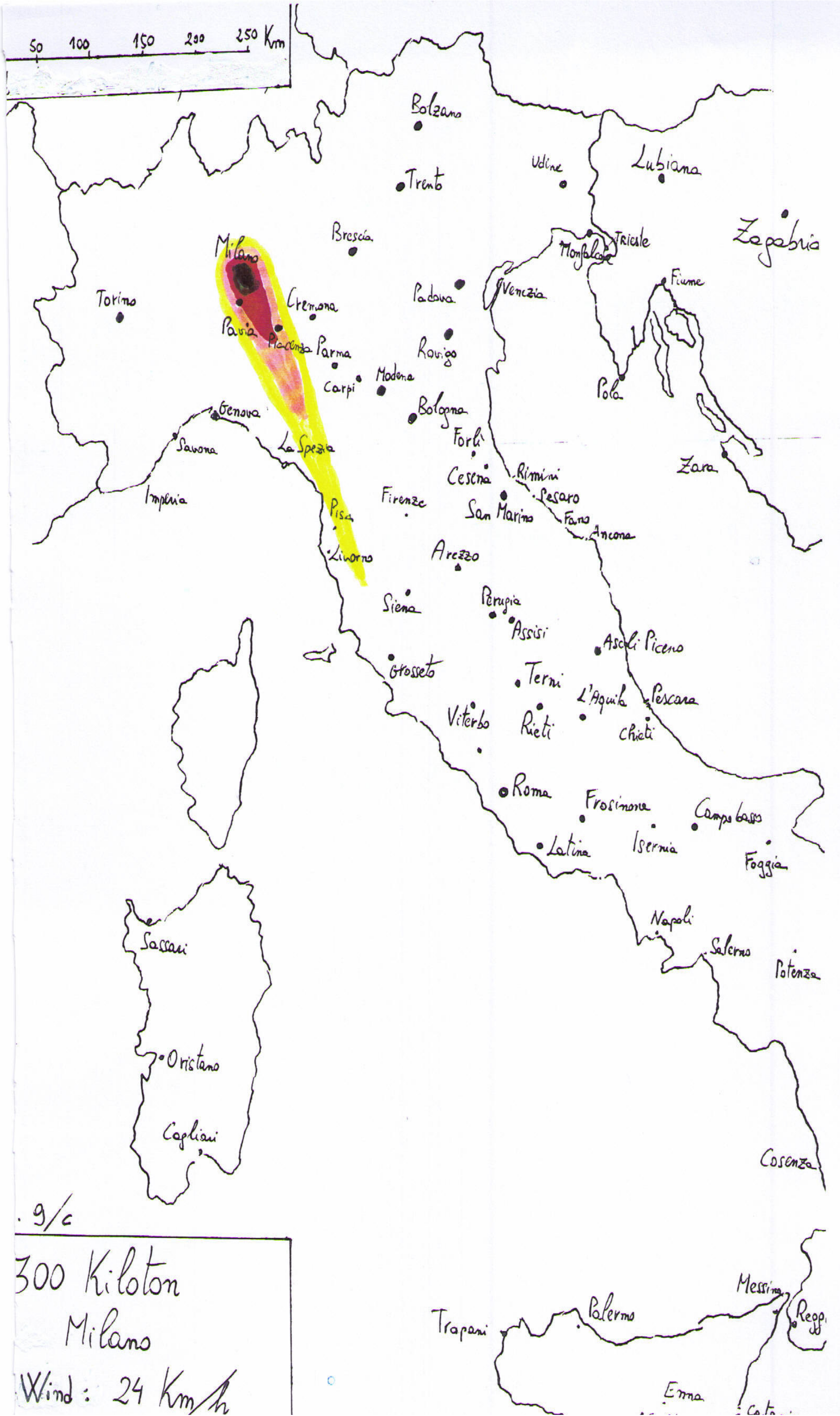
Rimini
Pesaro
Zara
Imperia
Firenze
Pisa
San Marino
Fano
Ancona
Livorno
Arezzo
Siena
Perugia
Assisi
Ascoli Piceno
Grosseto
Terni
L'Aquila
Pescara
Viterbo
Rieti
Chieti
Roma
Frosinone
Campobasso
Latina
Isernia
Foggia
Napoli
Salerno
Potenza
Sassari
Oristano
Cagliari
Cosenza
9/a
20 Kiloton
Milano
Wind: 24 Km/h
Messina
Palermo
