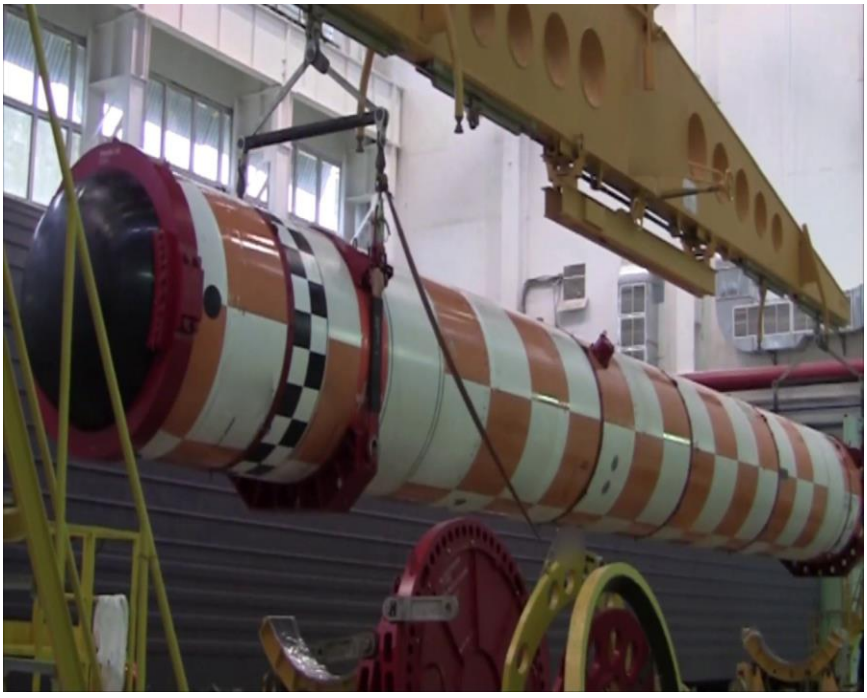

NUCLEAR TSUNAMI: MYTH OR REALITY?

Analysis of the likelihood nuclear bombs to produce earthquake and devastating tsunami.

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I. The long lasting dream of Russian's in heaving nuclear torpedo with devastating power.

The idea of having super-powerful nuclear torpedo originates from the prominent nuclear physics Andrei Sakharov, who also played a crucial role in building the biggest nuclear bomb ever built - the Tsar Bomba. In particular, Sakharov in his *Memoir* explains how he came up to the idea of building nuclear torpedo. As Sakharov stressed, after the test of the Big Bomb he was "concerned that the military couldn't use it without an effective carrier", because a "bomber would be too easy to shoot down" (Shakarov, 1990, pp.220). Thus, his idea was building giant torpedo that will be launched by a submarine that would be capable of carrying 100-megaton nuclear warhead, which will have strong enough body to withstand the exploding mines, fitted with an atomic-powered jet engine that will enable the torpedo to travel long distances to reach their targets (harbors), and capable to detonate both in air and underwater.

However, Sakharov gave up on his idea after the conversation that he had with the Rear Admiral Fomin. In the conversation, Admiral Fomin told Sakharov that he is "shocked and disgusted by the idea of merciless mass slaughter, and remarked that the officers and sailors of the fleet were accustomed to fighting only armed adversaries, in open battle" (Sakharov, 1990, pp.221). After this conversation, Sakharov hadn't discussed this idea with anyone else because he considered that it would be foolish wasting "extravagant sums required on research and development work on such torpedoes", because he feared that this project "couldn't be kept in secret (among other reasons, because radioactive contamination of the ocean would be inevitable), and contra-measures (nuclear mines, for instance) could easily be devised to detect and destroy the torpedoes enroute to their targets" (Sakharov, 1990, pp.221).

What we know about the recent "version" of Russian nuclear torpedo?

While delivering his annual State of the Union address, the Russian President Vladimir Putin revealed that 300 new models of weaponry, including 18 new ICBMs, 2 submarine-based ballistic missiles and underwater drones, will increase the defense capabilities of the Russian Federation in the forthcoming years.

