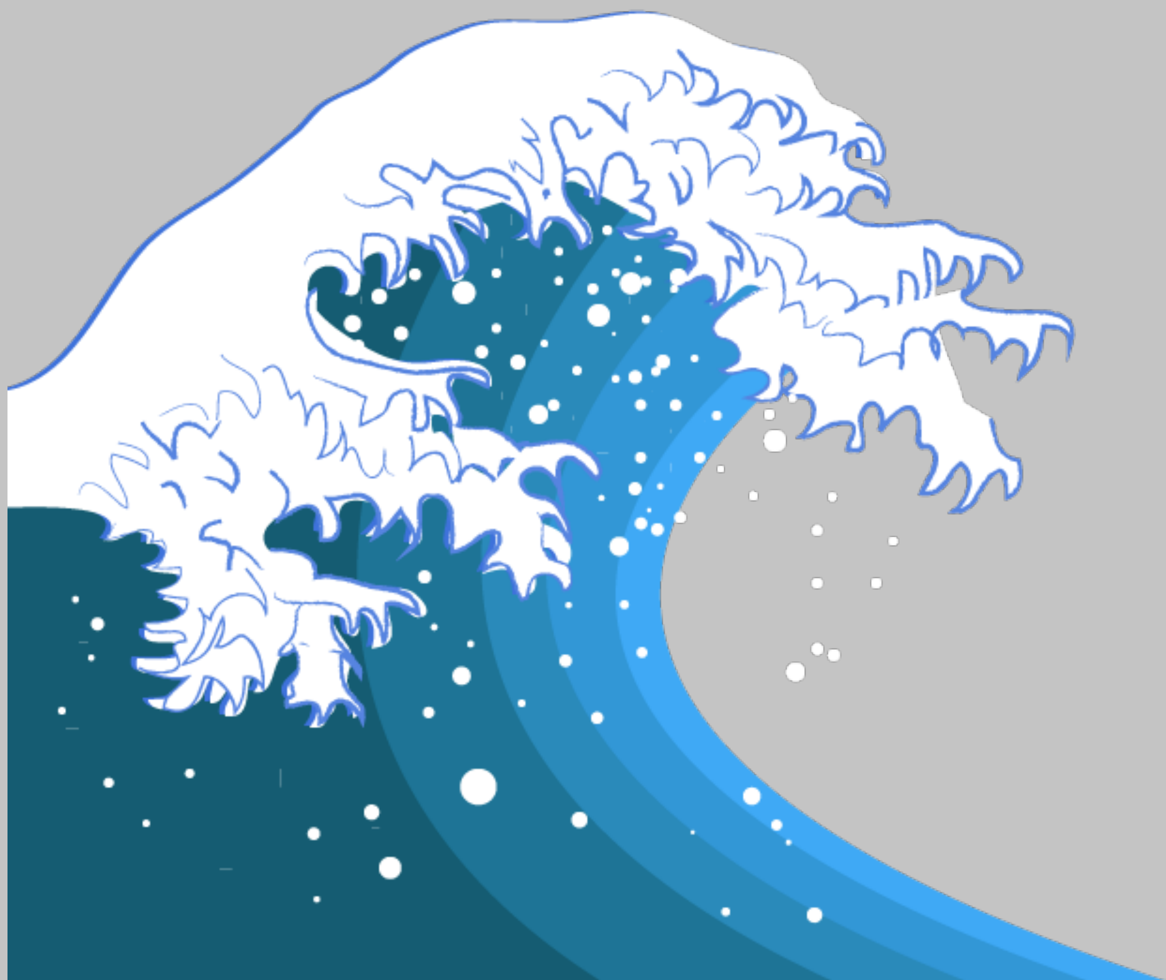


Graphics: keenbeandesign.com

What Did They Know And When?
Fukushima Daiichi
Before And After The Meltdowns

Symposium: The Medical and Ecological Consequences of the Fukushima Nuclear Accident
The New York Academy of Medicine, New York City, NY
March 11, 2013

Presented by Fairewinds Energy Education
Burlington, VT
fairewinds.org

In Honor Of:

- The Staff at both Fukushima Daiichi and Fukushima Daini are heroes, not just to Japan, but to the world.
- Their bravery saved Japan from massive evacuations.
- I wish to express my profound respect for their selfless effort during the first days and weeks following the accident at Fukushima Daiichi.

