

The Effects of a Global Thermonuclear War

4th edition: escalation in 1988

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INTRODUCTION: The following is an approximate description of the effects of a global nuclear war. For the purposes of illustration it is assumed that a war resulted in mid-1988 from military conflict between the Warsaw Pact and NATO. This is in some ways a worst-case scenario (total numbers of strategic warheads deployed by the superpowers peaked about this time; the scenario implies a greater level of military readiness; and impact on global climate and crop yields are greatest for a war in August). Some details, such as the time of attack, the events leading to war, and the winds affecting fallout patterns, are only meant to be illustrative. This applies also to the global geopolitical aftermath, which represents the author's efforts at intelligent speculation.

There is much public misconception concerning the physical effects of nuclear war--some of it motivated by politics. Certainly the predictions described here are uncertain: for example, casualty figures in the U.S. are accurate perhaps to within 30% for the first few days, but the number of survivors in the U.S. after one year could differ from these figures by as much as a factor of four. Nonetheless, there is no reasonable basis for expecting results radically different from this description--for example, there is no scientific basis for expecting the extinction of the human species. Note that the most severe predictions concerning nuclear winter have now been evaluated and discounted by most of the scientific community.

Sources supplying the basis for this description include the U.S. Defense Nuclear Agency manual on nuclear weapon effects, scientific papers describing computer simulations of long-term effects published by groups ranging from the U.S. government to left-leaning scientific organizations, and research by a similar variety of groups on weapons characteristics and strategy.

1 July 1988: Gorbachev is killed when his plane is attacked by a Stinger surface-to-air missile in East Germany; military heads take control in Moscow, accuse the CIA of responsibility for the assassination, impose a news blackout in the U.S.S.R., and send troops to East Germany and Poland to impose martial law.

15 July 1988: West Germans propose intervention in East Germany following reports of violence there; clashes occur along the border between the two Germanys; NATO puts its forces in West Germany on alert.

19 July 1988: A massive Soviet invasion of West Germany begins: NATO airfields are attacked by missiles with chemical warheads as tanks pour across the border. U.S. nuclear forces are put on alert: Bergstrom Air Force Base (AFB) near Austin receives 4 B-52 bombers dispersed from their home base.

31 July 1988: With Soviet forces 200 kilometers (km) (120 miles) inside northern West Germany, NATO issues a vague ultimatum to the U.S.S.R.

1 August 1988: NATO nuclear weapon depots are attacked by conventional and chemical weapons; ongoing

naval combat claims a Soviet ballistic missile submarine in the Arctic Ocean.

4 August 1988: NATO threatens the use of tactical nuclear weapons against Soviet forces advancing towards urban areas in western West Germany.

6:00 AM CDT 5 August 1988: Soviet attacks begin against U.S. military satellites: two ground-based laser facilities are used to disable intelligence satellites in low Earth orbit and damage or harass sensors on those in higher orbits. "Killer" satellites are launched and will reach target satellites over the next few hours. Some of the Soviet civilian population is being moved to bomb shelters, subway tunnels, and out of cities. In West Germany invading Soviet forces launch some tactical nuclear weapons against NATO forces.

10:00 AM CDT 5 August 1988: NATO forces begin launching tactical nuclear weapons against Soviet forces in West Germany and bases in East Germany. North Korea invades South Korea while launching chemical weapon strikes against U.S. and South Korean forces.

12:00 noon CDT 5 August 1988: Nuclear hostilities on a global scale begin as the U.S.S.R. launches a preemptive strike. Over 1,000 Soviet missiles--carrying 5,400 warheads--are launched as a counterforce strike against the U.S. and its NATO allies.

Current population figures are: Rio Grande Valley--690,000; Travis County--550,000; Texas--16,800,000; the United States--245,000,000; the world--5,150,000,000.

12:05 PM CDT: Nuclear weapons are detonated aboard several Soviet satellites in low Earth orbit over the U.S. and other areas, generating electromagnetic pulses (EMP). This devastates electronics in these areas. Most unhardened computers and related equipment are rendered useless, destroying communication, information, and power supply networks on a nationwide scale. Transportation vehicles using electronics are inoperable. Many satellites are disabled. While few human casualties have occurred so far, much of the civilian elements of a continent-spanning society are devastated. For most American civilians this is the only warning of the coming attack they will receive: no effective civil defense program exists.

