RESIDUAL RADIOACTIVITY and the Grand Strategy of the United States
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RESIDUAL RADIOACTIVITY

and the Grand Strategy of the United States

By Dr. Edgar A. Parsons

Charts and Photos Supplied by Author.

THE GROWING FUND OF KNOWLEDGE concerning residual radioactivity, or fallout, makes imperative a re-examination of our military policy of massive retaliation. Viewed in the light of present knowledge, the conclusion is inescapable that the concept of massive retaliation must be altered drastically.

Fallout affects the lives and fortunes of Americans in this and succeeding generations, as well as the fate of our Allies and all the peoples of the earth. A recognition of the hazards and implications of the effects of fallout will govern our plans for the employment of intermediate range ballistic missiles (IRBM) and intercontinental ballistic missiles (ICBM); the type of employment necessarily dictates the numbers of these missiles to be produced. An analysis of our present course will not only save billions of dollars, but save the US and perhaps much of the world from catastrophe or oblivion. What we do with certain newly-released information is our decision, and in a democracy such fateful decisions are appropriately made by an informed and enlightened citizenry.

The purpose of this analysis is to relate the significance of residual radioactivity to the present massive retaliation strategy of the US. The method is first to establish the magnitude of the problem by citing the estimated casualties from our present war plans; then to describe fallout in general terms, including its distribution locally and world wide. Following this is a review of certain calculations giving the world's maximum permissible concentration of contaminations and yields from nuclear and thermonuclear weapons, and a limited evaluation of certain operational procedures which maximize the fallout hazard. Recommendations and suggestions are also given.

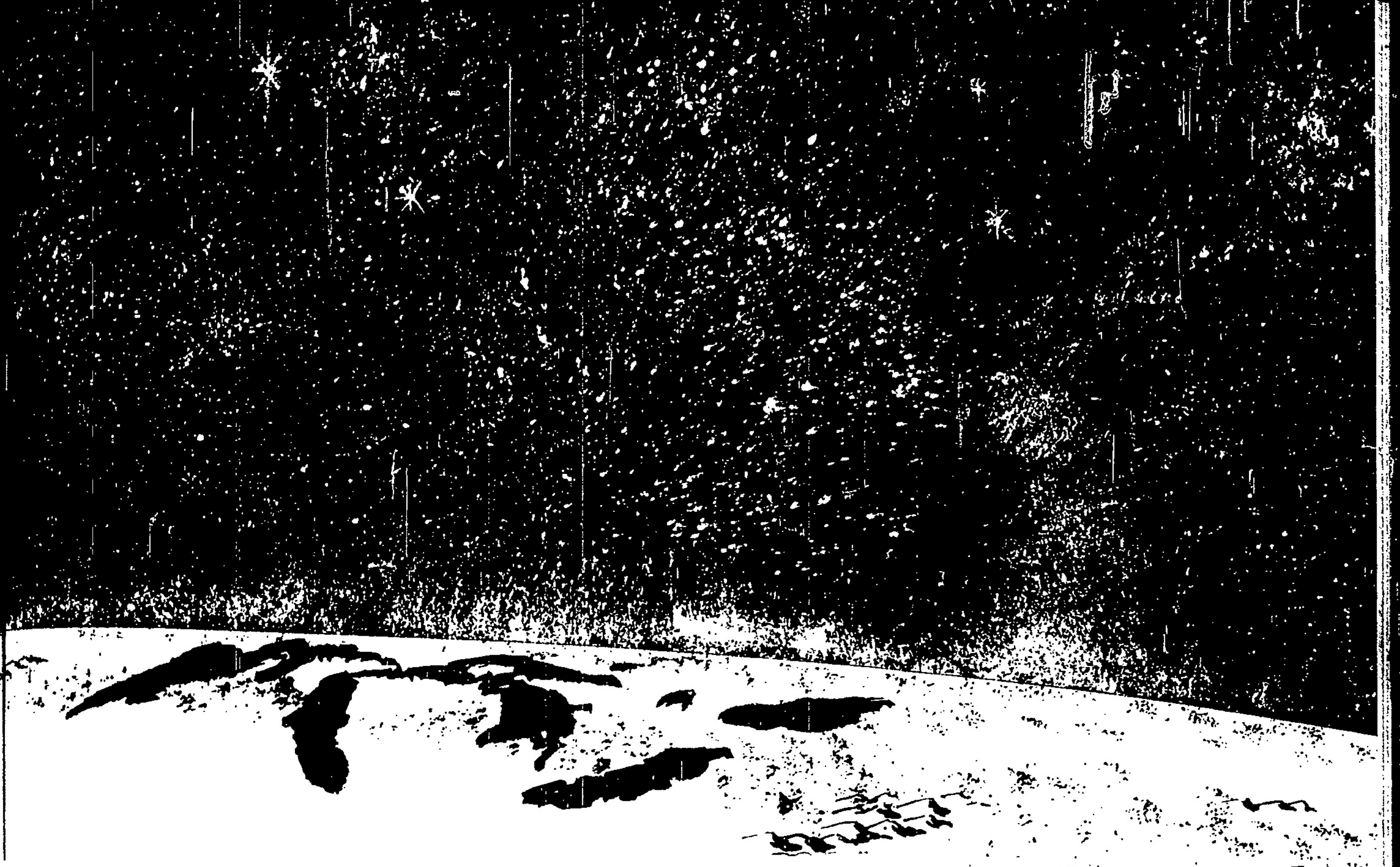
There is a limitation to the total number and yield of thermonuclear bombs that can be absorbed by the earth and the peoples on the earth. To exceed this number would jeopardize the continuation of life on earth as we know it. To stay beneath this maximum number does not mean an absence of harmful effects. By directing attention to wartime concepts of employment of thermonuclear weapons, it is intended to avoid the kind of political controversy that sparked the latter days of the 1956 presidential campaign.

While there may have been room between the 2 political parties for controversy regarding the radiation hazards of peacetime testing, there was implicit acknowledgment of the mutual extermination levels resulting from wartime exchanges of thermonuclear weapons.

The world was shocked in June of 1956 by the officially released testimony that current war plans of the US contemplated "several hundred million deaths" from fallout. These casualties would result from massive retaliation on the USSR, but would not be confined to the territory of the Soviet Bloc. According to Lt Gen Gavin, who described these war plans in Congressional testimony, the nationality of millions of these casualties would be determined by the winds at the time of attack. Casualties might occur in India, Japan and the Philippines; on neutral countries and hostile countries. Lt Gen Gavin went on to state, "If the wind blew the other way they (the fallout casualties) would extend well back up into Western Europe."

The world-wide ignorance of this description of US war plans is not difficult to understand. A report to the Congress on 27 July 1956, summarized the present status of public understanding of fallout as follows:

"In 1948 the Hopley report believed it unlikely that atomic bombs would be exploded on the ground



and thus create a major fallout problem for civil defense. . . .

"Official announcement of the fallout hazard was not made by the Atomic Energy Commission until February 1955.

"The information released on that date by the AEC might easily convey to the lay reader a misleading impression of the extent and duration of the radioactivity hazard. While explaining that fallout is due to surface nuclear explosions which draw up large amounts of materials into the bomb cloud, the first paragraph of the statement also observes that the 'main radioactivity' is dissipated within a few hours and concludes with a sentence that air explosions do not produce any serious radiological hazard.

"The AEC release referred to radioactivity within the first 36-hour period. The persistent or lingering radioactivity received practically no attention. Dr. Libby acknowledged that there was no reason to confine the discussion in that manner and states it 'was an inadvertent omission.'

"The subcommittee sees no excuse for inadvertencies or casual treatment of atomic energy when life and death matters such as this are involved. The AEC displays a kind of easy optimism about nuclear explosion effects. The AEC spokesmen dwell upon the effects of 'nominal' bombs rather than those of the high-yield megaton weapons. Data presented to the subcommittee on the intensity of local radiation hazards are diluted by resort to global averages and other minimizing assumptions. The genetic effects of radioactivity are passed by with the comment that 'there is a wide range of admissible opinion on this subject.' Important information on atomic energy is often released in driblets, through speeches of AEC Commissioners, and couched in highly technical and hypothetical terms rather than in authoritative, concise, plain-spoken facts."