An unnamed source familiar with the intelligence assessments in the US told CNBC that the underwater drone armed with nuclear warhead is still in prototype stage and the nuclear propulsion system [to date] has not been tested, yet. Thus, it is expected to be in

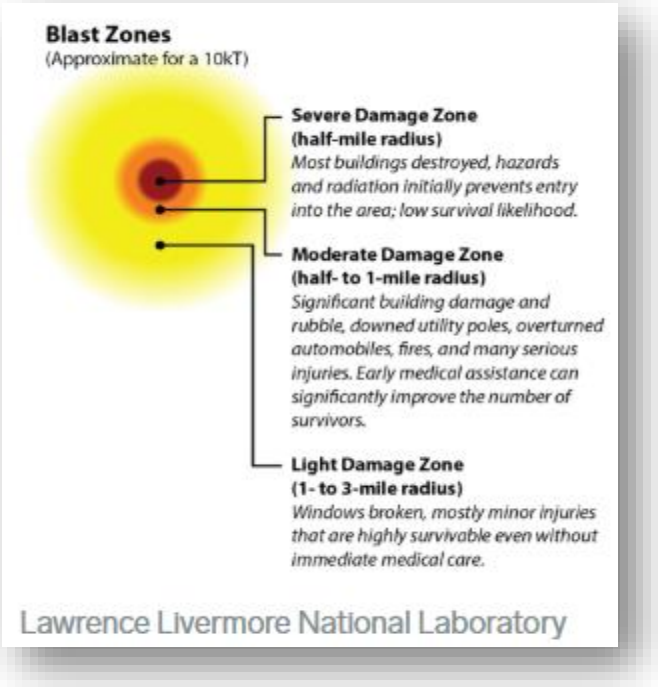
the inventory of the Russian arsenal no earlier than 2027, whereas the air-to-ground hypersonic missile is expected to be part of the Russian arsenal by 2020.

The Poseidon program was first announced in 2015. The 2018 Nuclear Posture Review of the United States defines “Poseidon” as an “intercontinental, nuclear-armed, nuclear-powered, undersea autonomous torpedo”. However, it is believed that the “Poseidon” can travel up to 10,000 km, with a maximum speed of 185km/h and is capable of operation in a depth up to 1,000m (3,300 feet).

Nonetheless, the recent announcement of new nuclear weaponry in the Russian arsenal raises the concerns of new nuclear armament race among the biggest adversaries – the United States and Russia, as Carnegie Endowment expert argues that “the impact of these weapons on strategic stability requires special analysis, but is unlikely to be positive”.

One is for certain, Russia President Vladimir Putin has inaugurated the world’s largest submarine “Belgorod” – a 600 feet (183m) long, dive up to 1,700 feet (518.6m). In terms of the new weaponry, they have been just announced and its status still remains unknown.

II. Effects of detonating nuclear bomb



The extent of damage as well as the output from detonating a nuclear bomb depends on the type of burst (explosion), environment and meteorological conditions, such as temperature, humidity, wind, precipitation and atmospheric pressure are *(S.Glasston & P.J. Dolan, 1977, pp.35)*.

In overall, all nuclear blasts are known to cause the following effects:

1. A flash of light.
2. A pulse of thermal (i.e., heat) energy.
3. A pulse of nuclear radiation.
4. A fireball.
5. An air blast (shock wave)
6. Radioactive fallout

In this regard, the flash of light, pulse of thermal energy and pulse of nuclear radiation are happening instantaneously, and they travel at a light speed.

