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February 13, 2025

Analysis of the book *Nuclear War: A Scenario* by Annie Jacobsen

In March 2024 Annie Jacobsen published the book *Nuclear War: A Scenario*.[2] In this book, she constructs a scenario where an initial nuclear attack by North Korea on the U.S. escalates into a full-scale nuclear exchange between the U.S. and Russia. This leads to a nuclear winter which in turn leads to "…the end of civilization as we know it…" where "…all present-day knowledge will be gone."[3] She goes into excruciating detail as to the effects of a nuclear explosion in Washington D.C. and then step-by-step as the nuclear conflict escalates into a full-scale nuclear exchange.

It is not clear why Jacobsen has written this book. Its main takeaways, that it is not good to be near a nuclear weapon when it goes off and that if a large-scale nuclear war occurs, some very bad things will happen, have been obvious for a long time. Further, despite having interviewed many high-level officials and having apparently accurately described the details of the destruction, her specifics regarding nuclear weapon effects are riddled with errors. What is worse, most all of the errors go in one direction, to exaggerate the effects of a nuclear explosion. Given that the effects of a nuclear explosion are horrendous, something to which the people of Hiroshima and Nagasaki can easily testify, it is not clear why she felt the need to exaggerate these effects.

Of course, the whole point of the book is to construct a scenario where a nuclear conflict escalates into an all-out war, leading to nuclear winter and possible human extinction. However, to achieve this goal, Jacobsen's scenario hinges on a number of improbable events, including ill-advised decisions by the Secret Service and a major mistake regarding the trajectories of U.S. Minuteman missiles flying from Wyoming to North Korea. This latter mistake unravels her entire scenario. What is worse, after laying out this doomsday scenario, Jacobsen has no suggestions on how to avoid it.

In this paper I will describe many of her errors regarding nuclear weapon effects, followed by a critique of her scenario, explaining her improbable choices and the error that undoes her entire book.

Errors Regarding Nuclear Weapon Effects

One of Jacobsen's more obvious errors is her claim that John F. Kennedy was the last U.S. President to see actual combat.[4] This statement ignores President George H.W. Bush, who was a naval aviator in World War II. Indeed, at one point his plane was shot down and he was the only

[1] This paper is the product of the author's personal research and the analysis and views contained in it are solely his responsibility. Though the author is also a part-time adjunct staff member at the RAND Corporation, this paper is not related to any RAND project and therefore RAND should not be mentioned in relation to this paper. I can be reached at GregJones@proliferationmatters.com
[2] Annie Jacobsen, *Nuclear War: A Scenario* (New York, Dutton, 2024).
[3] P. xii and p. 297 [Footnotes containing just page numbers refer to Jacobsen's book.]
[4] P. 262.

member of the three-man crew to survive—an illustration of how at some points history hangs by a thread.

Much of the early part of the book consists of detailing the effects of a one-megaton surface burst on the Pentagon. At first, she correctly states that the fireball is little more than a mile (5,700 feet) in diameter.[5] Only a few pages later she incorrectly increases its area by a factor of four writing that it is 1.1 miles in radius.[6]

The destructive blast effects of a nuclear weapon are quantified in terms of blast overpressure. An overpressure of 5 pounds per square inch (psi) is sufficient to destroy many structures. Jacobsen says that the 5 psi overpressure will extend to 7.5 miles.[7] Actually it will extend to about 2.8 miles.[8] Jacobsen has overestimated the affected area by a factor of 7. Jacobsen also says that the 1 psi effects will extend to some 10 to 12 miles. Actually, the 1 psi effects only extend to 7.2 miles, an area some two times smaller. Further she says that people in the 1 psi area will have ruptured lungs, when in fact, even the threshold for lung damage is around 12 psi.[9]

A firestorm would also result from a nuclear detonation. The exact size of the area of the resulting firestorm is somewhat uncertain but analysts tend to choose a radius for the burn area from a one-megaton weapon where the thermal radiation fluence is 10 calories per square centimeter (cal/cm^2).[10] For a ground burst this distance would be about 5.0 miles, which is an area of about 80 square miles. Again, Jacobsen uses a somewhat exaggerated estimate of "100-square-mile (or more)."[11]

Jacobsen also notes that the large-scale fire "creates its own weather" generating large-scale winds. However, she fails to understand the full import of this phenomenon.[12] The winds blow in towards the fire limiting the spread. The fire storm at Hiroshima was roughly circular and it did not spread beyond where the initial fires started. Jacobsen incorrectly believes that the firestorm would spread and "consume all of greater Washington, D.C., and the suburbs beyond."[13]

