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IF IT HAPPENED HERE:
THE IMPACT OF A NUCLEAR BOMB ON ADELAIDE

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NUCLEAR BOMB

"Nuclear bomb" is the umbrella term for any explosive device that derives its destructive force from nuclear reactions. When detonated, a nuclear bomb releases energy in the form of massive heat, light, blast, and radiation through either fission (splitting atoms) or fusion (combining atoms). The key component of any nuclear bomb is fissile material such as Uranium-235 or Plutonium-239.

Examples of nuclear bombs include atomic bombs and hydrogen bombs.

Atomic bombs gained notoriety during World War II after the detonation of "Little Boy" and "Fat Man" in Hiroshima and Nagasaki, killing at least 100,000 people instantly. Hundreds of thousands more died due to injuries or radiation sickness.

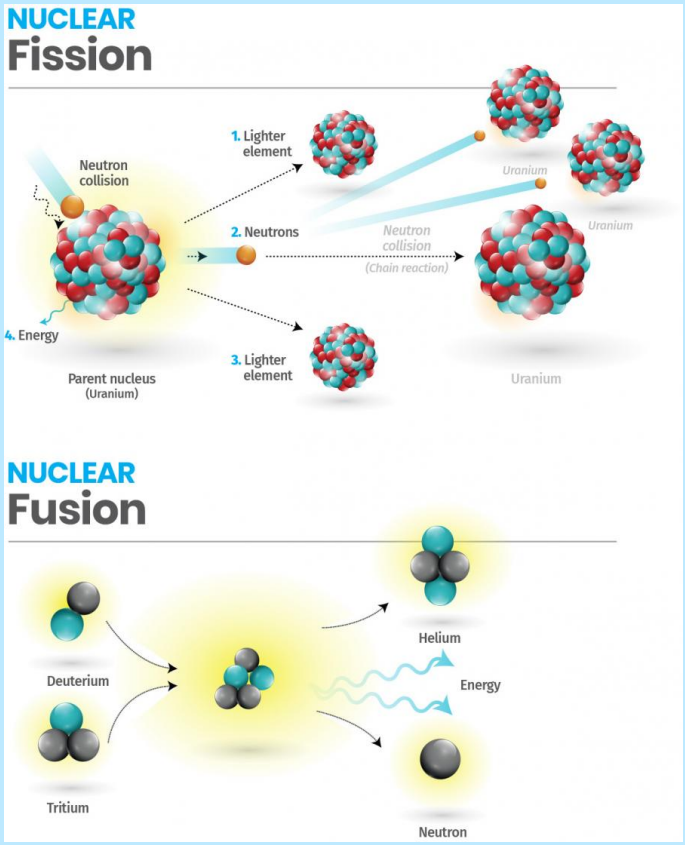

Figure 1: Nuclear Reaction – Fission and Fusion

Note: From *Fission vs fusion: an explainer* (https://www.ansto.gov.au/news/fission-vs-fusion-an-explainer)

BOMB YIELD

The impact of a Nuclear Bomb depends on the yield of the nuclear bomb. The higher the yield, the more devastating is the nuclear bomb. The yields of "Little Boy" and "Fat Man" in Hiroshima and Nagasaki were estimated to be 15 kilotons (kt) and 20kt of trinitrotoluene (TNT) explosives equivalent respectively.

Scarily, nuclear bombs have advanced significantly since World War II, and the most powerful nuclear weapon ever created and tested is the "Tsar Bomba" in 1961 with a yield of 50,000kt.

NUCLEAR BLAST MODEL

Adelaide is the capital city of South Australia. Its population is around 1.4 million and it is the fifth most populous city in Australia. To understand the impact of a nuclear bomb on Adelaide, I first chose a nuclear blast model.

Firstly, my model assumes that the nuclear bomb is detonated on a surface, known as surface burst, as opposed to air burst.