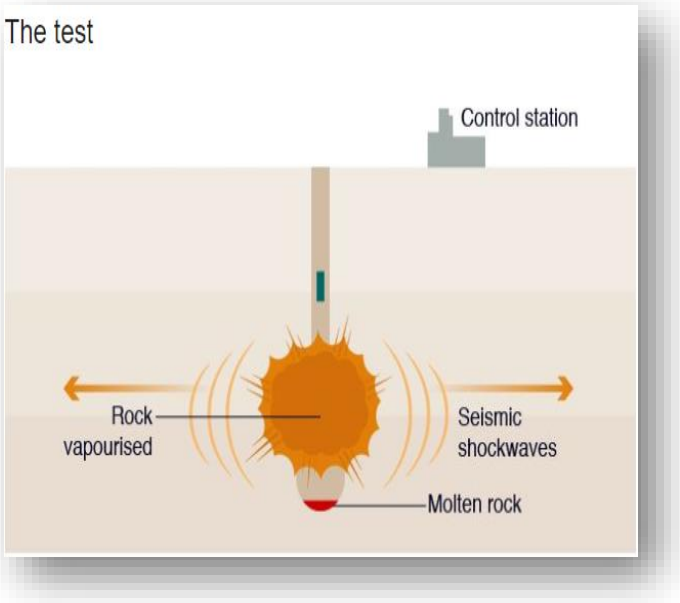
However, the extent of thermal radiation depends on the nature and yield of the weapon, and particularly on the environment of the explosion.

Therefore, regardless of the height of burst, approximately 85 percent of the explosive energy of nuclear fission weapon produces air blast (pressure and shock waves), thermal radiation and heat; 5 percent are consisted of the initial nuclear radiation released/produced in seconds or minutes of the detonation; whereas the last 10 percent is total fission energy [or delayed nuclear radiation] emitted over a period of time. Worth mentioning is that, the delayed nuclear radiation occurs mainly from the fission products that "in the course of their radioactive decay, emit gamma rays and another type of nuclear radiation called "beta particles" *(S.Glasston & P.J. Dolan, 1977, pp.17)* .

The betta particles have a considerable less penetrating power compared to a gamma rays, but they are still highly hazardous for the human beings. As previously said, the immediate effects and the output of detonation of nuclear bomb vary on the location of the point of burst related to the surface of the earth.

Hence, the study entitled as "Effects of Nuclear Weapons," conducted for the purposes of the Department of Defense (DoD) and Department of Energy (DoE) of the United States, identifies 5 types of burst (explosion):

- Air burst
- High-altitude burst
- Underwater burst
- Underground burst
- Surface burst



For the purposes of this article, we will focus only on the **underwater bursts (explosions)**. *(Picture source: BBC)*

In terms of underwater burst, the extent of damage depends whether that occurs in shallow water or deep water. In an event of nuclear blast underwater, all the thermal energy that has been released from the fireball, as well as the neutrons, beta particles and gamma rays released within a short period of time from the explosion, will be absorbed by the surrounding water. Thus, once the fireball reaches the sea surface, the beta particles and the gamma rays will play as some sort of initial radiation. Hence, the water fallout from the explosion will

be very radioactive, especially if the detonation occurs in the shallow water "could suck up tons of ocean sediment, irradiate it, and rain it upon nearby areas".

In short, the biggest threat from the underwater explosion will be the radioactive fallout, that is considerably less powerful compared with those occurred from air blast, but not the tsunami-type waves.

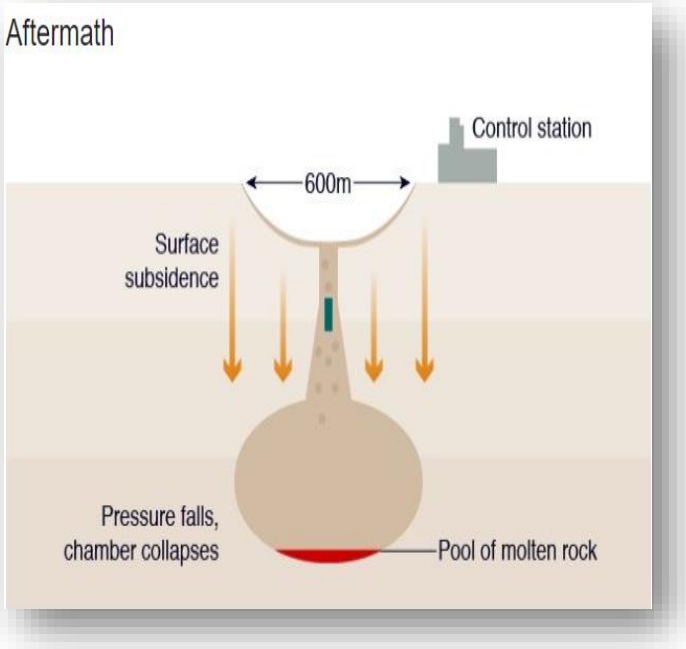
For these purposes, please visit the following link that is a **simulation of the extent of the damage** that a nuclear bombs with various yields can cause on the ground/surface.