In recognition of the extreme dangers of fallout, the current planning assumptions of the Federal Civil Defense Administration assume "that surface bursts *will* generally be employed since radioactive fallout from such bursts can increase casualties and interfere with military or civilian activity for days or weeks."

LtGen Gavin's testimony on current war plans was reviewed twice by both the Security Review Branch of the Department of Defense and also by VAdm Arthur C. Davis, who was especially recalled to active duty

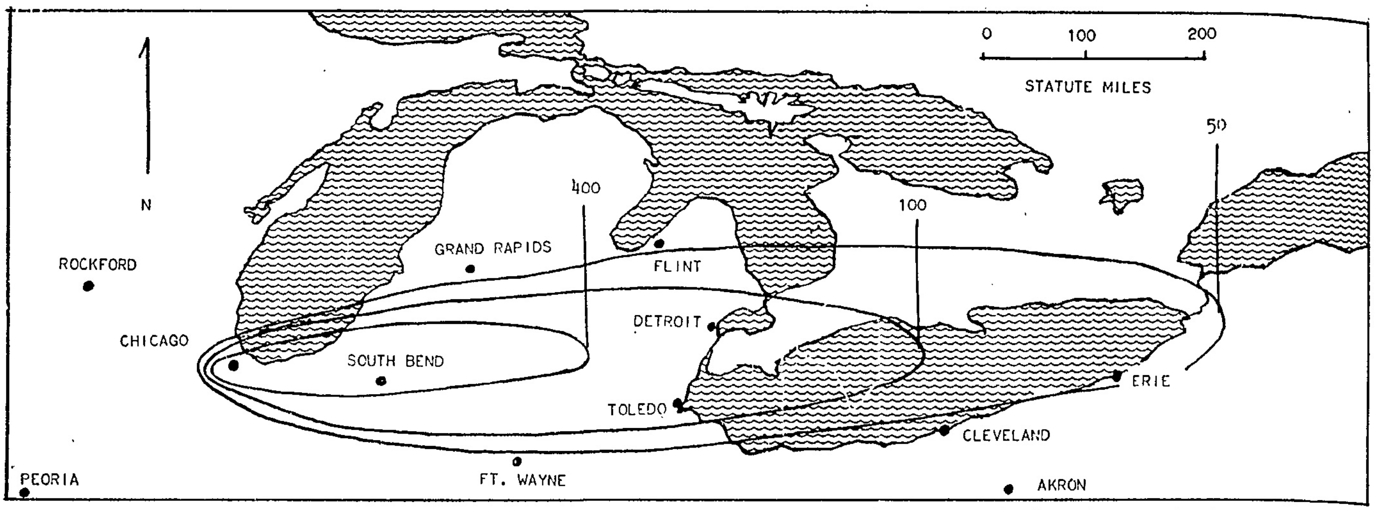


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Figure 1: Fallout Pattern from a Typical High-Yield Bomb Cloud

to serve as censor at the Air Power hearings. The passages on fallout deaths were not questioned by these censors. Department of Defense officials were, nevertheless, described as being "shocked" at the release and "made vain efforts to prevent publication of the testimony."

Incidents such as these tend to reinforce the conclusion that if the characteristics of fallout are not fully understood, they may not be given adequate consideration in the design of an optimum military strategy.

Since fallout may produce most of the casualties and continue to affect the world environment for years, a review of its more significant characteristics is appropriate. Prompt radiation is relatively insignificant as compared with either blast and thermal damage, or fallout, and the effects of prompt radiation are herein considered to be included with blast and thermal damage.

Fallout covers areas far greater than the blast and thermal area of high-yield weapons. For example, using the well-known cube root scaling law, the area of complete destruction from a 10 MT weapon is about 47 square miles; light damage will occur as far as 16 miles from ground zero, or a total blast area of almost 800 square miles.

By contrast, the area encompassed within an idealized fallout pattern is approximately 25,000 square miles.

The magnitude of the fallout area is illustrated in Figure 1 by superimposing, on a Chicago ground zero, the fallout pattern from the averaged or "idealized" winds and the yield of the 1 March 1954 detonation at the Pacific Proving Ground. Within this 25,000 square mile area, stretching from Chicago to Buffalo, some 12,500 square miles would be contaminated with an effective biological dose in excess of 100r; and inside that 12,500 square miles, approximately 5,000 square miles (the area of the State of Connecticut) would be contaminated with an effective biological dose in excess of 400r. Inside the 400r area, a significant percentage of persons would be expected to die; at the 100r line, a few percent would become ill, and the 50r line indicates the general extent of the area within which substantial emergency protection measures would be required.

Different yields of weapons, wind structures, altitude of detonation, or kinds of land surfaces would result in different patterns; also this is the amount of fallout for a *single* high-yield weapon. Further, the actual number of casualties would depend on the amount of special protective shelter available, the precautions taken by the persons within the contaminated areas, the effective biological dose as contrasted with the total dose, etc. Space limitations forbid detailed analysis here of the effects of radiation, but the literature on this subject is becoming plentiful.

In considering the pattern of fallout on the surface of the earth, it is convenient to use an idealized curve which simplifies the outline of areas. Actual boundaries are described by much more complex curves which result from variations in wind vectors and the configuration of the surface. Figure 2 illustrates the effect of dif-

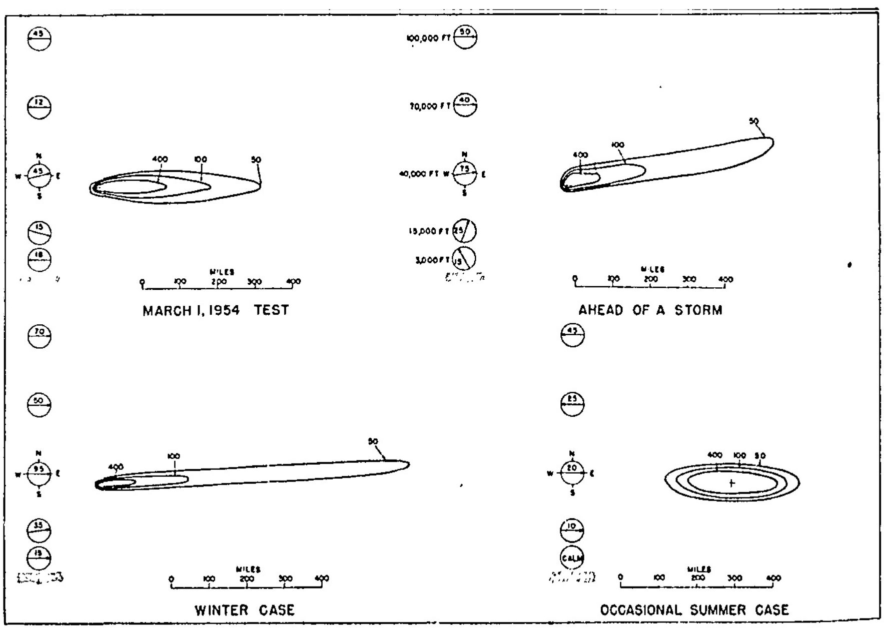

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Figure 2: How Winds and Seasons Affect Fallout Pattern

ferent winds on the idealized fallout pattern. In the lower left of Figure 2 is shown the fallout pattern one might expect in the winter with wind speeds of over 100 miles per hour.

The upper right hand portion of Figure 2 shows the effects of very high winds in the upper altitudes, such as might precede a storm.

The lower right hand illustration in Figure 2 shows a pattern found in the southern US with westerly winds in the lower levels, and easterly winds in the higher altitudes.