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[5] P. xvii
[6] P. xxii
[7] P. xxiii
[8] This number is based on my own calculations derived from data in Samuel Glasstone and Philip J. Dolan, *The Effects of Nuclear Weapons*, United States Department of Defense and United States Department of Energy, 1977. https://www.osti.gov/servlets/purl/6852629
[9] Ibid., p. 552.
[10] See for example: William Daugherty, Barbara Livi and Frank Von Hippel, "Casualties Due to the Blast, Heat and Radioactive Fallout from Various Hypothetical Nuclear Attacks on the United States," *The Medical Implications of Nuclear War*, National Academy Press, Washington D.C., 1986, p. 213. This work uses a firestorm radius of 12 kilometers for a one-megaton air burst. The thermal radiation fluence at this distance is 10 cal/cm^2. (Ibid., p. 63) Note, that this distance is significantly different for the one-megaton *ground burst* Jacobsen uses in her scenario. https://www.ncbi.nlm.nih.gov/books/NBK219152/pdf/Bookshelf_NBK219152.pdf
[11] P. 187.
[12] P. 186.
[13] P. 186.

Jacobsen does not clearly understand the nature of the thermal radiation is that causes the fires. She incorrectly calls it "soft x-ray light."[14] The very high temperatures in the vicinity of the nuclear detonation leads to the emission of soft (low energy) x-rays but air is opaque to this radiation and absorbs it. The resulting superheated air generates the fireball which then re-emits this energy as thermal radiation in the ultraviolet, visible and infrared regions of the spectrum.[15] It is radiation in these regions of the spectrum that constitutes the thermal radiation.

These errors have no significant impact on Jacobsen's doomsday scenario; still, they demonstrate Jacobsen's lack of understanding of the effects of nuclear weapons and her lack of care to fact-check her information. As we will see in the next section, her scenario is not credible as it relies on a number of improbable events, ill-advised decisions by the Secret Service and a major mistake that demolishes the scenario.

Scenario Critique

The book's scenario begins by North Korea launching a single ICBM at Washington DC. Initially Jacobsen says that we don't know why North Korea has launched this attack but later calls the leader of North Korea "a mad king."[16]

North Korea has never fired one of its ICBMs to full range but rather fires them virtually straight up so that they come down very near North Korea. This is likely because North Korea does not have the tracking ships needed to observe the latter parts of a missile's flight if it were to be fired at full range into the Pacific Ocean. Therefore, North Korea does not know the accuracy of its ICBMs when fired to full range or whether the missile warhead can survive the resulting oblique reentry angle. In Jacobsen's scenario the missile is equipped with a one-megaton warhead even though North Korea has never tested a nuclear weapon with a yield larger than about 250 kilotons. Yet in Jacobsen's scenario the untested missile and warhead work perfectly, scoring a direct hit on the Pentagon with the warhead delivering its full yield.

In the second part of this scenario, North Korea launches a submarine carried ballistic missile at the Diablo Canyon nuclear power plant in California. The missile is launched from a very old diesel-electric submarine at a distance of 350 miles with a 300 kiloton warhead. Again, the missile works perfectly and hits very close to the nuclear reactor.

It is quite unlikely that such an old diesel-electric submarine could traverse the entire Pacific Ocean undetected. Jacobsen quotes from the analyst Ted Postal, who supplies helpful hints to North Korea as to how such a submarine might evade detection but Postal seriously overestimates the performance of these old submarines.[17]

[14] P. xvii.
[15] Samuel Glasstone and Philip J. Dolan, *The Effects of Nuclear Weapons*, United States Department of Defense and United States Department of Energy, 1977, pp. 305-307. The superheated air also expands rapidly, generating the blast wave.
[16] P. 226 & p. 252.
[17] P. 119.

There is also the issue of whether Kim Jong Un would trust the submarine commander with control of a nuclear weapon. This is an issue that has affected other authoritarian regimes. For many years, Chinese ballistic missile submarines did not go on patrols for just this reason.[18]

Jacobsen's scenario becomes extremely doubtful when she writes about how the U.S. might formulate a response to these attacks. She claims that the U.S. has a "launch on warning" policy that requires the U.S. to launch its responding missiles before any attacking missiles can land in the U.S. This would force the launch decision to be made in a matter of minutes.

It is unclear if the U.S. or Russia has such a policy. If they do it would be intended for a case where a very large attack is occurring and there is concern that the enemy attack might destroy the ability to respond. It hardly would apply to the case where a single missile has been launched. At any rate, such a policy is hardly a law of physics or even a law of the U.S. Any President could decide to take as much time as he wanted. In fact, in Jacobsen's scenario, the U.S. response is not based on a launch on warning policy but only occurs after a nuclear detonation in California.