Trapani
Enna



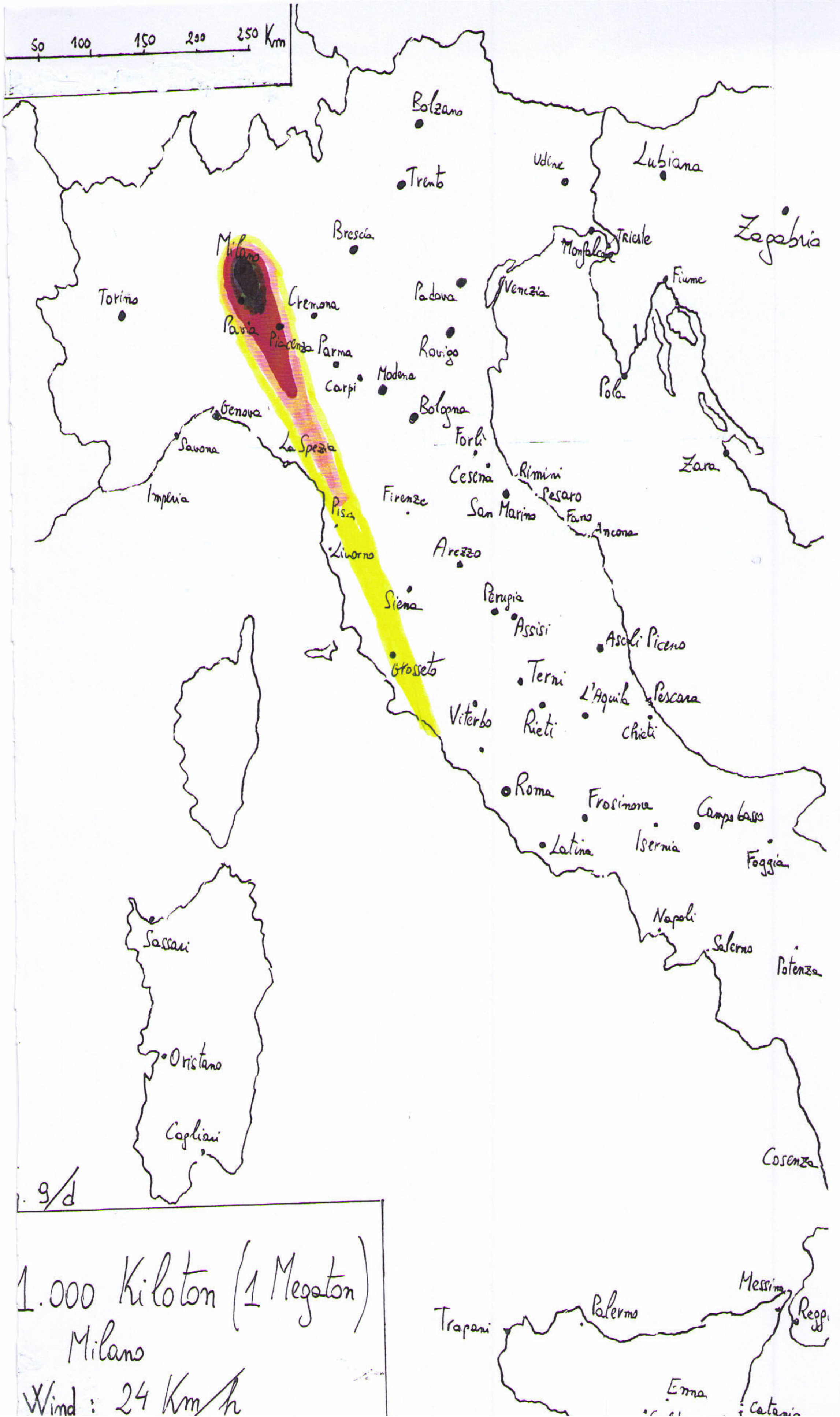
9/b

100 Kiloton
Milano
Wind : 24 Km/h



. 9/c

300 Kiloton
Milano
Wind: 24 Km/h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Isernia
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Potenza
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Wind : 24 Km/h