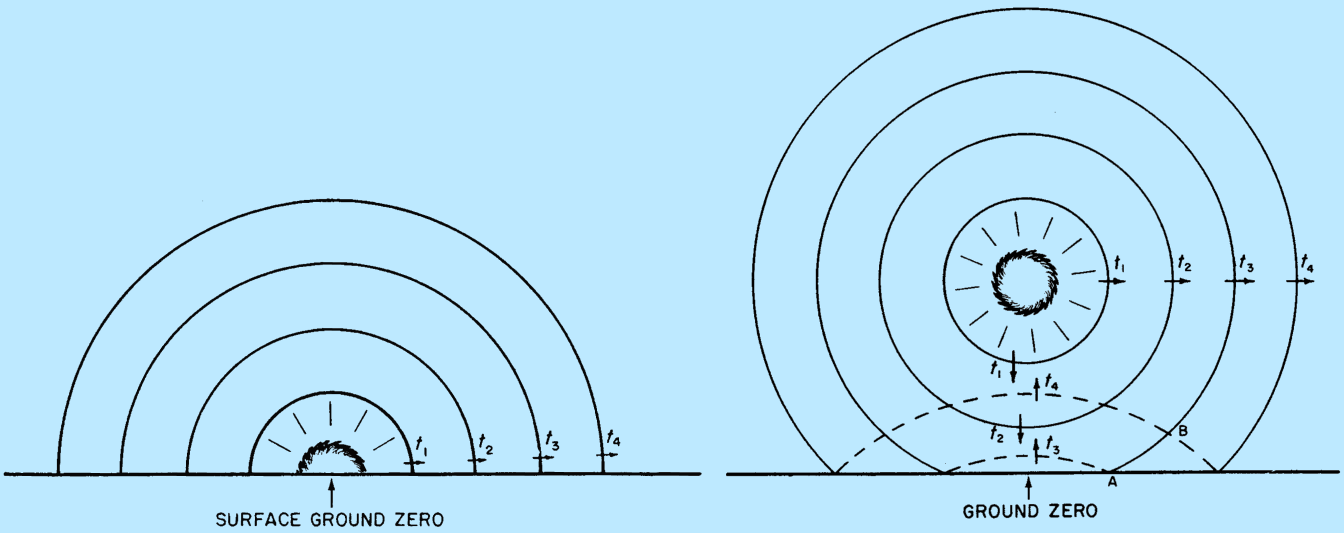

Figure 2: Surface burst versus air burst - (Left) Blast wave from a surface burst; (Right) Blast wave from an air burst; t_1, t_2, t_3, t_4 show increasing time progression

Note: From *Glasstone et al., The Effects of Nuclear Weapons, Figure 3.21 and Figure 3.34* (https://atomicarchive.com/resources/documents/effects/glasstone-dolan.html)

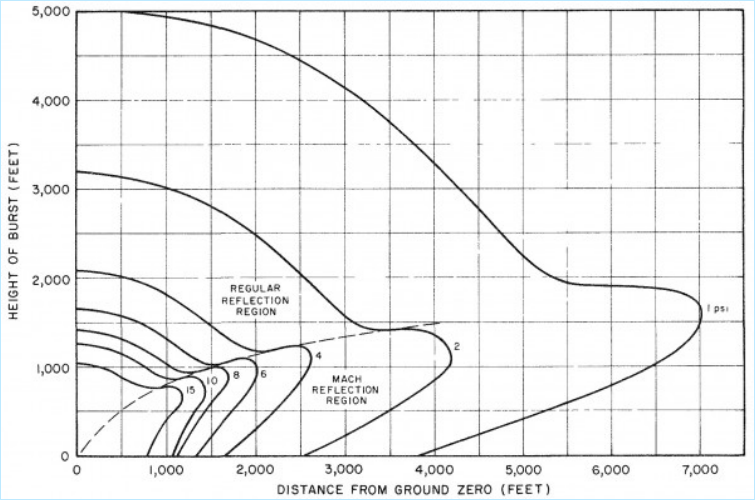

Figure 3: Models used by NUKEMAP

Note: From *Glasstone et al., The Effects of Nuclear Weapons, Figure 3.73c* (https://atomicarchive.com/resources/documents/effects/glasstone-dolan.html)

Secondly, the mathematical equations for nuclear burst are complex. An existing simulation tool called NUKEMAP is used for my simulations. NUKEMAP uses models of peak overpressures with scalability. For example, for surface burst, the models for a 1kt yield burst shown in Figure 3 are implemented. The models are scalable for any yield.