In Jacobsen's scenario, the efforts of the Secret Service to protect the President are reminiscent of the Keystone Cops. A helicopter evacuates the President from the White House though the takeoff is delayed "several minutes" by the need to try to find parachutes.[19] There is a concern that the electromagnetic pulse (EMP) from the coming nuclear explosion might cause the helicopter to crash even though the helicopter is hardened against EMP. As a result, the Secret Service has President, the President's military aide and one agent with the president parachute out of the helicopter together right before the nuclear explosion. The nuclear weapon hits D.C. very soon thereafter. The blast wave hits "a fraction of a second later" killing the military aide and the agent.[20] The President is seriously injured and alone. Two other Secret Service agents parachute just after the President. Jacobsen does not say what happens to them but apparently, they never find the President.

In Jacobsen's scenario, the President is flying to "Raven Rock Mountain Complex, the Pentagon's Alternate National Military Command Center."[21] He has been in the air about 9 minutes and I calculate he is about 20 miles from D.C.[22] Jacobsen does not explain why the President is not flown to Joint Base Andrews which is only about a 5 minute flight away. The President could then board Air Force One and be well away from any nuclear detonation—especially since there would be no need to delay to find parachutes. Even if the President is being flown to Raven Rock, why does he parachute out of the helicopter? It would be much easier to land the helicopter and see if it is disabled by EMP. This way the President is not seriously injured, the military aide and Secret Service agent are not killed. Further though Jacobsen claims that the blast wave hits the parachuting President and his aide in a fraction of a

[18] David C. Logan, "China's Future SSBN Command and Control Structure," Strategic Forum: National Defense University, November 2016, p. 2. https://inss.ndu.edu/Portals/68/Documents/stratforum/SF-299.pdf?ver=2016-11-28-093723-680
[19] P. 131.
[20] P. 164 and p. 211.
[21] P. 155.
[22] Nine minutes is the difference between p. 155 and p. 164. If the helicopter is traveling 150 mi/hr, then it covers 22.5 miles in nine minutes.

second after detonation, actually, at a distance of over 20 miles, the blast wave's travel time would be somewhere between a minute and a minute and one half.[23] The blast wave's strength at this distance would be so diminished as to not cause any problems. Jacobsen's scenario exerts extreme improbable effort to take the President out of play.

It is now that Jacobsen makes her greatest mistake, one that unravels her entire doomsday scenario. The U.S. has responded to the North Korean attack by launching 50 Minuteman ballistic missiles from Wyoming. According to Jacobsen, these missiles fly "over the North Pole."[24] This leads the missiles to fly over Russian territory. The Russians thus believe that the U.S. is launching a preemptive decapitating attack on Moscow and launch hundreds of missiles carrying one thousand nuclear warheads at the U.S. Seeing this attack, the U.S. launches its full arsenal at Russia. Doomsday is now unavoidable.

However, Jacobsen apparently never bothered to see what the trajectory of a missile fired from Wyoming to North Korea looks like. The trajectory can be easily plotted using various websites. Figure 1 shows the result.[25] The trajectory does not go over the North Pole but rather over southern Alaska. The trajectory indeed passes over Russia but over extreme eastern Russia—essentially Vladivostok. This city is about 4,000 statute miles from Moscow. This is about the same distance as from London to Chicago. The Russians would not believe that the Minuteman missiles were flying towards Moscow and they would not think that the U.S. is launching a preemptive attack. Jacobsen's entire scenario falls apart. Rather, the nuclear exchange would likely stop after the initial U.S. nuclear attack hits North Korea. Jacobsen's Armageddon would be averted.

Jacobsen then has North Korea detonate another nuclear weapon to cause damage in the U.S. but it is not an explosion on the ground. Rather North Korea has placed a "small" nuclear weapon in a satellite to explode 300 miles (almost 500 kilometers) over the U.S.[26] This explosion is intended to cause a high-altitude electromagnetic pulse (HEMP, often shortened to just EMP) to damage electrical devices. Jacobsen believes that this will cause the entire U.S. power grid to fail as well disable computer-controlled devices in a wide variety of uses. Thus the U.S. will be returned to the Stone Age.