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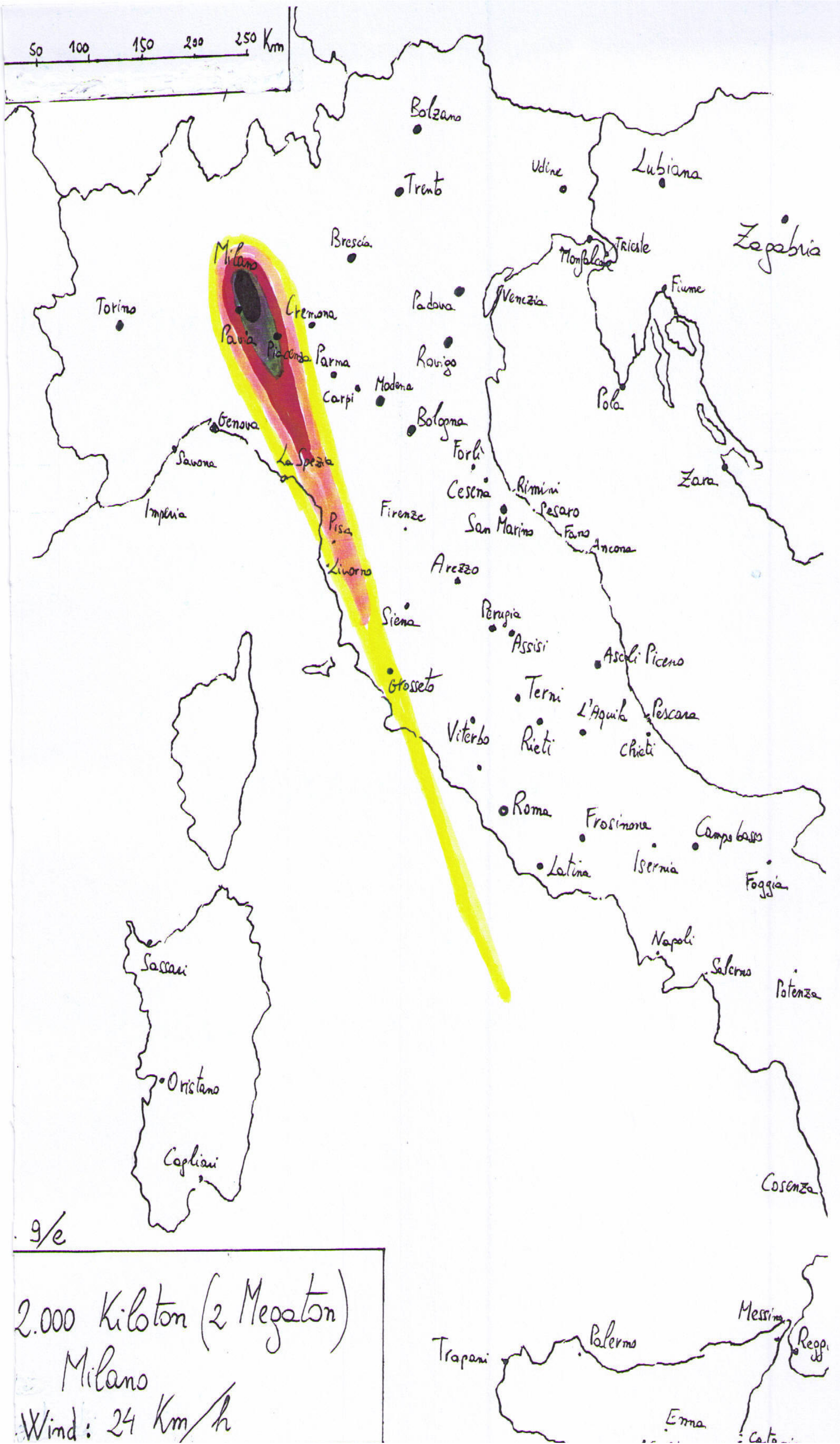
Palermo
Trapani
Enna



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Salerno
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2.000 Kiloton (2 Megaton)
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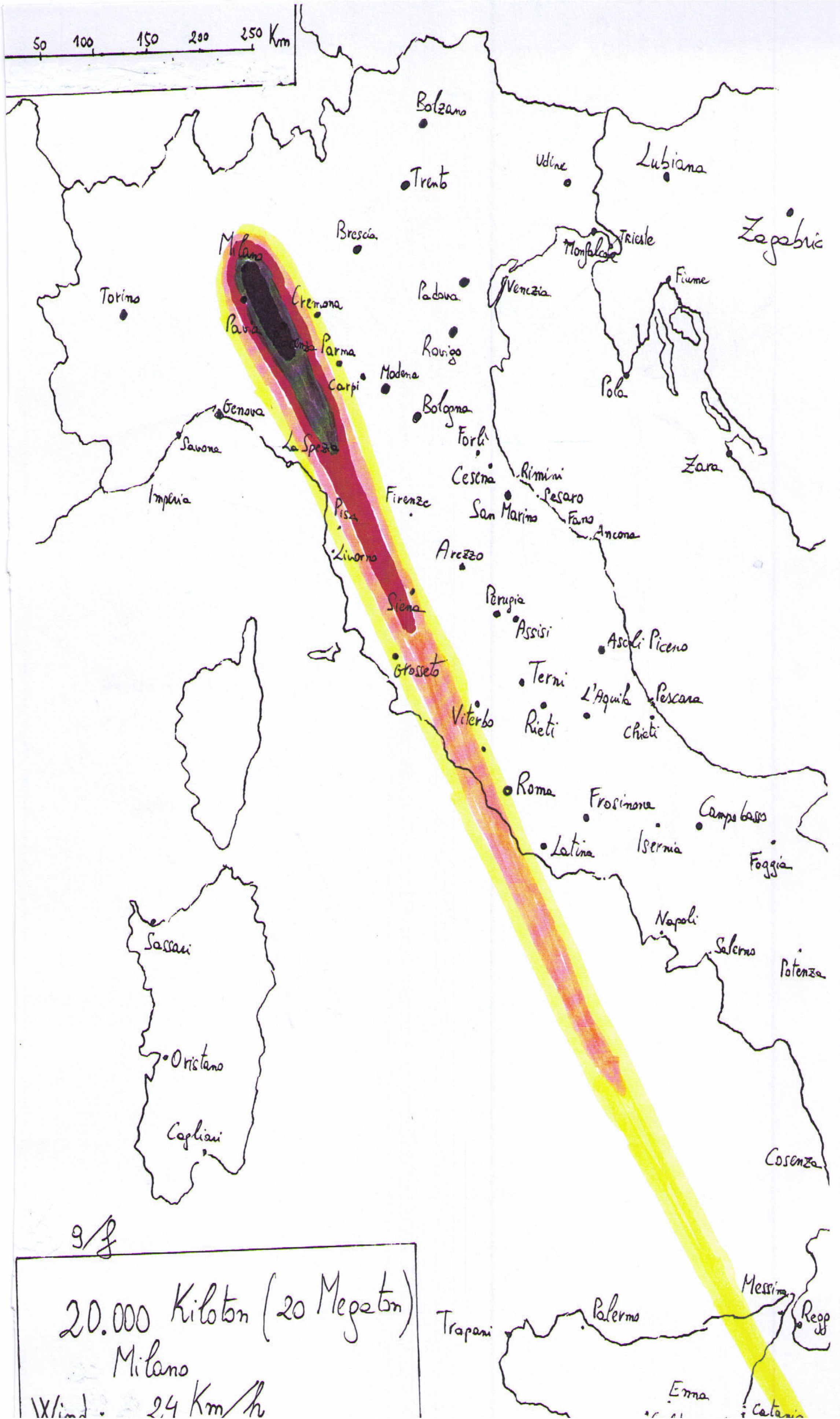
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Cesena
Rimini
Imperia
Firenze
Pesaro
San Marino
Fano
Pisa
Ancona
Livorno
Arezzo
Perugia
Siena
Assisi
Ascoli Piceno
Grosseto
Terni
L'Aquila
Pescara
Viterbo
Rieti
Chieti
Roma
Frosinone
Campobasso
Latina
Isernia
Foggia
Sassari
Napoli
Salerno
Potenza
Oristano
Cagliari
Cosenza
9/f
Messina
Trapani
Palermo
Reggio
Enna
Catania
20.000 Kiloton (20 Megaton)
Milano
Wind: 24 Km/h