Sequence of Presentation

SECTION 1: Before Operation: Design & Construction

SECTION 2: Before Operation: Political Issues

SECTION 3: Radiological Releases

SECTION 4: Conclusions

SECTION 1

Before Operation: Design & Construction

The Fukushima Daiichi Catastrophe
Made In America In The 1960s

Licensed By The AEC, Designed By GE, And Constructed By Ebasco

The Mark 1 BWRs at Fukushima Daiichi are almost identical to The Pilgrim and Vermont Yankee nuclear power plants as well as 22 other Mark 1 BWRs built throughout the United States.

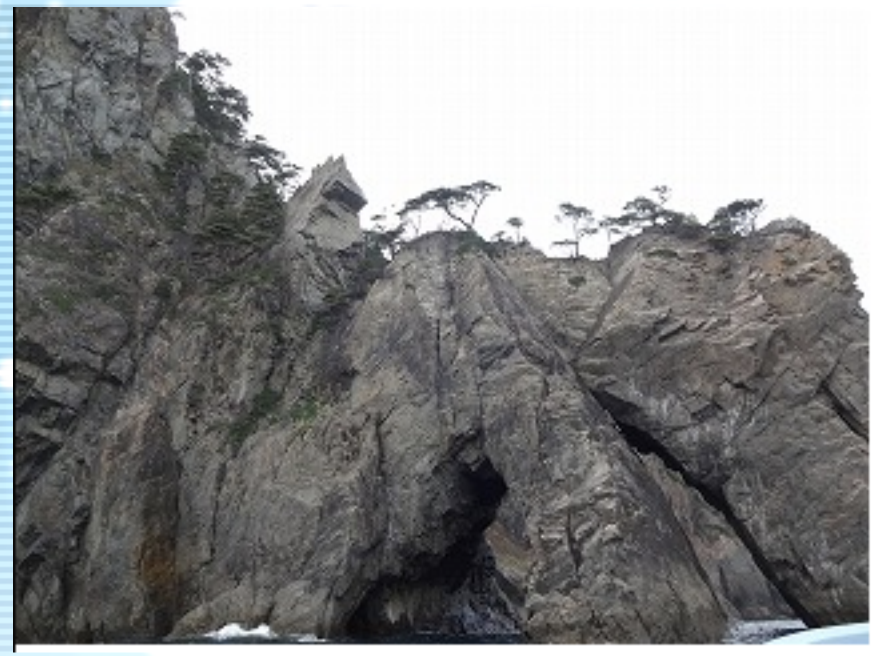
The main difference between the US plants and the Japanese plants is the significant amount of highly radioactive spent fuel stored in the US reactor spent fuel pools located five stories above the nuclear reactors.

Six GE & Ebasco Design Errors:

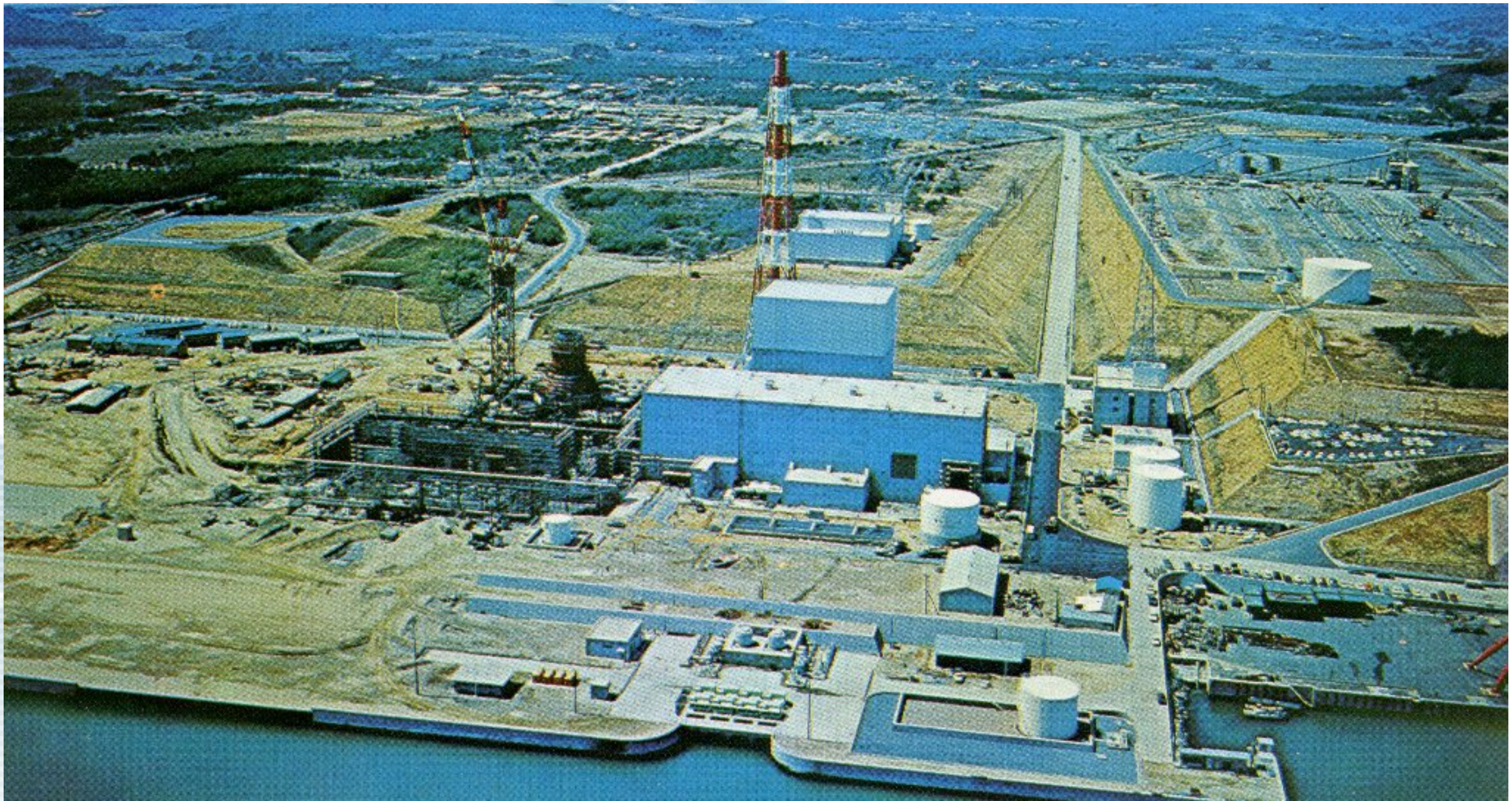
1. Reduced the height of cliff to water;
2. Very short Tsunami wall – unable to protect;
3. Diesels placed in basement – in the path of rising and surging waters;
4. Emergency pumps located on the shore line are not submersible pumps;
5. Diesel Fuel Tanks placed in flood plane;
6. Faulty Mark 1 Containment – unable to contain radiation because it is too small for reactor.

In 1960

- The Fukushima Daiichi site contained a 35 meter (115 foot) cliff
- The cliff was cut to 10 meters (33 feet) in order to build closer to the ocean