U.S. strategic bombers begin leaving their bases. This includes 25 B-52s and 5 B-1Bs in Texas, with four of these B-52s leaving Bergstrom AFB near Austin. These 30 bombers are carrying 400 nuclear bombs and missiles.

12:10 PM CDT: NATO missiles in Europe (U.S., British, and French weapons) are launched against Warsaw Pact targets. This includes U.S. Pershing II and Gryphon missiles, most of which were not yet retired under the INF treaty.

Soviet submarine-launched ballistic missile (SLBM) warheads begin reaching targets in Texas and other parts of the U.S. Over the next 15 minutes 55 SLBM warheads succeed in reaching targets in Texas out of 74 launched (the rest were on missiles that malfunctioned early in flight). In Travis County, a 1.5-megaton (1 mt equals the explosive energy of 1,000,000 tons of TNT) warhead detonates 2.5 km (1.5 miles) over Bergstrom AFB. Over the next few minutes ten warheads, each between 200 kilotons and 500 kilotons (1,000 kt equals 1 mt) detonate over Bergstrom and in a pattern extending 100 km (60 miles) to the north, west, and east--this in an attempt to destroy the four escaping bombers.

Each explosion produces a fireball which radiates intense light (flash) for about 10 seconds: all exposed combustible material ignites up to ranges of 3 to 9 km (2 to 5.5 miles); second degree burns to exposed skin and fires are produced up to 6.5 to 18.5 km (4 to 11.5 miles) away. The atmospheric shock wave (blast) from each explosion causes partial or complete destruction of all buildings within 1.5 to 4.5 km (1 to 3 miles) and

causes moderate damage and 50% injuries or deaths at 5.5 to 15 km (3.5 to 9.5 miles) in the 10 to 40 seconds following detonation. (These figures represent the variation among 200-kt to 1.5-mt warheads exploded in the air or on the ground.) Severe damage and fires result in much of Austin.

Immediate nuclear radiation from the weapons being used is generally absorbed by the atmosphere before it reaches people surviving the flash and blast. (This radiation is only important with small nuclear weapons such as the bombs dropped on Japan in World War II or the tactical nuclear weapons being used in Europe. Delayed radiation from fallout is a different matter, however.)

12:15 PM CDT: The U.S. launches intercontinental ballistic missiles (ICBMs) against the U.S.S.R. These are launched from underground silos in Montana, North Dakota, South Dakota, Wyoming, Colorado, Nebraska, and Missouri. Some SLBMs are launched at this time as well.

12:25 PM CDT: The U.S.S.R. launches most remaining nuclear forces, attacking cities and other targets in the U.S. and Western Europe as well as mainland China.

Antiballistic missiles (ABMs) with nuclear warheads are being launched to defend Moscow from incoming warheads. Throughout the U.S.S.R. several types of surface-to-air missiles (SAMs) are also being used against incoming nuclear warheads--occasionally with success.

12:30 PM CDT: Soviet ICBM warheads begin reaching U.S. targets. NORAD headquarters near Colorado Springs receives a few 20-mt warheads: the ground shock produced by each one attains 7.3 on the Richter scale. U.S. submarines begin launching SLBMs against the U.S.S.R. In Texas, 80,000 people have already died.

Altogether, over 1,000 tons of debris from Soviet ballistic missiles will fall over the U.S.; much will burn up in the atmosphere, but some larger objects will hit the ground with energy equivalent to their own weight in TNT.

12:35 PM CDT: Another wave of Soviet warheads arrives in Texas: 45 of the 53 ICBM warheads targeted in Texas actually detonate successfully. In Travis County, a 550-kt warhead detonates on the ground at the former site of Bergstrom AFB, adding to the devastation in Austin. In the Rio Grande Valley, a 550-kt warhead detonates on the ground at the Raymondville Coast Guard station and a second one two minutes later; Raymondville is destroyed.

With Soviet warheads minutes away, Israel launches nuclear missiles and nuclear-armed aircraft against capitals and military targets of most other Middle Eastern nations.