III. Earthquakes and tsunamis

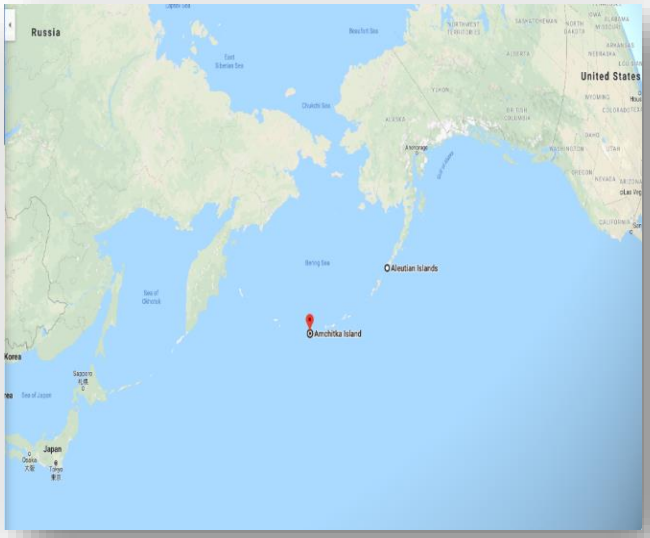
The main questions that are subject for analysis of this article are: what is the likelihood for a nuclear bomb to produce earthquake, and, can a nuclear bomb generate devastating tsunami waves as Russians argue?

There is a myth and fear spread among people that deep underground nuclear bombs can generate natural earthquakes. At the very beginning, **it is false**, and in addition we will provide evidences for that. The stages of underground nuclear tests are well described on the following link.

During BENHAM test when a 1.1 megaton nuclear device was detonated at the Nevada Testing Site, the following was noticed related to the ground shocks *(S.Glasston & P.J. Dolan, 1977, pp.238-241)*: *(Picture source: BBC)*



> "*In a fully-contained deep underground explosions there would be little or no air blast…Much of the energy is expended in forming the cavity around the burst point and melting the rock, and the remainder appears in the form of a ground shock wave…As this shock wave moves outwards it first produces a zone of crushed and compressed rock, somewhat similar to the rupture zone associated with crater formation… Finally at considerable distances from the burst point, the weak shock wave (carrying less than 5 percent of explosion energy), becomes leading wave of a series of seismic waves… A seismic wave produces a temporary 62 (elastic) displacements or disturbance of the ground – typical of earthquake motion…*"



According to the same study, the BENHAM test took place on a focal depth ranging from 0.6 to 3 miles, but not exceeding 4 miles, which is 3 times lesser than the minimum 12 miles focal point depths for almost all natural earthquakes that have occurred in the testing area. Additionally, during this test a "maximum vertical displacement was 1.5 feet (or 0.45m), at location 1.5 and 2.5 miles north of the explosion point". Besides that, the MILROW nuclear device with yield lesser than 1megaton (October,1969) tested at a depth of 4,000 feet (1,200m), as well as the CANNIKIN test for nuclear weapon with yield lesser than 5 megaton (November,1971) tested at a depth of 5,875 feet (1,790m) bellow the Amchitka Island proved that "**there was no evidence of any increase in the frequency of such earthquakes in the sensitive Aleutian Islands region following the MILROW and CANNIKIN**" nuclear test events. (Ibid,p.241).

NOTE: it is believed that earthquakes are occurring in a depth ranging from 20km up to 700km. Also, it takes an earthquake with a Richter magnitude exceeding 7.5 to produce a destructive tsunami.