The upper half of Figure 3 compares the average winter winds with the average summer winds. The winter winds are much stronger and tend to blow in a more definite west to east direction; whereas the summer winds, especially in the southern US, have no single precise wind direction. Also shown in Figure 3 are hypothetical fallout patterns for an individual winter day and for an individual summer day. In the case of the pattern in the Los Angeles area, the winter fallout would have been deposited in a northeasterly direction; in the summer, the Los Angeles fallout would have been to the southeast. Similarly, the winter fallout for the New York City area would have been deposited northeasterly, and due east in the summer.

Figure 4 (next page) is a map of the US showing the fallout patterns assumed for Operation Alert 1956. The lowest radiation intensity shown in Figure 4 is 100 roentgens. If the 50r line utilized in Figures 1-3 were shown, the areas covered would have been much greater. It is interesting to note the extremely large areas covered by an attack with a total yield of only 70 megatons, two-thirds of which were air bursts and thus did not contribute to the local residual radioactivity.

Using the normal decay rate for fission products, it would take many months for the fallout to decay to the level of the estimated permissible dose for personnel who are exposed to radiations every working day. This level is .3r per week. In the case of the 100r lines shown in Figure 1, over a year would be required for the fallout to decay to the level of .3r per week.

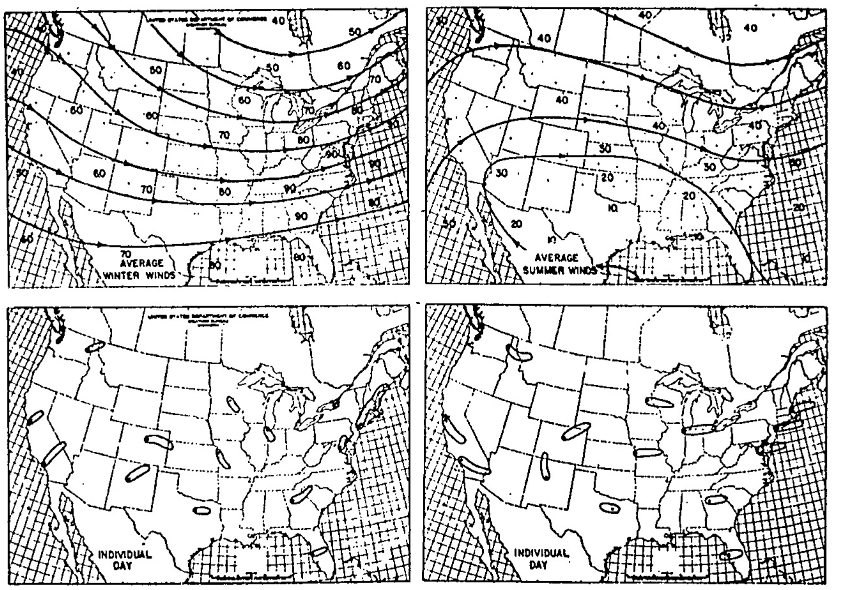

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Figure 3: Variability of Fallout Areas and Seasonal Winds

The difference between the tropospheric fallout and the stratospheric fallout is illustrated by Figure 5. The heavy black lines show the latitudinal distribution of world wide fallout for the spring of 1954 and for February 1955. The horizontal portion of these lines show the accumulated intensity of the stratospheric fallout; the bulge in the 2 lines extending from about 10 to 50 degrees north latitude measures the higher intensities of the tropospheric fallout.

Experience indicates that weathering would probably accelerate the decay. Nevertheless, the persistency of fallout has far-reaching consequences.

The fallout patterns shown in Figures 1-4 are not intended to suggest that all of the fallout is contained within the various iso-intensity lines. The patterns contain what Atomic Energy Commissioner Dr. Willard F. Libby has characterized as the local fallout, despite the fact that this local fallout might be deposited several hundred miles from ground zero. The tropospheric fallout con-

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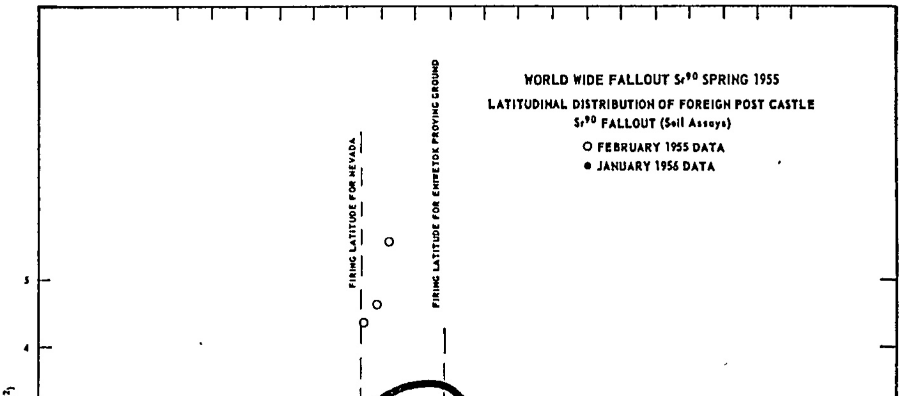