12:50 PM CDT: A massive barrage by U.S. SLBMs mostly overwhelms the Moscow ABM system; American, British, French, and Chinese nuclear warheads targeted within 100 km (60 miles) of Moscow total over 500. About 200 reach their targets (although only about 40 were lost to ABMs): while most Soviet leaders in underground shelters survive (the primary goal of the local ABM system), most civilians in the subway tunnels and other shelters will die over the next few hours.

The Moscow area ranks with the six ICBM fields in the U.S. as the hardest hit areas of the world. An average of 350 warheads detonate in each ICBM field, each producing a crater 350 m (400 yards) across; a total of 100,000 sq. km (40,000 sq. mi.) is devoid of life. Out of 1,000 ICBM silos, 100 still had ICBMs; now six are left usable.

The nuclear weapons that have reached Texas so far were directed against U.S. military forces and

capabilities. Although this attack did not specifically target the civilian population, it has so far killed 800,000 and injured 3,000,000 people in Texas.

1:00 PM CDT 5 August: A third strike reaches Texas, with 146 warheads launched. Two 750-kt warheads detonate over Austin. In the Rio Grande Valley, a 1.1-mt warhead detonates over Brownsville, three 350-kt warheads detonate around McAllen, and 550-kt warheads are groundburst in Harlingen and at Cameron County Airport. Massive fires and severe blast damage occur throughout all of these metropolitan areas.

This concludes most of the nuclear war in Texas: 273 warheads were fired at 233 targets, and 215 detonated successfully, with a total yield of 128 megatons (about 40 times the explosive force of all conventional bombs and shells used in World War II). In addition, about 5 off-course warheads struck randomly in Texas. At this point 3,500,000 Texans have been killed.

2:00 PM CDT: About 5% of the land area in Texas is burning. In a few areas conditions permit firestorms to develop. In contrast to the World War II atomic bombings in Japan, continuous fire areas sometimes cover hundreds of square km (or sq. mi.), preventing survivors from escaping. Fires cover about 700,000 sq. km (270,000 sq. mi.) in the United States, 250,000 sq. km (100,000 sq. mi.) in the U.S.S.R. and 180,000 sq. km (70,000 sq. mi.) in Europe. Scattered or continuous fires rage across more than one-third of the area of several states, including North Dakota, Ohio, New Jersey, Maryland, Rhode Island, Connecticut, and Massachusetts.

3:00 PM CDT: Intense naval combat between U.S. and Soviet ships and submarines includes the use of tactical nuclear weapons. U.S. naval superiority has been offset by Soviet naval nuclear superiority: U.S. ships are being destroyed by nuclear cruise missiles and nuclear torpedoes. By the end of the day the superpowers will have lost over 100 vessels altogether.

Since most major dams in the U.S. have been destroyed by nuclear explosions, flooding is progressing downstream from these reservoirs. Some rivers particularly affected are the Missouri, Colorado, and Tennessee Rivers.

5:00 PM CDT: The mushroom clouds from nuclear explosions have drifted 100 to 300 km (60 to 180 mi.) downwind, frequently forming the leading edge of large smoke plumes. In the darkness beneath these plumes, temperatures have dropped noticeably.

Vaporized soil and other material, mixed with radioactive bomb residues, settles to the ground in areas where mushroom clouds pass overhead: this is fallout. Immediately downwind of groundbursts, radiation from fallout may be severe enough for exposed persons to already suffer ill effects. The black rain occurring beneath many clouds is radioactive--sometimes enough to burn the skin after prolonged contact.

Smoke downwind of urban fires is also hazardous. The blasts and fires have consumed 70% of the world's industrial capacity. Toxic chemicals have been released in large amounts.

7:00 PM CDT: Soviet bombers are delivering weapons against U.S. cities and other targets, including high-yield bombs and long-range cruise missiles. None of these targets are in Texas, however. The largest individual weapons used in the war are a couple of 50-mt Soviet bombs dropped in China: craters 2 km (1.3 mi.) across are produced, and severe or moderate damage is produced in an area up to 100 km (60 miles) across.

NATO and Warsaw Pact tactical nuclear weapons are being used by the hundreds along the front in West Germany. Missiles and aircraft have been launched against most cities and military targets in Europe, and

nuclear combat has degenerated to disorganized use of short-range systems, especially missiles and nuclear artillery shells. U.S. Green Berets are crossing enemy lines carrying the smallest nuclear weapons to be used: these atomic demolition munitions are used to destroy bridges and similar targets and have explosive yields as low as 10 tons of TNT equivalent (somewhat more than the truck bomb that destroyed the Marine barracks in Lebanon in 1983).