In 2022, RAND published a report on possible North Korean attacks using various forms of non-nuclear WMD.[27] I was one of the reports co-authors and I authored the report's chapter on EMP which focused mainly on high-altitude EMP. The possible effects of EMP on electrical systems are highly uncertain as they are based on a few nuclear tests conducted in the early 1960s, when electrical devices were quite different from the ones used today. There is a wide range of

[23] This distance is great enough that *The Effects of Nuclear Weapons* does not bother to calculate either the time of arrival or the blast wave's greatly reduced strength.
[24] P. 168.
[25] Great Circle Map. https://www.greatcirclemap.com/ To be precise, the trajectory shown is from the Cheyene, Wyoming airport to the Pyongyang, North Korea airport.
[26] P. 256 and p. 263. Jacobsen does not specify the yield of this small nuclear weapon.
[27] Bruce W. Bennett, Kang Choi, Gregory S. Jones, Du-Hyeogn Cha, Jiyoung Park, Scott W. Harold, Myong-Hyun Go, and Yun Kang, "Characterizing the Risks of North Korean Chemical and Biological Weapons, Electromagnetic Pulse and Cyber Threats," RRA-2026-1, the RAND Corporation and the Asan Institute for Policy Studies, 2022. https://www.rand.org/pubs/research_reports/RRA2026-1.html

opinion as to the seriousness of this threat. Jacobsen chooses to rely on the school of opinion that sees the threat as very serious.

EMP consists of three components, E1, E2 and E3. E2 is similar to a lightning strike against which most electrical systems are already protected. E3 could affect major components of the electrical grid. However, E3 is only significant for weapon yields greater that about 100 kilotons, so E3 would not be an issue in Jacobsen's posited attack. E1 could be serious and damage a variety of electrical devices. However, the optimal height of burst to cause E1 effects is 60-100 kilometers. The atmosphere at this altitude is too dense to allow the operation of satellites which is why Jacobsen's posits a detonation altitude of almost 500 kilometers. However, the E1 effects at this detonation altitude would be weak and likely not cause any serious damage.

Further, any possible North Korean EMP attack is quite irrelevant in the book's scenario. When the North Korean EMP weapon is detonated, 1,000 high-yield Russian nuclear weapons are in flight towards the U.S. Whether various electrical devices are disabled by North Korean EMP will hardly matter since most of them will be destroyed when the Russian nuclear weapons detonate in the U.S.

Jacobsen does not specify how many U.S. nuclear weapons are launched at Russia but it is probably somewhere around 1,500.[28] She also does not describe the targets or the weapons' gruesome effects of this U.S. attack. Similarly, though she has Russia attack Europe as well, she only states that it is hit by a "slew" of weapons.[29]

The result of this large-scale destruction is a nuclear winter, which might lead to around 5 billion deaths—mostly by starvation. The Robock paper on which Jacobsen bases her estimate assumes a world population of only 6.7 billion giving about 1.7 billion survivors.[30] Some Southern Hemisphere countries such as Australia and Argentina would survive mostly intact.[31] Still this massive amount of death is not enough for Jacobsen, who raises the specter of human extinction or that the few surviving humans are reduced to a Stone Age like state and must "begin anew."[32] She raises the concern that "all present-day knowledge will be gone."[33] Given that several Southern Hemisphere countries would survive intact, how this would happen is unclear.

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[28] It is estimated that the U.S. has about 1,770 deployed nuclear weapons. However, 82 of these weapons will have already been fired at North Korea in Jacobsen's scenario and some of the aircraft delivered weapons will likely not survive long enough to be used. See: Hans M. Kristensen et. al., "United States nuclear weapons, 2024," *Bulletin of the Atomic Scientists*, Vol. 80, No. 3, 2024.
https://www.tandfonline.com/doi/epdf/10.1080/00963402.2024.2339170

[29] P. 273.

[30] Alan Robock et. al., "Opinion: How fear of nuclear winter has helped save the World, so far," *Atmospheric Chemistry and Physics*, 2023, p. 6697. https://acp.copernicus.org/articles/23/6691/2023/acp-23-6691-2023.pdf The was the world's population was about 6.7 billion in 2006. The current world population is about 8.2 billion. See Worldometer https://www.worldometers.info/world-population/

[31] Ibid.

[32] P. 290.

[33] P. 297.

What then is to be done about the threat of nuclear annihilation? Jacobsen dodges this question, a fact that left some reviewers of the book highly dissatisfied.[34] Her last two sentences in the book "It was the nuclear weapons that were the enemy of us all. All along." hint that she might support the 2017 Treaty on the Prohibition of Nuclear Weapons.[35] This treaty aims to abolish all nuclear weapons and to prohibit any work on such weapons.

However, given the widespread knowledge of the design and manufacture of nuclear weapons combined with the ease with which peaceful nuclear activities can be used as a cover for nuclear weapons development and the small size of the weapons themselves, even in 2017, the goal of nuclear weapon abolition was not easy. Since then, the difficulties have only grown substantially.