Figure 5: World Wide Fallout Sr90—Spring 1955

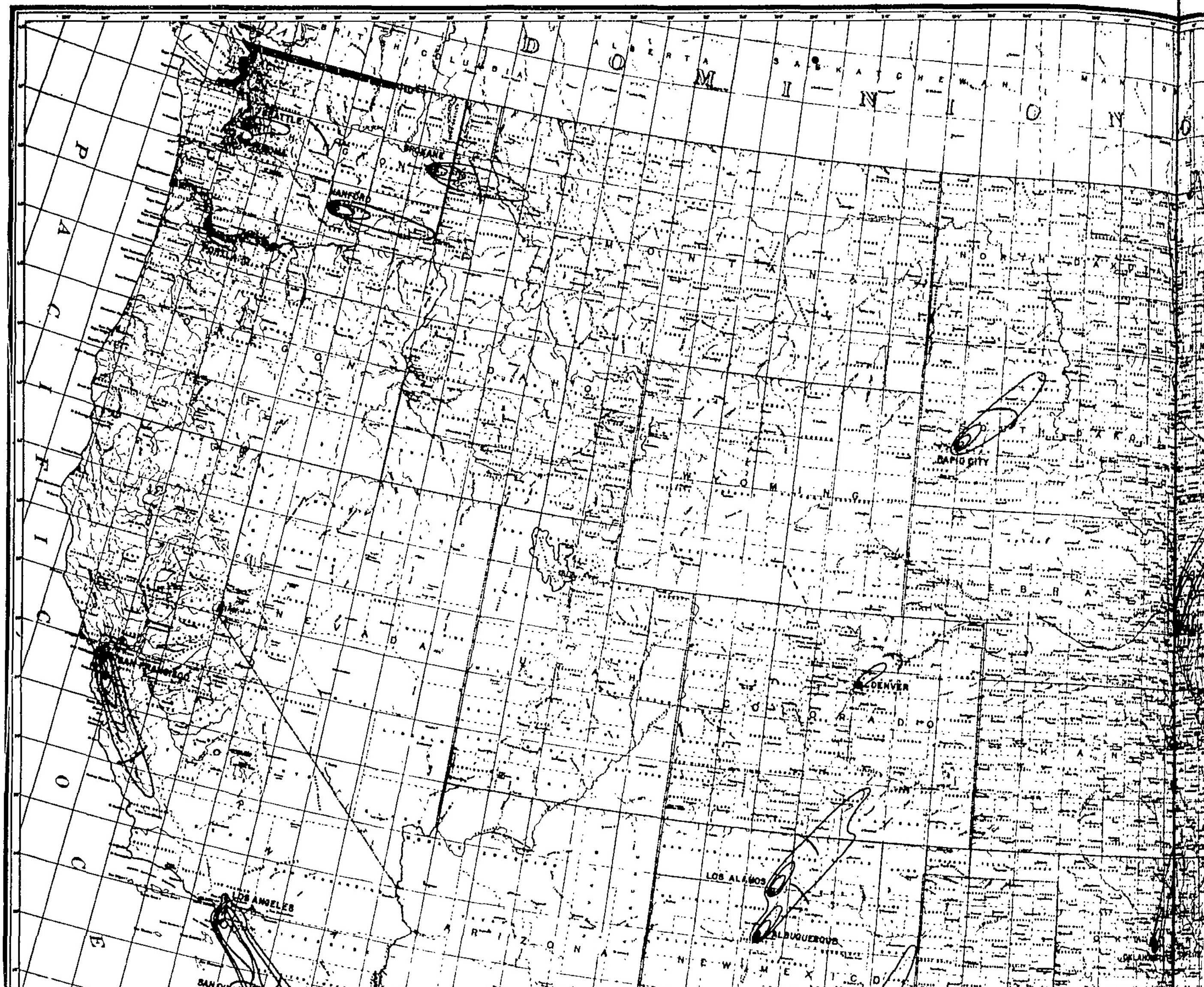
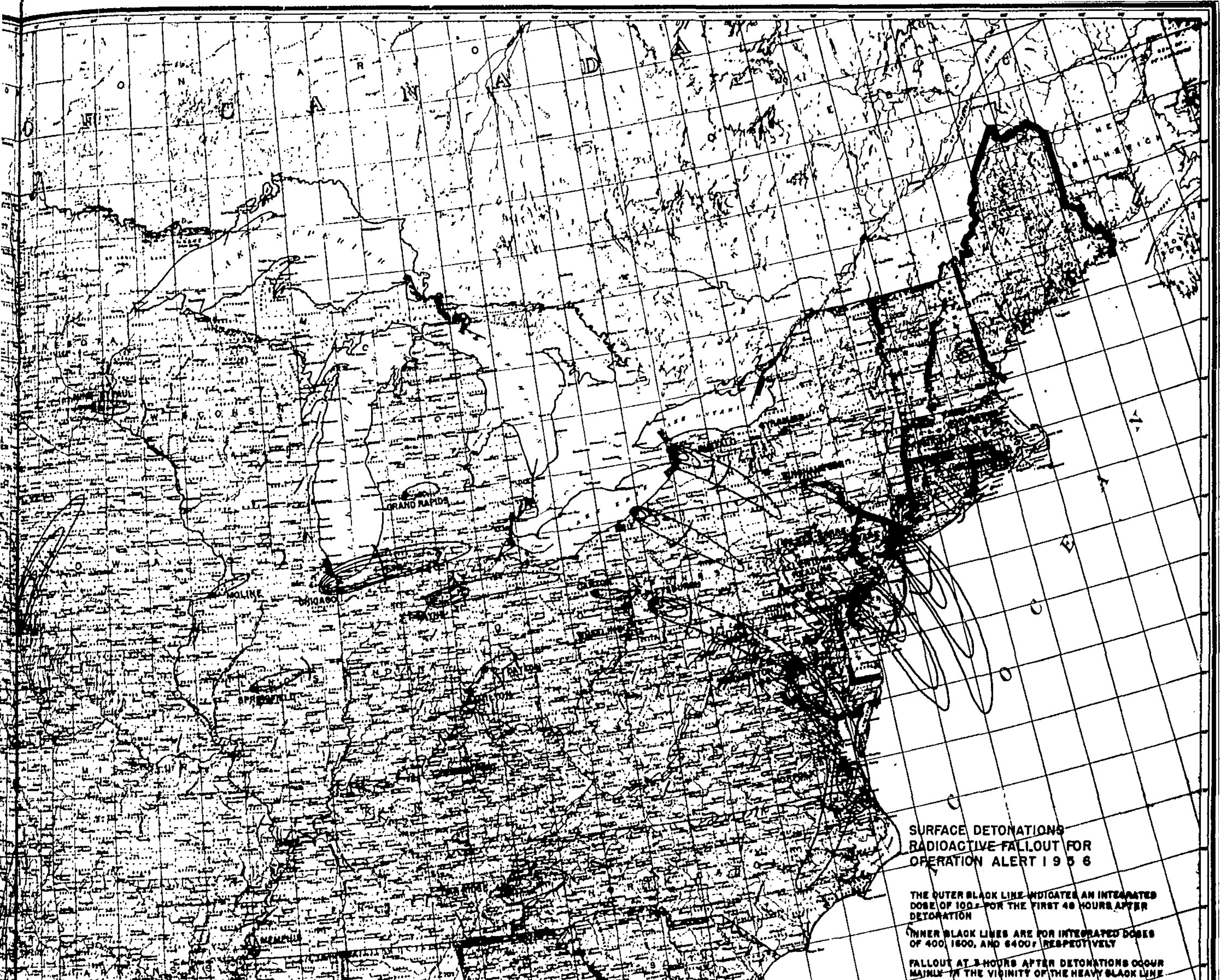


Figure 4: Fallout patterns assumed for Operation Alert, 1956, the nation-wide Civil Defense exercise. Fallout patterns are drawn in accordance with actual winds. Assumed ground zeros were: 63 centers of population and industry; 9 SAC bases; 4 Atomic Energy installations. 124



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bombs were assumed; ranging from 20 KT to 5 MT, with a total yield of about 78 MT. On 24 targets, 2 to 5 bombs were assumed. More than one out of ten persons were assumed to have been killed, and vast areas made untenable by fallout.

sists of the contaminated portions in the troposphere which are distributed throughout the world in the same general latitude as ground zero. The "stratospheric world wide fallout" is caused only by detonations in the megaton range. While the tropospheric fallout would descend to earth in one or two months, the stratospheric world wide fallout requires an average time of about 10 years to reach the earth's surface.

Figures 6 and 7 compare the tropospheric fallout from the "Mike" shot on 1 November 1952 and the "Bravo" shot on 1 March 1954. These detonations were similar in that both are described as being in the megaton range, both were detonated at or near the earth's surface on a coral island, and both had atomic clouds that penetrated into the stratosphere. The main difference was the season of the year. It is interesting to note in Figure 6 that fallout from both detonations reached the western US and Africa in about the same number of days, but travelling in opposite directions from ground zero. The radioactive fallout in the "Mike" shot was very much heavier than in the "Bravo" shot as shown by the intensities in Figure 7.

The four Mercator Projections of Figures 6 and 7 illustrate far better than any number of words the way that fallout becomes distributed throughout the world and is both a local and a world wide hazard.

Strontium 90, an isotope with a half life of 28 years, creates the most serious long term fallout hazard; in addition to its very long half life, Sr90 is a close chemical relative to calcium and a "bone seeker." These properties facilitate the transfer of this radioactive element from the soil to various plants; from plants to animals, and from animals to humans. The lower the calcium content of the soil, the greater the probability of Sr90 transfer to humans.

The significance of these factors: a) the 28 year half life of Sr90, b) Sr90 world wide distribution from test shots, and c) the average time of 10 years for descent from the stratosphere to the earth's surface, is shown in Figure 8. This figure was prepared and released in April 1956 by the Atomic Energy Commission as a part of a press release of another of the very informative speeches of Commissioner Libby.