9:00 PM CDT: Some bombers from Texas are delivering their weapons to Soviet soil, having survived Soviet air defense forces (many using nuclear-tipped anti-aircraft missiles). About half of the weapons carried by Texas bombers actually reach their targets (amounting to 200 warheads with a total yield of 40 mt). Nearly all of these weapons have selectable explosive yields, and usually a yield much lower than the maximum option is used. Only ten of these bombers manage to reach friendly territory afterwards, and they are generally forced to make emergency landings: the U.S., for instance, has less than 100 surviving runways capable of handling B-52s.

12:00 midnight CDT 5/6 August 1988: The nuclear exchange is generally over. In the U.S. 5,800 warheads detonated totaling 3,900 mt. Soviet and NATO weapons successfully used in Europe numbered 3,300 (1,200 mt) (excluding tactical weapons). About 6,100 warheads (most of them American, but some Chinese, British, and French) exploded in the U.S.S.R. with a total yield of 1,900 mt. Mainland China (P.R.C.) received 900 (detonating) warheads (1,300 mt) from its northern neighbor. Other areas receiving at least a dozen warheads include Canada, North and South Korea, Japan, Taiwan, Greenland, Puerto Rico, India, Israel, Australia, Guam, Cuba, Syria, and Egypt. Hundreds of other nuclear weapons have been used in naval combat, in troop combat in West Germany and along the U.S.S.R./P.R.C. border, and in defending the Soviet Union from nuclear attack. About 50% of the global strategic and theater nuclear arsenal has been used. About 10% was launched but did not reach a target and 30% was destroyed on the ground. Altogether, World War III has involved the detonation of 18,000 warheads with a total yield of 8,500 mt. Including tactical weapons, there were 67,000 nuclear weapons in the world a day ago; now, there are 10,000 left.

In Texas 6,400,000 have been killed (38% of its original population). Of the 10,400,000 survivors, 3,000,000 have severe injuries and 2,000,000 have lesser injuries. In the Rio Grande Valley 340,000 have been killed (49%) and 90,000 injured (13%); in Travis County over 400,000 are dead (75%). In the U.S. about 110,000,000 people have died altogether, with the 135,000,000 survivors including 30,000,000 injured. In the U.S.S.R. about 40,000,000 have been killed out of a pre-war population of 285,000,000. Mainland China has had 100,000,000 killed out of a population of 1,090,000,000. Examples of other countries: United Kingdom, 20,000,000 killed (out of 57,000,000); Denmark, 2,700,000 killed (out of 5,100,000); Australia, 3,000,000 killed (out of 16,000,000). In Mexico over 3,000,000 have been killed, mostly in cities on the border with the U.S. Throughout the world about 400,000,000 have died.

9:00 AM CDT 6 August: Survivors in urban areas are having little success at finding medical help. For the United States as a whole, hospital beds in surviving hospitals total 80,000, while severe injuries total 20,000,000. About 9,000,000 people in the U.S. have severe burns on much of their bodies, while only 200 beds in burn care facilities survive in the country. Many remaining hospitals lack even emergency power, due to the EMP attacks. The vast number of injuries force doctors and nurses to try to ignore patients that cannot be saved or have non-life threatening injuries. Many survivors in urban areas are in the process of fleeing to neighboring areas in search of medical care and to escape fires; this puts them in the open, often exposed to fallout.

Midnight CDT 6/7 August: Israel is being attacked by Egypt, Jordan, and Syria. About one-third of Israel's military forces survived the Soviet nuclear attack; they are now occasionally using nuclear artillery shells against attacking troops. Other Arab states are preparing to join the campaign.

The situation is tense between India and Pakistan: both nations have a handful of small atomic bombs, and India was attacked with Chinese nuclear weapons. Meanwhile civil war is developing in South Africa and various other nations.

Early 7 August: Deposition of fallout in Texas is generally over with, and 80% of the radiation that will result from this fallout has already been emitted. Fire-produced pollutants are noticeable throughout the state--including smoke, smog, and various hazardous chemicals--with urban areas still burning.