SIMULATED EFFECTS OF NUCLEAR BOMB ON ADELAIDE

With NUKEMAP, I have investigated the effects of nuclear bomb on Adelaide based on different yields. The simulation results are:

Nuclear Bomb Yield (kt)	Equivalent	Fireball Radius* (m)	Casualty Estimated by NUKEMAP**	Estimated Casualty 2025***
15	"Little Boy" (dropped in Hiroshima)	261	18390	21393
20	"Fat Man" (dropped in Nagasaki)	293	23280	27082
100	W-76 (current US thermonuclear warhead)	560	83320	96926
300	W-87 (current US thermonuclear warhead)	870	168790	196353
50000	"Tsar Bomba" (largest nuclear bomb tested)	5050	1022210	1189137

* Anything inside the fireball is effectively vaporized.
** Casualty includes fatalities and injuries estimated by NUKEMAP based on LandScan Global Population 2011
*** Number of 2025 based 16.33% increment of Adelaide population from 1,262,940 (2011) to 1,469,163 (2025)

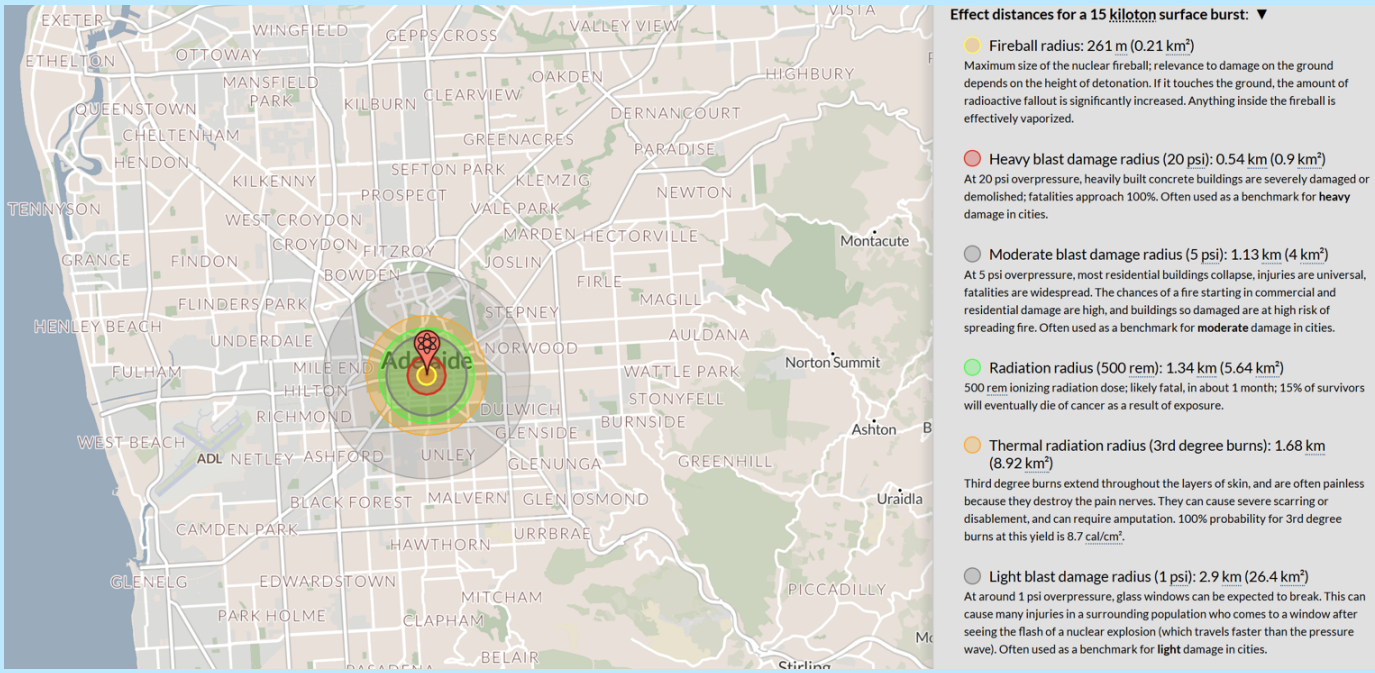

Figure 4: Simulation results with 15kt nuclear bomb detonated in the CBD of Adelaide

Note: Simulated using NUKEMAP. Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