The "Castle" test series occurred in the spring of 1954, and Figure 8 portrays the rate at which the "Castle" Sr90 would very slowly descend to earth. Its descent, however, is faster than its decay, so the peak Sr90 intensity anticipated as a result of

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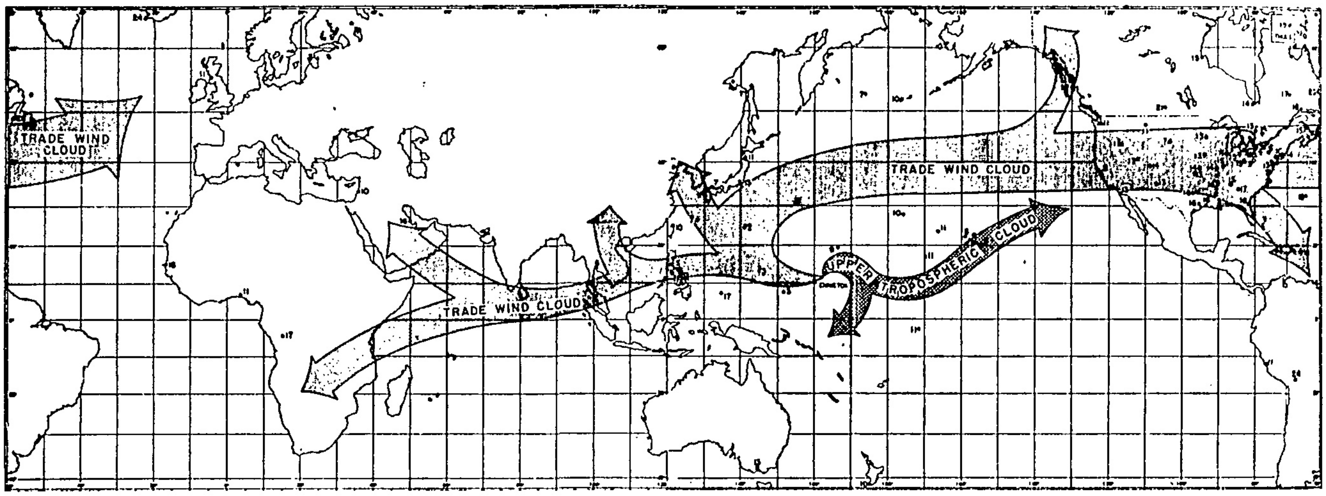

Figure 6a

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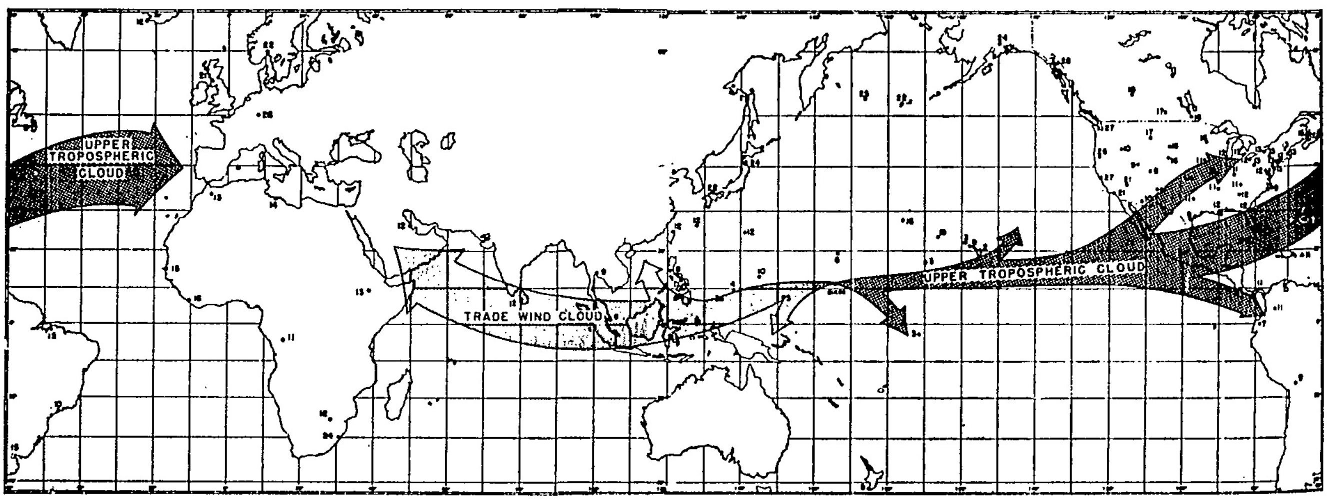

Figure 6b Comparison of Early History of "MIKE" Fallout (6a) and "BRAVO" Fallout (6b). The figures indicate the number of days between detonation and the first ground observation of fission products.

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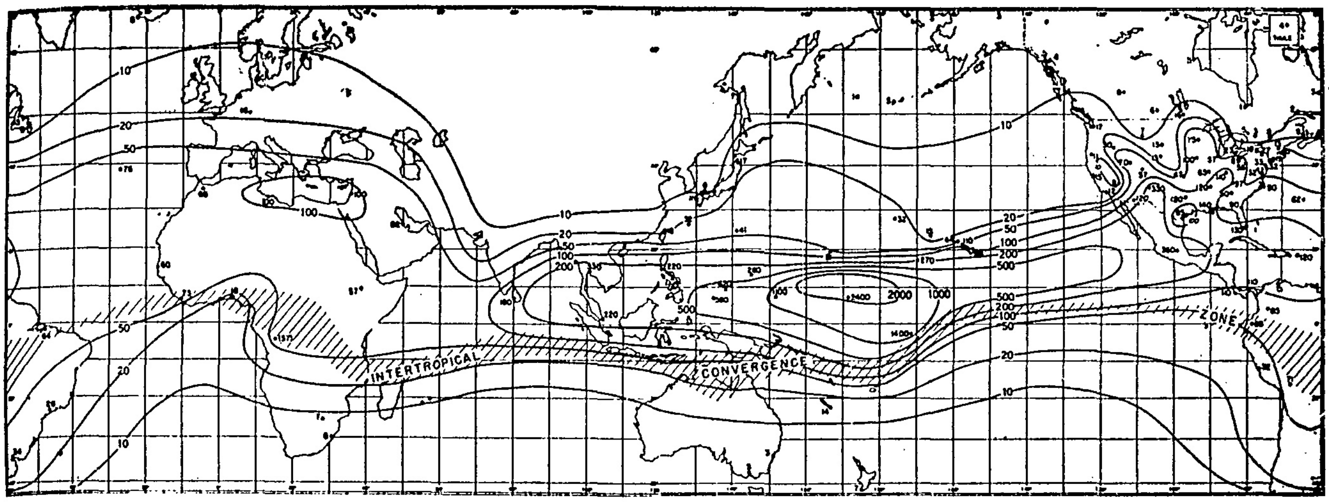

Figure 7a

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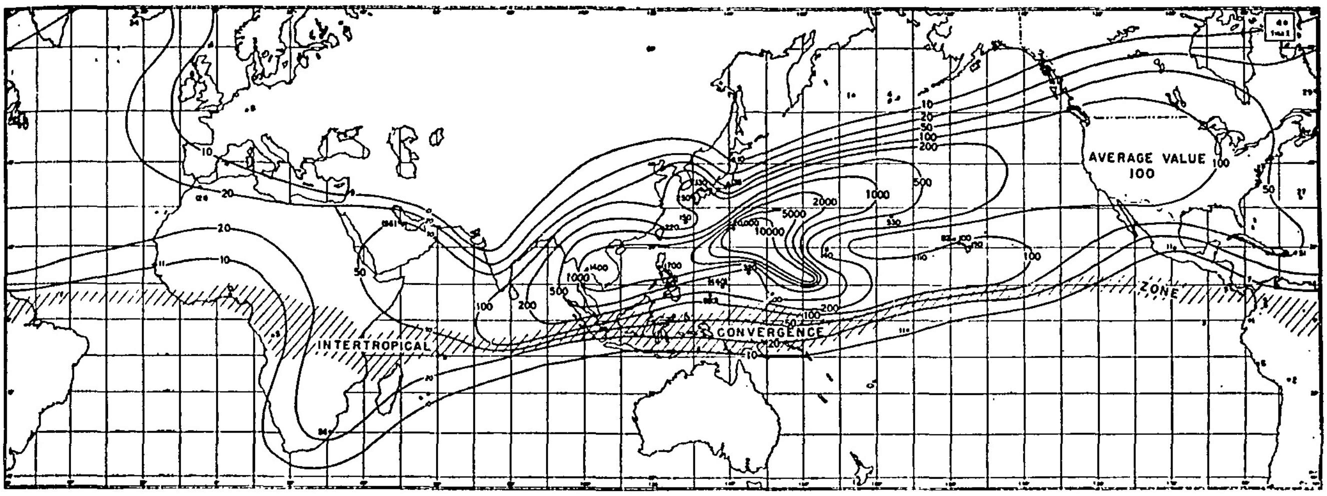

Figure 7b **Comparison of "MIKE" and "BRAVO" Fallout, 2 to 35 days after detonation. (in millicuries per 100 square miles)**

the "Castle" test series in 1954 would not be obtained until 1970.