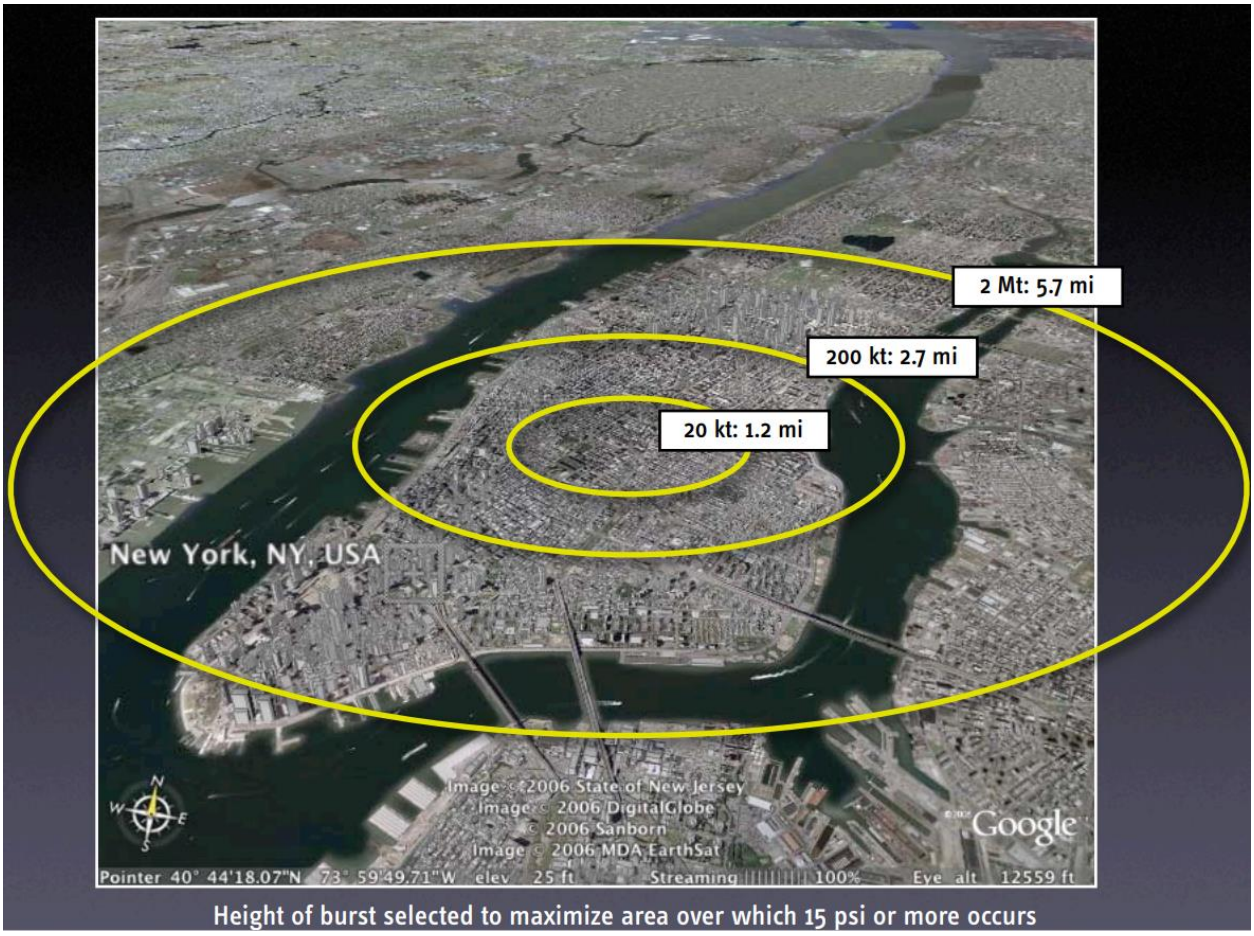
Last but not least**,** both Russia and the United States have nuclear torpedoes in their arsenal. In particular, U.S has developed the Mark 45 with yield of around 11 kT, whereas and Russians have developed the T-15 with yield of around 4 kT. In the period from April to November 1962, the United States have exercised a top-secret operation code-named as "DOMINIC - I", during which 36 nuclear tests were conducted with a nearly 38.1 Mt total yield. As a part of the operation "DOMINIC I", on 11 May 1962, the United States Navy conducted the ASROC weapon system and weapon effects test, a rocket-launched antisubmarine nuclear depth charge (ASROC) capable of carrying around 10kt nuclear warhead. The ASROC test known as

Operation "Swordfish," was detonated at a depth of 650 feet.