In those parts of Texas affected by fallout, radiation sickness is already evident in many survivors, including symptoms of nausea, vomiting, and skin burns. In a few small areas fallout has been severe enough to already have killed many of those exposed, by causing radiation damage to the central nervous system. Survivors are having difficulty dealing with injuries, lack of food and medical help, and emotional shock.

The U.S. government is essentially gone, as well as most state governments; only two state capital cities survive (the missiles targeted on them malfunctioned). The Rio Grande Valley is receiving refugees from Mexico--survivors of devastated areas seeking help.

10 August: The smoke clouds in the northern hemisphere are spreading to produce a band around the world covering the primary participating nations. Large amounts of particles in the atmosphere include 1,500 million tons of dust, 25 million tons of smoke from vegetation, and 80 million tons of smoke from cities and other manmade sources. This last type of smoke has the greatest impact: smoke from petroleum and petroleum products is particularly effective at absorbing sunlight. Altogether, about 0.4 cubic km (0.1 cu. mi.) of dust and smoke is in the stratosphere.

Typical sunlight levels in Texas are comparable to an overcast day; in some areas, smoke from large continuing fires reduces mid-day light levels to that of twilight. The average temperature in Texas is 22° C (72° F), compared to 29° C (85° F) a week ago.

12 August: About 90% of the radiation that will result from fallout in Texas has been emitted. The average radiation dose in Texas is about 500 rem; by comparison, a dose of 100 rem in less than a week causes radiation sickness in half of people exposed; 50% of people exposed to 450 rem in a short period will die within 30 days; and a dose of 1,500 rem will kill nearly all people exposed within 10 days. Persons who stayed indoors the whole week generally cut their dose by 70%; staying in designated areas of marked fallout shelters would reduce dosage by 99%.

For the entire U.S., the average dose in the open from fallout is 1,200 rem; by comparison the average for the Soviet Union is 150 rem. The difference comes from the larger average yield of Soviet weapons, the larger size of the Soviet Union, the frequently "dirtier" nature of Soviet weapons, and the fact that more Soviet warheads are exploded on the ground (increasing fallout). For Europe the average dose in the open is 500 rem. This fallout is of course unevenly distributed: in the U.S. the dose exceeds 1,800 rem in about 8% of the land area, and the dose exceeds 500 rem in about 1% of the U.S.S.R.

In most of the areas affected by fallout, radiation is diminished sufficiently to be of little concern to people there. However, areas downwind of nuclear strikes on nuclear power plants are still dangerous--in some locations 100 km (60 mi.) downwind of such strikes, radiation levels are high enough to kill in 2 days. Radiation levels are still high enough to cause sickness from 2-days' exposure in areas up to 500 km (300 mi) downwind of the ICBM fields.

Delayed fallout is being deposited throughout the northern hemisphere: this is from radioactive material

launched into the stratosphere, falling over a larger area for months to come. The health effect from this, however, will not be noticeable against the background of other problems.

20 August: In the northern hemisphere, smoke in the lower atmosphere is subsiding (although smoke in the upper atmosphere still absorbs much sunlight). Unusual weather includes windy conditions in some coastal areas. Fog has developed over the oceans and smog envelops the interior of North America and Eurasia. Fallout from the northern hemisphere is now reaching the southern hemisphere. Radiation levels there will peak at ten times the natural background levels--this will not pose a health risk, but it produces fear in many countries.

Many persons suffering radiation sickness are now showing additional symptoms: hair loss and leukopenia. (Those that survive to the end of the year will regrow their hair.)

Combat continues in central Europe, mostly without tactical nuclear weapons. The position of the front is little changed, with forces on either side unable or unwilling to budge.

25 August: The ozone layer has been cut in half over the northern midlatitudes. In spite of this, nearly all of the Earth's surface is receiving less solar ultraviolet radiation than before the war: smoke in the northern hemisphere blocks most sunlight, and as this smoke was initially injected into the atmosphere much ozone was displaced into the southern hemisphere. This situation will change.

Disorganized forces from Iraq, Iran, and Libya are beginning to join the Arab battle against Israel. North Korean forces have overrun many remaining cities in South Korea. Civil war has developed throughout China: with much of the government and military wiped out by Soviet nuclear attack, surviving communist forces are under attack and ethnic conflicts are developing. Tibet has declared independence. Ethnic conflict is also breaking out among surviving populations in some parts of the Soviet Union and Europe.