The build-up of Sr90 is shown in Figure 8 in two forms: 1) the absolute quantity and 2) in terms of "MPC Units." MPC is an abbreviation for "maximum permissible concentration," specifically, "one microcurie of radio strontium for the standard man," the MPC recommended by the National Committee on Radiation Protection for Atomic Energy Commission workers.

By 1970, the MPC calculated by the Atomic Energy Commission will reach .0125 MPC or 1¼ per cent MPC. After 1970, the rate of descent will be substantially lower than the rate of decay. This Atomic Energy Commission calculation was based on 24 megatons of fission products in the stratosphere.

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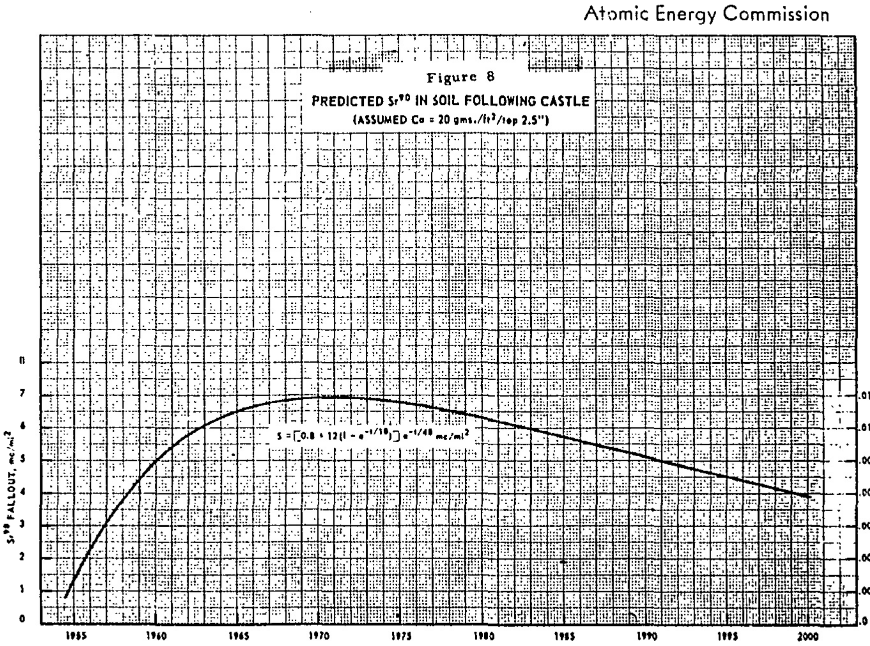
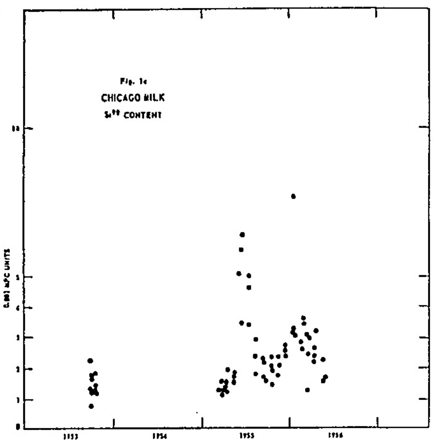


Figure 8: Predicted Sr90 in soil, following "CASTLE"



Atomic Energy Commission

Figure 9a: Sr90 Content of Chicago Milk

It naturally follows that if 24 megatons of fission products cause the MPC to rise to 1¼ per cent, then 1,600 megatons of comparable detonations will cause the MPC to be 100 per cent.

Additional informative measurements of the Sr90 distribution from test shots are also available from the Atomic Energy Commission. Figures 9a and 9b compare the Sr90 content of Chicago milk with foreign milk; Figures 10a and 10b compare the Sr90 content of Wisconsin cheese with foreign cheese. Both these sets of data measure the way that fallout from test shots (not exclusively of US origin) is increasing to an indefinite peak.

For soil of low calcium content, such as those in certain parts of Wales, the Atomic Energy Commission has predicted activity 40 times greater than that average in Figure 8.

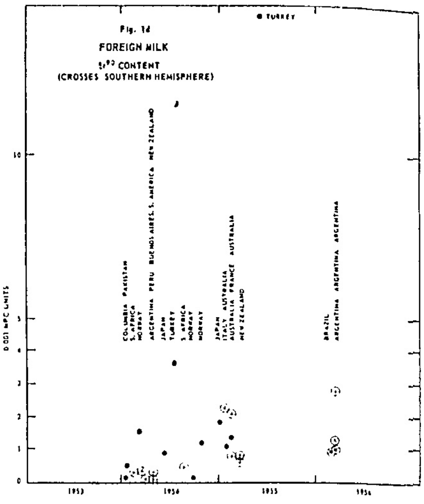
Because of the presence of the Nevada Proving Ground within the US, we now have the highest total fallout in the world. This amounts to about .040 MPC units for the soil; but various ameliorating factors operating from now to the early 1970's lead Dr. Libby to "the conclusion that the body burden in the US from weapons *fired to date* would be about .004 units or possibly as high as .010 MPC units seems justified."

Only 6 years ago, before the thermonuclear breakthrough, the world MPC was placed at 755,000 nominal KT bombs, or 15,000 MT. Early in 1957, in a speech at Northwestern University, Dr. Libby described the method of calculating a new and revised MPC of 11,000 megatons. Dr. Ralph E. Lapp has estimated, on the basis of Dr. Libby's speeches referred to here, that the MPC is 2,600 MT, or about one-fourth of Dr. Libby's figure. Further, noting that the MPC concept is restricted to a healthy adult, educated in risks and working under controlled and supervised conditions, Dr. Lapp applied the International Committee on Radiation Protection recommendations to his calculation of 2,600 megatons. This recommendation states: "With reference to prolonged exposure of large populations, the ICRP recommends that the maximum permissible levels should be reduced by a factor of 10 below those accepted for occupational workers." Dr. Lapp's resultant is an MPC of 260 MT, approximately one-fortieth the MPC of Dr. Libby.

It is also obvious that there is some disagreement within the Atomic Energy Commission concerning this general concept, for Commissioner Thomas E. Murray did not subscribe to that section of the Atomic Energy Commission's semiannual report containing Dr. Libby's 11,000 megaton MPC miscalculation.

The available public information on the size of the US stockpile would seem to indicate that regardless of the actual amount required to contaminate the world to the MPC level, we either have that amount now, or will have in the foreseeable future. LtGen Gavin's statement, for example, "current planning estimates run on the order of several million deaths," is one measure of our stockpile size and capability. Another measure is the size of SAC, as given to the Senate Committee on Air Power. SAC was described as having 1,400 B-47's and 300 B-36's, and replacing the B-36's with some 500 to 850 B-52's.

If this force managed to fly a total of 1,500 missions, with an average of 10 MT per mission, the total yield would be 15,000 MT, an amount in excess of Dr. Libby's MPC. This calculation does not include any fissionable materials that might be delivered by Tactical Air Command, pilotless aircraft and missiles, the Army, or the tremendous capabilities of the Navy. In addition, the United Kingdom and NATO forces would be expected to add their



Atomic Energy Commission

Figure 9b: Sr90 Content of Foreign Milk

atomic and hydrogen bombs to the Allied striking power. If one adds to these sums an appropriate allowance for the thermonuclear stocks of the USSR, it is obvious that the MPC is a matter of immediate concern for the world's strategists and chiefs of state.