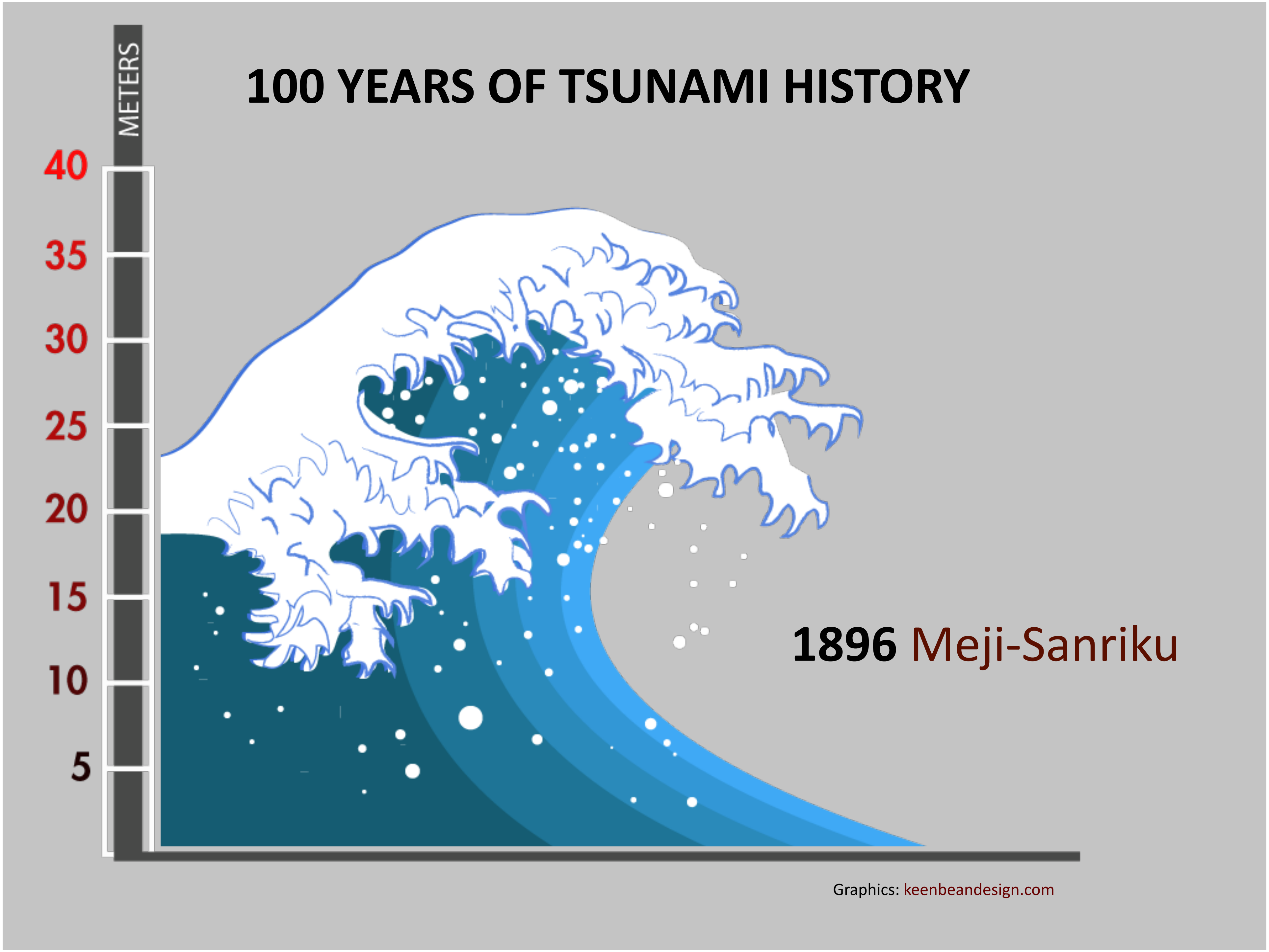
After Daiichi Was Built



原子力発電所　上のしゃしんは，けんせつ中の福島１号原子力発電所です。出力は，46万きろわっと。

Tsunami – Japanese tsu "harbor" + nami "waves”:

- Produced by a seaquake or undersea volcanic eruption;
- Tsunami travel thousands of miles over the open ocean;
- Tsunamis can have heights of up to 50 m (165 ft) and reach speeds of 950 km (589 mi) per hour;
- They are characterized by long wavelengths of up to 200 km (124 mi) and long periods, usually between 10 and 60 minutes.