The three-year war in Ukraine has made clear that Russia has declined to where it is a medium-level military power. Its only claim to great power status is its large nuclear arsenal. Russia is very aware of this fact and has repeatedly reminded the world of its nuclear arsenal and has threatened to use it. It seems very unlikely that Russia would give up its nuclear arsenal.

China is rapidly expanding its nuclear forces in an attempt to more closely match the U.S. and Russia. Its arsenal has expanded from about 250 weapons in 2017 to around 600 today and is expected to reach 1,000 by 2030.[36] North Korea has been rapidly expanding its nuclear arsenal and now has somewhere between about 70 and 110 nuclear weapons.[37] Iran has reached the position where it could produce a missile-deliverable nuclear weapon in just a few months.[38]

Given these developments, abolishing nuclear weapons, something that was never going to be easy, looks very difficult indeed. At this time, there appears to be no alternative to relying on the status quo where deterrence continues to prevent nuclear war. Jacobsen's book serves no purpose other than to state the obvious—that nuclear war is terrible and we should try very hard to avoid it.

Conclusions

Throughout her book Jacobsen tries to establish her credibility by providing the effects of a nuclear explosion on Washington D.C. in great detail. In fact, her book is riddled with errors. What is worse, most all of the errors are in one direction, to exaggerate the effects of a nuclear

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[34] See for example: Barry Gewen, "Let's Say Someone Did Drop the Bomb. Then What?," *The New York Times*, March 24, 2024. https://www.nytimes.com/2024/03/24/books/review/nuclear-war-annie-jacobsen-countdown-sarah-scoles.html

[35] P. 297. On the treaty see: https://disarmament.unoda.org/wmd/nuclear/tpnw/

[36] "Military and Security Developments Involving the People's Republic of China, Report to Congress," U.S. Department of Defense, 2024, p. IX. https://media.defense.gov/2024/Dec/18/2003615520/-1/-1/0/MILITARY-AND-SECURITY-DEVELOPMENTS-INVOLVING-THE-PEOPLES-REPUBLIC-OF-CHINA-2024.PDF

[37] Gregory S. Jones, "Current Estimate of North Korea's Plutonium, HEU Stocks and Nuclear Arsenal," June 14, 2024. https://nebula.wsimg.com/39c34f7b362b791e881eea2f79210745?AccessKeyId=40C80D0B51471CD86975&disposition=0&alloworigin=1

[38] Gregory S. Jones and Henry Sokolski, "Iran Could Build a Nuclear Weapon Sooner Than You Think," *Foreign Policy*, October 10, 2024. https://foreignpolicy.com/2024/10/10/iran-nuclear-weapon-warhead-missile-how-soon/

explosion. Given the great devastation that results from such an explosion, it is unclear why Jacobsen felt the need to overstate it.

The efforts in Jacobsen's scenario to protect the President from a nuclear attack on Washington D.C. are almost comic. She goes out of her way to make the Secret Service take ill-advised steps to ensure that the President is taken out of the picture. Instead of landing the Presidential helicopter before it might be disabled by the EMP from the nuclear detonation on Washington D.C., she instead has the Secret Service parachute the President out of the helicopter, where a Secret Service agent and the President's military aide are killed and the President is seriously injured and out of communication for the rest of Jacobsen's scenario.

Jacobsen does not consider the much safer and easier option of flying the President to Joint Base Andrews, where the President could board Air Force One and quickly leave the danger area. At the same time the President would remain in communication and thereby in continuing command of the U.S. nuclear forces.

Jacobsen's biggest error and one that unravels her whole scenario, is her belief that U.S. Minuteman missiles launched from Wyoming pass over the North Pole on their way to North Korea. In her scenario, the Russians see these missiles and misinterpret them as a preemptive attack on Moscow. The Russians conduct a very major nuclear attack on the U.S. and the U.S. responds with all of its forces. Large-scale destruction and nuclear winter result.

Actually, the missiles pass over southern Alaska and only near Vladivostok on their way to North Korea. Since Vladivostok is about 4,000 statute miles from Moscow, the Russians would not believe the Minuteman missiles were flying towards Moscow and they would not think that the U.S. is launching a preemptive attack. The Russians would not launch their attack and the U.S. would not respond. Nuclear Armageddon would be avoided and the world would be saved.

Jacobsen provides no prescription to avoid her doomsday scenario and there appears to be no alternative other than to rely on the status quo where deterrence continues to prevent nuclear war. Jacobsen's book serves no purpose other than to state the obvious—that nuclear war is terrible and we should try very hard to avoid it.

Figure 1

Minuteman Trajectory From Wyoming to North Korea