Also, it is reasonable to believe that neither the USSR nor the US would be making fissionable material available to other countries until they had atomic weapons stockpiles sufficiently great to accomplish any conceivable military objective. The existence of respective US and USSR programs is further indicative of nuclear plenty. The US "Atoms for Peace" program involves the allocation of 40,200 kilograms of fissionable material, valued at about $1,000,000,000. For orientation purposes, the nominal atomic bomb of 20,000 tons of TNT equivalent involves the fission of *one* kilogram of uranium or plutonium.

This is not intended to imply that the "Atoms for Peace" program consists of materials directly usable for bombs; elaborate treaty provisions attempt to minimize such hazard. So far as is known, the USSR has made no announcement concerning the total fissionable material allocated to its 11-nation program and the USSR-sponsored Joint Institute for Nuclear Research. Whatever the allocations, they could not conceivably have been made at the detriment of the military effort of either country.

Fallout from massive retaliation may jeopardize our world supremacy by affecting food supply in 2 ways.

One of these is through direct contamination of the soil by Strontium 90. The other way is through lowering the earth's temperature, which would make it impossible to grow some crops and decrease the yields of other crop lands. This somewhat unusual and unexpected effect has been described by Dr. von Neumann, Commissioner of the Atomic Energy Commission, to the Joint Committee on Atomic Energy.

"Dr. von Neumann: A large volcano, Krakatoa, erupted in the 19th century. Krakatoa reduced the solar heating of the earth by something between 5 and 10 per cent over 3 years. It has been calculated that one eruption like this every year would be enough to bring back the conditions of the last ice age. We have reason to believe that the amount of material thrown up by Krakatoa was about 100 times that of the largest nuclear explosion so far. . . .

"Representative Cole: How many Krakatoas did you say would bring about the ice age?

"Dr. von Neumann: Usually it is believed about one a year.

"Representative Cole: One a year?

"Dr. von Neumann: Yes, it would take a little while.

"Representative Cole: If the time ever should come that there would be nuclear or thermonuclear explosions to the point of a hundred a year, then in time we could anticipate the ice age?

"Dr. von Neumann: We would notice real climatic changes after 10 or 20 years of that. But, of course, there are other effects you would notice a great deal, long before that time."

Atomic Energy Commission

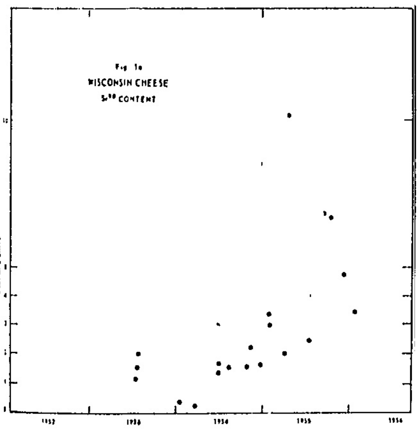


Figure 10a: Sr90 Content of Wisconsin Cheese

As these observations indicate, a great many bombs would be required to bring on another ice age. Is the number greater or less than that which SAC and the Allied Forces will try to deliver? A lowering of the average temperature of 10 to 15 degrees for even a few years might well destroy our way of life. At the very least it would cause chaos of the magnitude of the Biblical floods.

Massive retaliation as contemplated today involves other exotic effects. Among these are the genetic imbalances caused by radiation; the fact that the more simple forms of life (such as insects) are more resistant to radiation than the more advanced forms (such as livestock and man), and the general problem of continuity of food supply. Our ignorance or recklessness will certainly not shield us from such effects.

Fragmentary information from the Atomic Energy Commission suggests that the "Redwing" and other series of tests held at the Eniwetok Proving Ground, provided data on ways to reduce fallout. The first statement on this subject was made by Atomic Energy Commissioner Lewis Strauss in his press release of 19 July 1956:

"It has been confirmed that there are many factors, including operational ones, which do make it possible to localize to an extent not heretofore appreciated the fallout effects of nuclear explosions."

Admiral Strauss' release was expanded upon by Dr. Libby:

"Particular attention was paid to the fallout problem in this operation and a major effort was made to produce a megaton range weapon with an inherently smaller amount of fallout for a given energy release. This effort was successful."

There is some hope that massive retaliation, if employed by the US at some future time, would not necessarily mean exceeding the world's MPC. What this "clean" bomb development means with respect to Dr. von Neumann's concern over lowering the world's temperature is certainly far from clear; and it is not known whether or not the discoveries of the Atomic Energy Commission with regard to minimizing fallout are being communicated to the USSR, or even to our Allies in the United Kingdom. If the objective of this AEC activity is to minimize military effects, it is always possible to return to the conventional types of ordnance employed in Korea and WWII.

The Air Force is somewhat contemptuous of the fallout with which it would have to contend defensively, as well becomes a young organization oriented to the offense, but its own tactics would appear to maximize the fallout problem for an enemy. In testimony before the Senate Committee on Air Power, an attack at 1,000 feet, using 10 megaton weapons and 2 bombs per location, was described as "a very efficient attack."

Attacks of this nature tend to aggravate the fallout problem, not only in the enemy country, but also in one's own country, and particularly if both countries are in the same general latitude.

Atomic Energy Commission

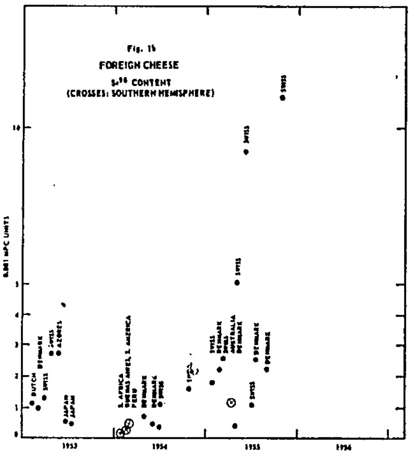


Figure 10b: Sr90 Content of Foreign Cheese

Figure 11 illustrates the Low Altitude Bombing System known as LABS. This system enables an aircraft to reduce the chance of radar detection by approaching the target at low altitude. At altitudes of several hundred feet a special problem is presented—how to escape the blast effects of the atomic or other type bomb. The LABS is designed to maximize escape time by lobbing the bomb as illustrated. The lower the altitude of bomb detonation, the greater the escape time, and the greater the local fallout problem. Such a device would also be useful to Soviet aircraft. If similar bombing systems are employed by the USSR, the USAF fallout hazard will be exceedingly costly to its operational effectiveness.

Prudent planning would suggest that a military policy of massive retaliation would make provision against the fallout caused by the enemy's first blow. Recognition of the fallout danger would be expected to be acute in the light of our war plans. Surprisingly, this is not the evaluation of fallout as expressed by Gen LeMay to the Senate Committee on Air Power:

"Gen LeMay: Now fallout is not the horrible thing that some people might lead us to believe in that if you can just get under a couple or three feet of ground, just in a basement or something like that and stay there for a while until this hot air has cooled off a little bit, and the air cools off rapidly, then you can get out."

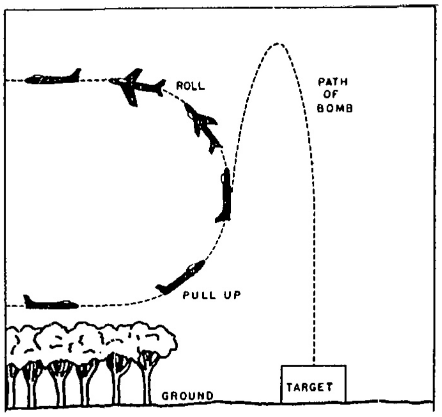
In accordance with this appraisal of fallout it appears that the Air Force has made few, if any, operational plans for decontamination of runways, hangars, exposed aircraft, in flight contaminations, flight planning to avoid fallout clouds, and servicing of contaminated aircraft. Special mention is made of the air-intake of a jet engine being approximately one hundred times that of a reciprocating engine and the greatly-increased danger of inflight contamination.