100 YEARS OF TSUNAMI HISTORY
METERS
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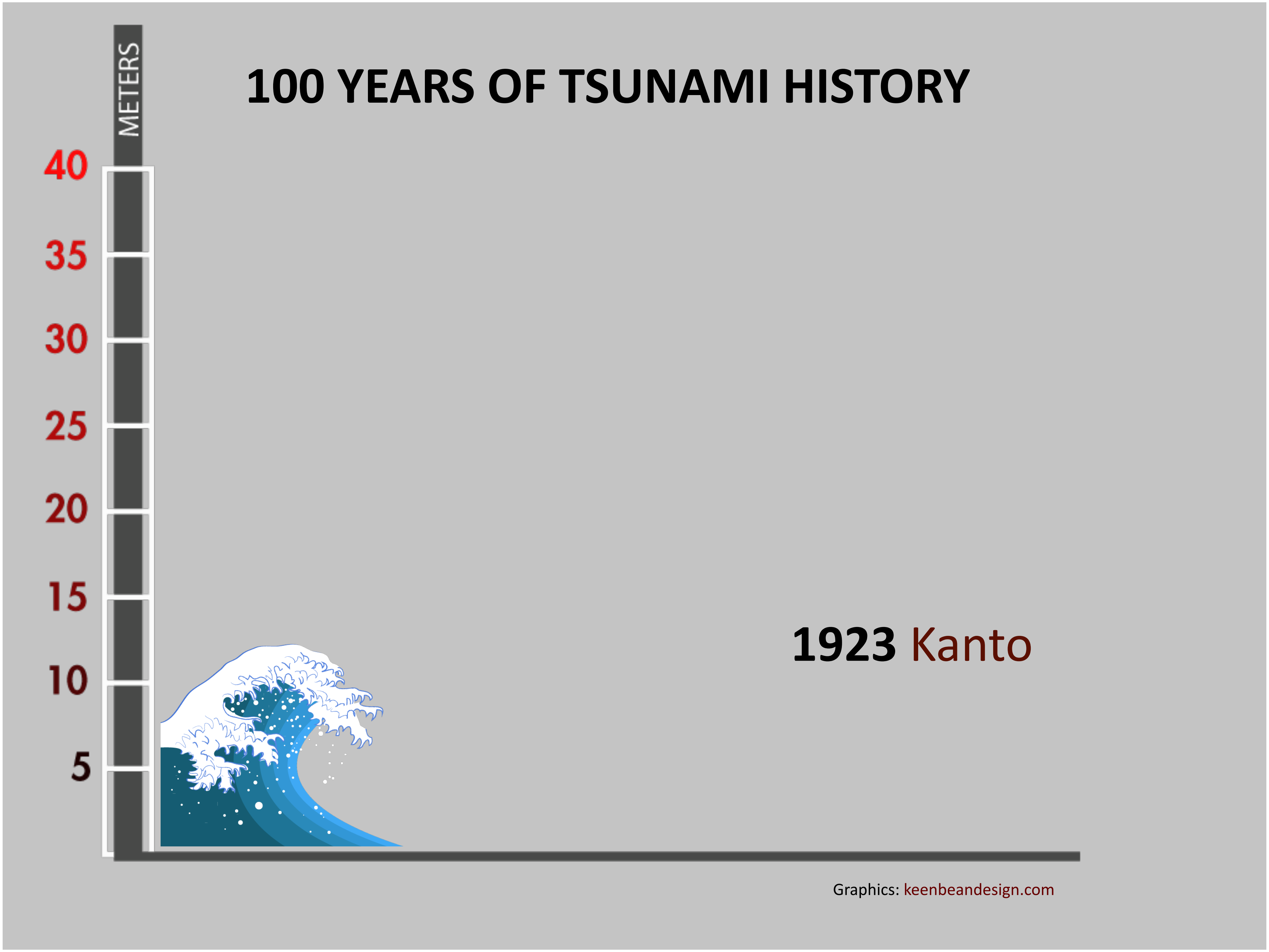
1896 Meji-Sanriku
Graphics: keenbeandesign.com