During this operation, the following was noticed:

- Spray dome stretched in a radius of 1,000 yards from surface-zero and rose up to 750 feet (228.6m);
- Radial plumes of water broke from the spray dome 7 seconds after the burst, and have reached a height of 2,100 feet (640.08m) within 16 seconds;
- As the plumes collapsed, a base surge was formed, by reaching maximum upwind distance of 2,000 yards 140 seconds after burst;
- As the base surge dispersed, a foam patch appeared about 20 minutes after the burst. ***(Photo: The Lyncean Group of San Diego)***

The test was successfully accomplished and proved the foreseen results - "grave danger" for the enemy's submarines. Although this weapon was intended for destroying enemy's submarines, they still poses a great destructive power, but it is insufficient to create/produce tsunami waves.



(Photo: Showing the effects of detonating nuclear bomb at low-air altitude, for nuclear bomb with yields of 20kt, 200kt and 2Mt. Source: Alexander Glasser,2007, "Effects of Nuclear Weapons", Princeton University)

IV. Analysis

The 2011 Tohoku earthquake registered near East coast of Honshu (Japan) with magnitude of 9.1 has caused a tsunami with devastating power. The aftermath of the 2011 Tohoku earthquake and tsunami was: 15,821 deaths, 3,962 missing, 5,940 injuries, more than 350,000 refugees, three nuclear reactors meltdown in Fukushima, tsunami waves have reached the United States, Alaska, Hawaii, Chile, Norway and Antarctica.

At the beginning, we will provide an illustration of the power of each magnitude of earthquake to produce energy, expressed in joules. As can be seen, each magnitude of earthquake have a different power of releasing energy, and goes as the following:

Richter Magnitude	**TNT for Seismic Energy Yield**	
-1.5	6	ounces
1.0	30	pounds
1.5	320	pounds
2.0	1	ton
2.5	4.6	tons
3.0	29	tons
3.5	73	tons
4.0	1,000	tons
4.5	5,100	tons
5.0	32,000	tons
5.5	80,000	tons
6.0	1 million	tons
6.5	5 million	tons
7.0	32 million	tons
7.5	160 million	tons
8.0	1 billion	tons
8.5	5 billion	tons
9.0	32 billion	tons (**32,000,000,000**kg of TNT=**133,888,000,000,000,000joules**)
10.0	1 trillion	tons
12.0	160 trillion	tons

Some additional information's, for the purposes of this debunk:

One ton = 1,000 kg.

One kiloton = 1,000t of TNT or 1,000,000 kg of TNT.

One megaton = 1,000,000t of TNT or 1,000,000,000 kg of TNT.

1 foot = 0.3048 meters.

Now, let's do the math. If we calculate the energy that can be released from a ***detonation of a bomb and the Tohoku earthquake*** we will get the following results:

- One megaton is equivalent to 1,000,000,000kg of TNT and is capable of releasing 4,184,000,000,000,000 (4.184×10^{15}) joules of energy, whereas the nuclear bomb of 2Mts is equivalent to 2,000,000,000 kg of TNT, and is capable of producing 8,368,000,000,000,000 (8.368×10^{15}) joules of energy.
- For a very large earthquakes, like Tohoku 2011 was, the moment magnitude (Mw) is the most reliable estimate of the earthquake size, related to the total energy released during the earthquake. After that, by using a standard formula, the Mw is then converted into a number similar to other earthquake magnitudes. According to the standard formula, the power of an earthquake of a 9.0 magnitude is equivalent to 32,000,000,000kg of TNT, and is capable of releasing 133,888,000,000,000,000 joules ($1,338 \times 10^{17}$). Hence, according to the standard formula, the earthquake of 9.0 magnitude has a power equivalent of a 32 Mt thermonuclear bomb, or compared, the 2Mts bomb is 16.6 times weaker than the earthquake with magnitude of 9.0 by Richter scale.