Similarly, the Army shows a predilection in their publicized maneuvers for dealing with nominal atomic bombs, and for bombs that are air bursts. For example, in Exercise "Desert Rock," Army troops maneuvered on the assumption that the bomb would be an air burst, and thus create insignificant residual radioactivity. This is consistent with the general evalution contained in *Effects of Atomic Weapons,* but not necessarily sound if the enemy desires to maximize fallout.

The fallout problem for those responsible for massive retaliation may be somewhat greater than heretofore contemplated. Consider, for example, the hypothetical problem "Radiological Recovery Plan for a Strategic Bombing Base" cited in the most authoritative manual prepared to date.

The problem made the following assumptions and decisions for illustrative purposes:

1) Runways were not hit, and the majority of planes were undamaged by the contaminating attack,
2) Aircraft were kept in operational readiness at all times,
3) Trained personnel and equipment were available to give aircraft a quick hose-down,
4) Only ground crews were used for pre-flight check and warm-up,
5) Strike and other personnel received no radiation during the attack,
6) Strike personnel were brought directly to their planes *24 hours after the attack (H plus 24),* and spent not more than 1½ hours in previously decontaminated areas before takeoff,
7) Strike personnel returned 24 hours later (H plus 48),
8) Strike personnel were affected only by radiation at their base, and received no dosage in flight,
9) Base personnel were trained and equipped with the necessary scrapers, bulldozers, tank trucks for hosing, etc.
10) Additional missions were not flown until H plus 120 hours.



Minneapolis-Honeywell Regulator Co.

Figure 11: Low Altitude Bombing Systems (LABS)

Recognizing all of the above simplifying assumptions, the cost of this attack to the SAC flying personnel and ground crew alike was calculated at 225r. This is over 22 times the recommended safety level of 10r established by the National Academy of Sciences. Because the dose was received over several days, it would cause only about 15 per cent of the personnel to be sick. In addition, the life expectancy of those receiving a dose of 225r would be decreased by an indeterminate amount, but which one authority would estimate at about 18 months. The rule of thumb is a 1 per cent decrease of life expectancy for each 100r received over an extended period of time.

The preceding analysis has been presented with appropriate documentation to facilitate criticism, for if the findings are valid, consideration should be given to various active steps. Among these are the following:

1) *A major effort to minimize the fallout problem.* This may be done in part by increasing the emphasis on the development of the so-called "clean" bomb.

2) *Modification of the bases of massive retaliation from land to water.* This consideration originates from the finding that a surface burst over deep water reduces the local fallout from about three-eighths to three-fourths the comparable fallout from a land surface burst. The reduction is due to the evaporation of many of the drops of water before they reach the ground.

From the enemy's viewpoint, such a defensive tactic would increase the ultimate hazard to him, providing he is in the same general latitude. From the defensive, this tactic would tend to increase the fall time of the contaminated particles, and because the decay of such particles is very great during the first hours or days, the fallout will be less dangerous when it does become deposited on the earth.

The built-in protective measures against fallout that are possible through water-based massive retaliation are illustrated in Figure 12, which shows the *Shangri-La* testing its radioactivity protection and decontamination screen of water. Contaminated particles falling on a vessel such as this would be washed into the sea. The particles themselves would tend to be much finer than those caused by land surface bursts, thus further contributing to the protective features of water-based retaliation.

Placement of the bases of massive retaliation *under* water, such as the nuclear submarine and Polaris weapons system, warrants careful consideration as our best strategy to counter the Soviet ICBM threat.

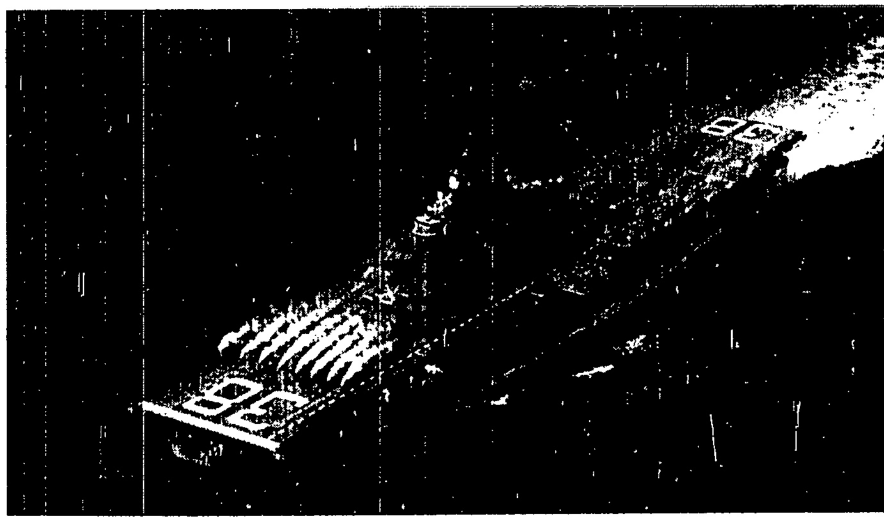


Figure 12: USS **Shangri-La** ***tests its anti-fallout protective and decontaminating system, with aircraft on flight deck. A moving base can escape fallout through its own movement, minimize the effects if caught. Using its built-in protective system, it can resume operations at a speed far surpassing that possible for similarly contaminated land bases.***

3) *Maximize the use of ground burst weapons of low yield in our massive retaliation operational planning.* Such tactics increase the local fallout problem for the enemy, by reducing the extent of either tropospheric or stratospheric fallout, and reduce the extent of the long-term fallout hazard to the US. The AEC experience shows that an atomic device exploded on the surface distributes about 80 per cent of its fission products on the ground within a few hundred miles of the burst point. Development of a "cleaner" bomb together with this tactic would make massive retaliation less costly in terms of US casualties resulting from the backlash. This strategy might also be adapted by an enemy who wishes to maximize the local fallout while minimizing damage from his own fallout.

4) *Development of improved decontamination procedures.* Such procedures are necessary to enable military missions to be performed with acceptable losses. As indicated earlier, the Navy has made tremendous advances in decontamination procedures and appears to have a unique advantage over the other services. It has readily accessible water which can be used as a decontaminant, a means of flushing the water through built-in and supplementary spraying mechanisms, and a ready place of disposal for the washdown water. It may be possible to develop other decontamination methods such as strippable paint, special chemicals, and scraping.

5) *Greater emphasis should be placed on pre-attack stockpiling of essential survival items for use in the immediate post-attack period.* This means modification and expansion of pertinent stockpiling programs of the Department of Defense and the Office of Civil and Defense Mobilization. Under conditions of massive nuclear attack, strategic and critical minerals and metals are not nearly so vital as finished goods that can maintain life. Life itself is our greatest productive asset — and its preservation must be a paramount objective of national policy.

6) *Construction of shelter against the radiation hazard for all persons in the US, and additional blast and thermal protection for persons living in or near target areas.* As the various figures accompanying this analysis show, there is no longer a "safe" place in the US. In addition to fallout distributed by the enemy's first blows, there would be a random distribution by unpredictable winds, and further scattering caused by air-to-air and ground-to-air combat and kills with possible resulting detonations from the shot-down aircraft. The greater the availability of shelter for the civilian population, the greater the freedom with which our own forces can use their most powerful weapons to knock down enemy aircraft or missiles.

It is hoped that this analysis will provoke sufficient consideration to the implication of the dangers of massive retaliation, and that some contribution will thereby be made to the development of a strategy grand enough to insure the attainment of our military objectives, and yet fine enough to accomplish these objectives with minimum and acceptable losses. US MC

Dr. Parsons graduated from the University of Akron (BSc) and Cornell University (PhD). From 1950 to 1954 he served with the Directorate of Intelligence, USAF. Many leading magazines have published his articles in the field of military science and strategy. He wrote this article, "To effect some contribution to the professional military literature on the significance of residual radioactivity, and to suggest certain steps that may be considered to minimize this unique threat to our security."