Naval combat between NATO and Soviet vessels has slackened. Before the war the U.S. had fifteen aircraft carriers; three were destroyed in port on the first day and five more have been destroyed by Soviet naval nuclear weapons. A number of submarines survive with ballistic or cruise missiles.

Hardly any satellites in Earth orbit are functioning. EMP bursts disabled most civilian satellites. Debris from anti-satellite attacks is dispersing and striking more satellites, while particle radiation from nuclear explosions above the atmosphere is trapped in the Earth's magnetic field, making near-Earth space lethal to men and satellites for months or years to come.

1 September: Light levels and temperatures in the northern hemisphere have reached their lows. Temperatures in the lower stratosphere (an altitude of 10 km/6 mi., where most atmospheric smoke is) are around 15° C (50° F)--this is 40° C (70° F) warmer than normal. At the ground, temperatures vary little with altitude (mountains are sometimes warmer than adjacent lowlands), but they vary significantly with distance inland. The interiors of North America and Eurasia are on average 10° C (18° F) cooler than normal--corresponding to normal temperatures for October or November. In west and north Texas temperatures are around 17° C (62° F); near the coast it is nearer 22° C (72° F). In the midlatitudes of the northern hemisphere sunlight is 25% or less of normal--sometimes insufficient for net plant growth. This helps reduce the formation of hurricanes this season.

At this point 9,000,000 Texans and a total of 140,000,000 Americans have died.

Mid-September 1988: Epidemics are developing among surviving populations, particularly food poisoning, dysentery, and typhoid. Displaced populations, including many injured, are particularly affected; those with

radiation sickness are particularly vulnerable, since radiation sickness involves damage to the immune system: susceptibility to disease for those is increased by a factor of 2 to 5. In some locations outbreaks of disease are a consequence of the use of biological weapons.

Early October 1988: Many crops are withering throughout the midlatitudes in the northern hemisphere. Sunlight, temperatures, and rainfall are all below normal; in many areas concentrations of ozone, smog, and other pollutants in the lower atmosphere are still high enough to afflict plants; and in restricted areas plants have suffered from fallout. This is particularly true in the American Midwest. About 200,000 sq. km (80,000 sq. mi.) in the U.S. is still radioactive enough to cause radiation sickness after two weeks' exposure.

At this point about 580,000 have died in the Rio Grande Valley (84% of the original population) and 40,000 are injured (6%); of Travis County's pre-war population, only 50,000 survive (9%)--most of whom have fled to neighboring areas. About 2,000,000 have died from fallout in Texas now, bringing the death toll to 10,000,000. Of the 6,800,000 survivors, 2,000,000 are injured and 2,000,000 are suffering radiation sickness (these two groups overlap). A total of 160,000,000 Americans have died, or 65% of the pre-war population; in the Soviet Union 90,000,000 have died. The death toll in the United Kingdom is 30,000,000 and in Denmark is 3,300,000. World population is now 4,300,000,000.

November 1988: The ozone layer in the southern hemisphere is now 5% depleted. The effect of this will not be noticed, however, since it is less than natural variations.

December 1988: Crop failures throughout the third world have caused famines in many areas and have also encouraged civil unrest. India has collapsed into civil war. Having devastated Israel, Arab nations are in chaos: the Middle East was heavily dependent on the Western nations economically. Surviving Taiwanese forces are participating in the civil war in mainland China.

Some third world countries, particularly Latin American countries, are launching raids on U.S. coastal areas by sea. These military task forces scavenge and steal what they can find, from raw materials and food to equipment for industrial, military, and agricultural use. Surviving industrial facilities on the coasts, particularly the Pacific and Gulf coasts, are targeted. A couple of raiding parties have visited the Port of Brownsville's former location and surrounding areas but found little of interest.

In the United States, exposure is a serious problem; the only source of heating for most survivors is wood fires.

March 1989: Temperatures in the northern hemisphere are 4° C (2° F) below normal on average. This will shorten growing seasons and prolong agricultural disruptions. Before the war Japan was heavily dependent on food imports; now even fishing in neighboring waters is still unproductive. In Japan 30,000,000 starved to death this winter. Surviving Japanese military forces have waged attacks as far as Australia in search of food sources.