However, according to the U.S Geological Survey's momentum tensor, the 2011 Tohoku earthquake registered near East coast of Honshu (Japan) was of magnitude 9.1, which released energy equivalent to 9.3 million megatons of TNT energy that created a devastating tsunami. So, if we calculate the energy that can be released from a ***detonation of a 2Mt bomb and the Tohoku tsunami*** we will get the following results:

- 9.3 million megatons of TNT is equivalent to 9,300,000,000,000,000 kg of TNT, or 9,300,000 Mts of TNT. Interpreted in joules of energy, it is equivalent of 38,911,200,000,000,000,000,000 or $3,891 \times 10^{22}$ joules of energy.
- Finally, the 2Mt bomb is 4,6 million ($4,6 \times 10^{6}$) times weaker than the 2011 Tohoku earthquake that caused devastating tsunami waves.

Even the biggest nuclear bomb ever tested, the Soviet-made Tsar Bomba of 58Mt (tested on 30 October 1961), that is capable of releasing about 2,42,672,000,000,000,000 (2.4×10^{17}) joules of energy, is nearly 162,000 (1.62×10^{5}) times weaker than the 2011 Tohoku tsunami.

So the question that here arise is, why the 2011 Tohoku tsunami was that powerful? All of these effects depends of the time and location where this occurs. The Tohoku earthquake occurred below the sea floor near the coast on a depth of about 29 km, lasted for 6 minutes caused by the collapse of the two tectonic plates on which Honshu Island lies on, by releasing tremendous quantity of energy that have produced shock and killer waves in a height ranging from several feet up to 33 feet , 40 feet and 132 feet. Furthermore, the devastating earthquake started with foreshocks on March 09 with magnitude of 7.4, at a distance of 40kms away from the epicenter occurred on the 11 March 2011 that is believed to had an impact on the intensity of the one occurred on the 11 March 2011.

According to the estimates of the Wisconsin Project on Nuclear Arms Control, the nuclear chain reaction (or series of nuclear fissions – splitting the atomic nuclei) occurs in a 0.07 microseconds. But, the complete process of bomb explosion occurs in a moment lesser than a microsecond according to the following estimate:

A critical mass of uranium is about the size of a softball (0.1 meters).

The time the neutron would take to cross the sphere is:

$$Time = .1seconds/(1x10^{7}meters/second)$$

OR

$$Time = 1x10^{-8}seconds$$

The complete process of a bomb explosion is about 80 times this number, or ***slightly less than a microsecond or .0000008 seconds.***

Summary of results:

	Yield/magnitude	**Temperature**	**Depth**	**Height of waves**	**Duration**
Earthquake (2011 Tohoku)	9.1 magnitude	3,891 x 10^{22} joules Lasted longer, thus, has released tremendous energy. As longer in duration, the more energy is released.	29 km	From 10 up to 40m in height	Lasted longer, thus, releasing tremendous energy. Slightly more than 6 minutes
Earthquake (underground)	9.0 magnitude	1,34 x 10^{17} joules	20km – 700 km	seismic waves	From several seconds to several minutes
Nuclear Bomb	58Mt	2.43 x 10^{17} joules	Air, surface	N/A	Detonation occurs in less than one microsecond
Poseidon	Up to 2Mt	$4{,}6x10^{6}$ joules	1,000 m	Possibly can induce waves, but not exceeding the normal height of the waves (2-3m)	The nuclear warhead detonation occurs in less than one microsecond

In sum, the nuclear tsunami is a MYTH ! Nonetheless, the nuclear drone in a form of gigantic torpedo would be a great danger for the hostile's army harbors and submarines due to the ability to pierce deeply into their territory or to approach to its submarines without being detected. Depending on the yield of the nuclear warhead, even if the nuclear drone-torpedo explodes on a certain distance from the submarines, they still can cause serious damages on the enemy's submarines.

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