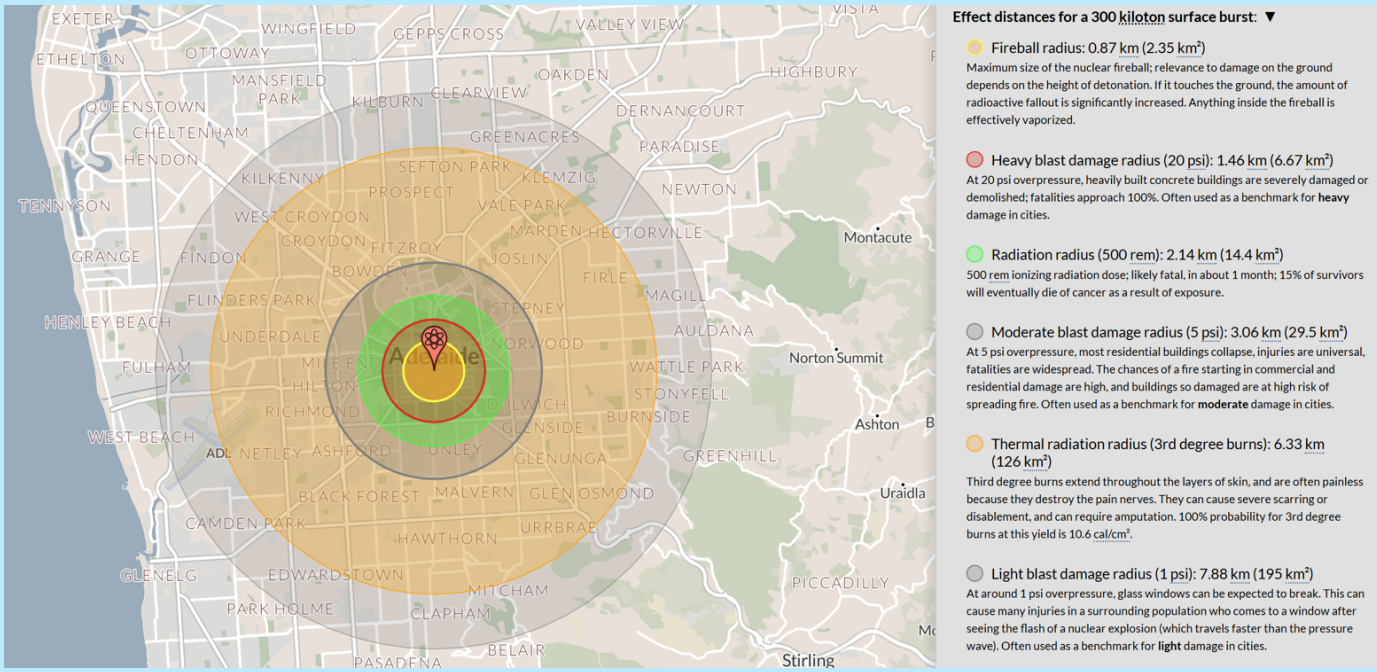

Figure 5: Simulation results with 300kt nuclear bomb detonated in the CBD of Adelaide

Note: Simulated using NUKEMAP. Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

The simulation results are shocking. The casualty numbers are astronomically high.

For example, the casualty number of a 300kt nuclear bomb is 196353! The bomb creates a fireball radius of 870m which engulfs almost the entire Adelaide CBD (approximately 1.6km x 2.2km) in a fireball with extremely high heat which will decimate everything within this radius. The core of the explosion can reach temperatures of 50 million degrees Celsius.

Figure 6: What Adelaide may look like after a nuclear bomb detonation - (Left) Victoria Square in Adelaide; (Right) Hiroshima after detonation of "Little Boy"

Note: (Top) © Ivan Leong; (Bottom) *National Archives* photo (https://www.nationalww2museum.org/war/articles/atomic-bomb-hiroshima)

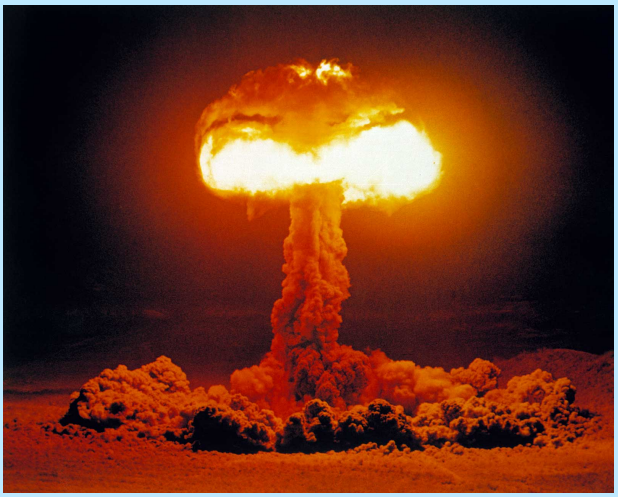

Figure 7: The iconic mushroom cloud of a nuclear bomb explosion

Note: From *The Mushroom Cloud* (https://www.atomicarchive.com/science/effects/mushroom-cloud.html)