The Midwestern U.S., formerly where most of the nation's grain was produced, received the greatest share of the fallout from strikes on ICBM fields; about half the rural population in this area escaped immediate effects but was killed by fallout. With modern farming technology unavailable, farming this year will be subsistence farming.

The Mississippi River now reaches the Gulf of Mexico 300 km (200 mi.) west of its former mouth. Over the next few years much of former New Orleans will sink below sea level.

Some peat bogs in the northern Soviet Union ignited by the nuclear war are still slowly burning; some will

continue to burn for a couple of years.

April 1989: Hundreds of thousands of Mexican refugees have come north hoping to find food. The population of the southwestern U.S. was relatively concentrated in urban areas; with these destroyed, Mexicans will soon represent a majority of the area's population. Violence often occurs when they encounter communities of survivors. Communities in the U.S. faring better than average include survivalist communities in the Northwest and Mormon communities in the Utah area.

May 1989: Radiation hazards from fallout-stricken areas continue to diminish. In the U.S. about 10,000 sq. km (4,000 sq. mi.) is still radioactive enough for two weeks' exposure to cause radiation sickness. Over 90% of this area was contaminated by fallout from strikes on nuclear reactors. This includes about 400 sq. km (150 sq. mi.) in Texas.

July 1989: Wildfires are recurring in the U.S., Europe, and Asia. Fires especially sweep through the vast areas where fallout killed vegetation. This includes strips of land extending hundreds of km (or mi.) from strikes on nuclear reactor sites, often carrying radioactivity into the air again.

Since the war, natural processes have begun to restore the ozone layer. In the northern hemisphere the ozone layer is 40% depleted, although localized depletions have sometimes been worse. The resultant increase in ultraviolet radiation has reduced plant growth and crop yields and made it easier to get sunburn. In the southern hemisphere ozone depletion is still around 5%.

August 1989: Disease has ravaged the surviving population in the U.S. About 30% of survivors have been afflicted with one or more of the following: dysentery, food poisoning, viral gastroenteritis, typhoid, influenza, and pneumonia. These diseases have killed about 10,000,000 in the past year. Bubonic plague has broken out, killing nearly 1,000,000 so far and spreading to Mexico. Starvation is also a major cause of death: total food production in the U.S. in the past year was about 2% of that for the previous year.

Famines are occurring throughout the third world--not from nuclear winter but from the social and technological collapse of agriculture. Much of the third world supplemented its agricultural capacity with fertilizers, insecticides, and food imports from the West. Political chaos in many areas and disruption of supply networks has also disrupted production. Food production in the third world in 1989 will be below half that of 1987.

Surviving Americans now number 45,000,000, including 4,000,000 Texans. A few million surviving Americans are permanently sterile due to radiation exposure. World population is now 3,300,000,000.

August 1991: The Earth's atmosphere has been quite nearly purged of soot and dust. Slightly cooler conditions persist due to large amounts of nitrogen oxides in the upper atmosphere. The primary impact is slightly shorter growing seasons in northern areas.

Now that third world countries are recovering agriculturally and beginning to reduce famine, they are being stricken by epidemics. Bubonic plague has spread to Latin America and is appearing in Europe. Africa, which has been particularly ravaged by war and famine, is now seeing the spread of various diseases going unchecked by modern medicine.

December 1992: Depletion of the ozone layer in the northern hemisphere is now only 15%, which is less than natural variations before the war.

2000: China, now under nationalist government, is trying to retake Manchuria (which had declared

independence after the war) and Mongolia. Other nations are sufficiently secure internally to launch invasions to acquire various resources.

2010: Some people exposed to fallout after the war are now dying of cancer; however, cancer as a cause of death among the survivors is minimal compared to other causes: disease, starvation, and exposure.

Chinese forces are operating in Southeast Asia, Japan, the Philippines, and particularly Siberia, where there is an influx of Chinese settlers.

2040: Some areas that received fallout from strikes on nuclear power plants and above-ground nuclear waste storage facilities are still uninhabitable and will remain so for some time to come. Genetic defects are found in as much as a few percent of the population born in the northern hemisphere after the war; however, most are not noticeable or are not handicapping. The more profound physical deficiencies are due to malnutrition. Some of the surviving nations have emerged by now as major powers, including Australia, New Zealand, China, Argentina, and Brazil.

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