The inferno is not the only nightmare. The detonation of a nuclear bomb sucks up dirt and debris from the ground that have become radioactive due to the nuclear explosion and create the well-known mushroom cloud. The radioactive material will be carried by wind and spread to very far distances before settling on the ground. This is known as fallout radiation. Fallout radiation impacts the environment severely, contaminating soil, water and food sources. Figure 8 shows simulated fallout. Even Clare (120km from Adelaide) will be affected if the wind is blowing North.

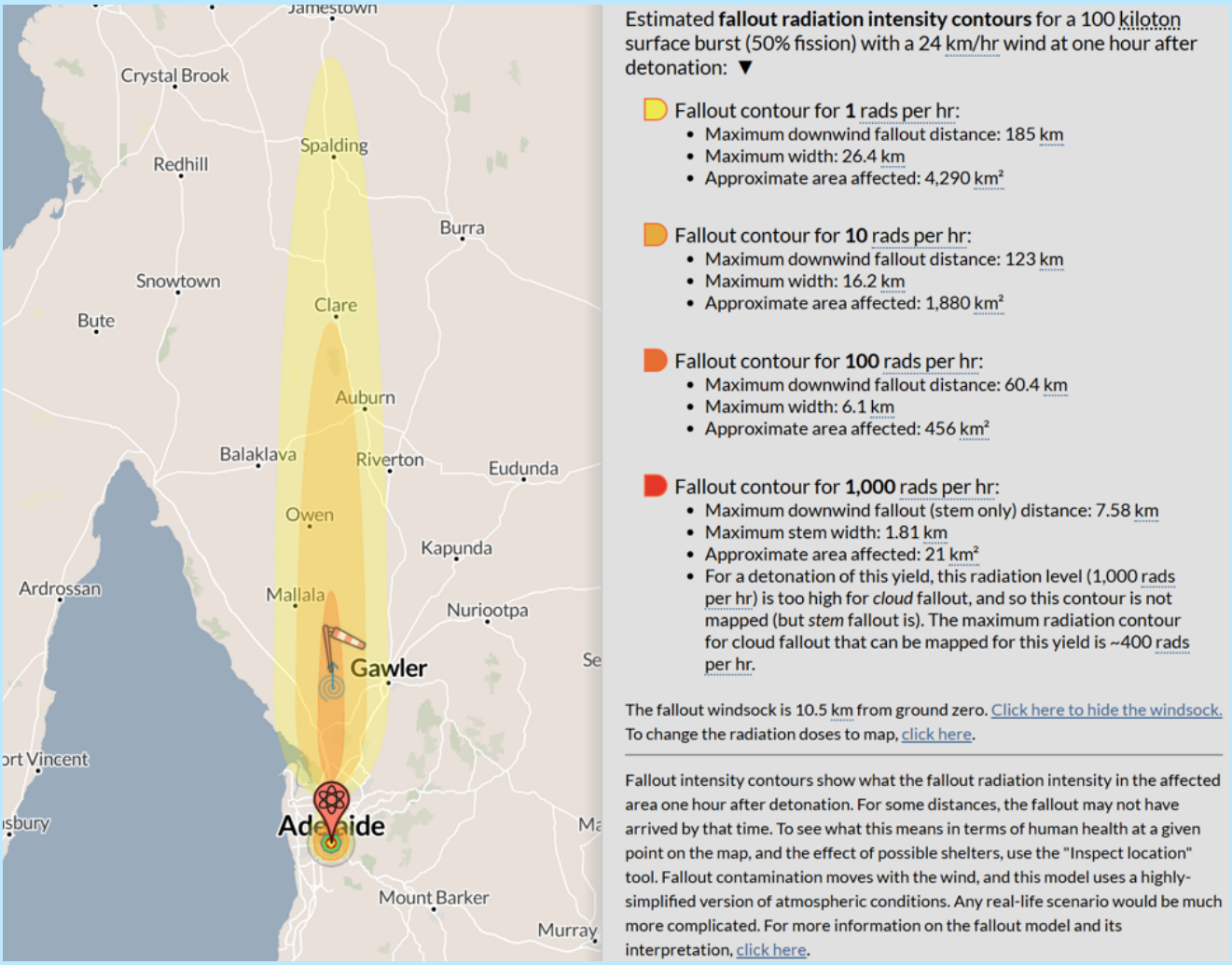

Figure 8: Simulated fallout with northerly wind

Note: Simulated using NUKEMAP. Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

LONG TERM IMPACTS

Uranium-235's half-life is 704 million years (meaning that half of a certain quantity of Uranium-235 will decompose into other elements (mainly Lead-207) in 704 million years by releasing alpha-particles) so it will take a very long time to decay.

People in Adelaide who survive the blast will still be exposed to high amounts of radiation. They will be at risk of Acute Radiation Syndrome (ARS). The symptoms of ARS include nausea, vomiting and fatigue. ARS also increases the risk of cancer.

As shown by the blast simulation in Figure 5 and fallout simulation in Figure 8, the environment surrounding Adelaide will be devastated. The beautiful beaches will be polluted, and the local habitat will be wiped out.

The society and economy of Adelaide will also be shattered. There will be mass casualties and displacements. Resources such as food and clean water will be scarce, healthcare systems will be overwhelmed, and the society will be in chaos!

CONCLUSION

I love science. This is the first science research that left me with a heavy heart. I never thought science would have created such a terrible weapon. Its destructive force is beyond my wildest imagination. A single bomb is sufficient to destroy Adelaide in seconds. Science is supposed to improve the life of human, such as curing diseases through medical science, bringing human together through various advancement in telecommunication and going to space, not to destroy everything.

I really regret the creation of such weapon. It may have ended World War II, but the cost is simply too heavy. I am relieved to learn that Australia has committed to never acquiring nuclear weapons and support the Treaty on the Non-Proliferation of Nuclear Weapons. Hopefully, the world is without nuclear weapons through mutual disarmament in the near future.

[880 words]

BIBLIOGRAPHY

Baxter, R. (2014), "The Dropping of the Atomic Bomb: A History Perspectives Book", Cherry Lake Publishing, Michigan, United States of America

Burgan, M. (2020), "Hiroshima and Nagasaki: The Atomic Bombings That Shook the World, Capstone Press, Minnesota, United States of America

Cross, R. (2001), "Fallout: Hedley Marston and the British Bomb Tests in Australia", Wakefield Press, South Australia, Australia

Glasstone et al. (1977), "The Effects of Nuclear Weapons", United States Department of Defence and the Energy Research and Development Administration

Hachiya, M. (2024), "The Doctor of Hiroshima", Octopus Publishing Group, London, England

Ham, P. (2011), "Hiroshima Nagasaki", HarperCollins Publishers, Australia

Jacobsen, A. (2024), "Nuclear War", Griffin Press, Australia

Kelly, C. C. (2007), "The Manhattan Project", Black Dog and Leventhal Publishers, United States of America

Langley, A. (2018), "Hiroshima and Nagasaki", Compass Point Books, Minnesota, United States of America

Morey, A. (2020), "It's the End of the World! Nuclear War", Bellweather Media, Minneapolis, United States of America

Poulsen, D. A. (2016), "And Then the Sky Exploded", Dundurn Press, Ontario, Canada

Rebman, N. (2025), "The Bombing of Hiroshima and Nagasaki", Apex Editions, United States of America

Rhodes, R. (1986), "The Making of the Atomic Bomb", Simon and Schuster, New York, United States of America

Ross, S. (2010), "A Place in History: Hiroshima", Arcturus Publishing, London, England

Selden, K (2015), "The Atomic Bomb: Voices from Hiroshima and Nagasaki", Routledge, New York, United States of America

Tucker, A. (2009), "Atomic Testing, Woomera, 1953", Scholastic Press, New South Wales, Australia

Walker, S. (2005), "Shockwave: Countdown to Hiroshima", HarperCollins Publishers, London, England

Wellerstein, NUKEMAP, (https://nuclearsecrecy.com/nukemap/)

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