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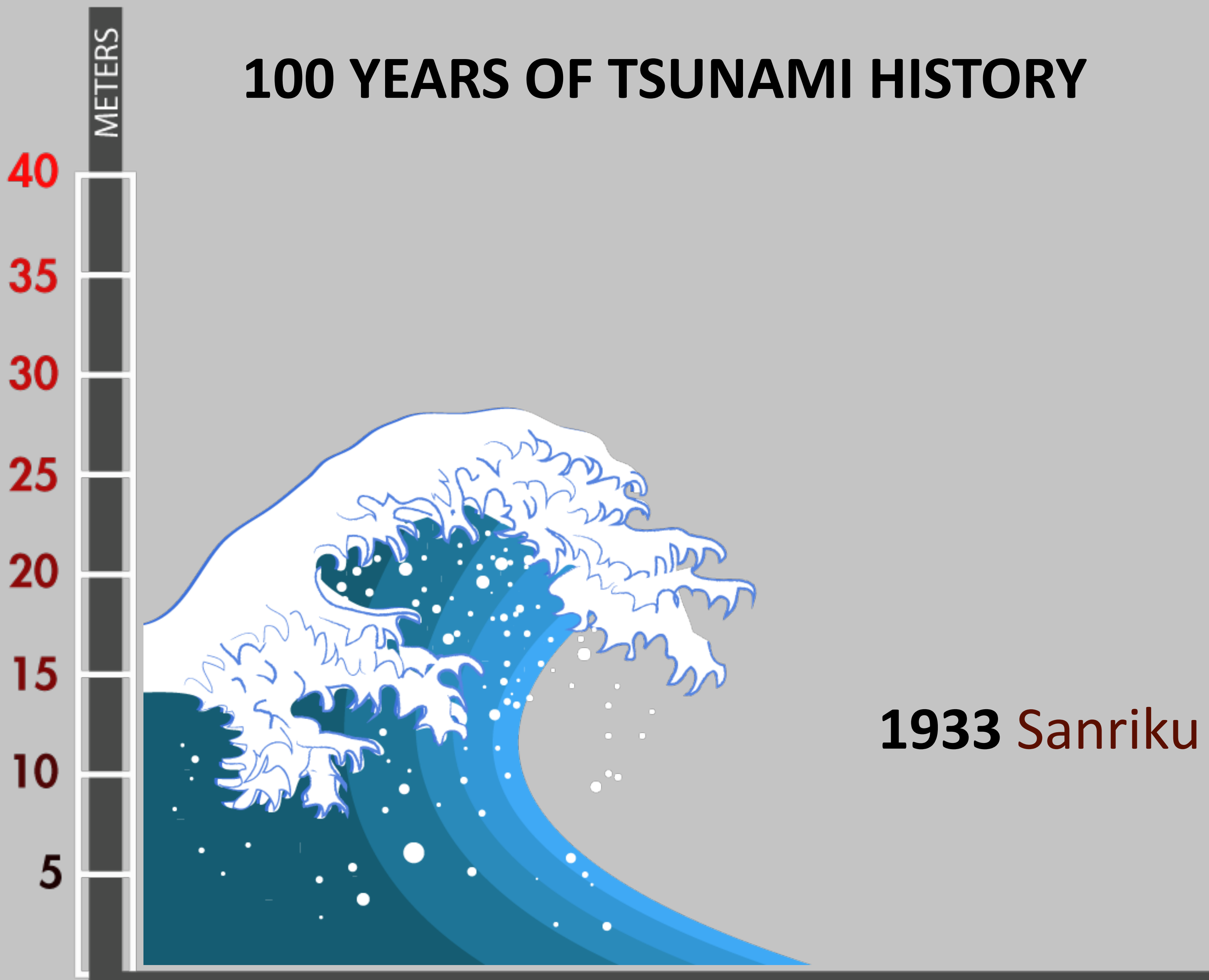
1923 Kanto
Graphics: keenbeandesign.com

100 YEARS OF TSUNAMI HISTORY



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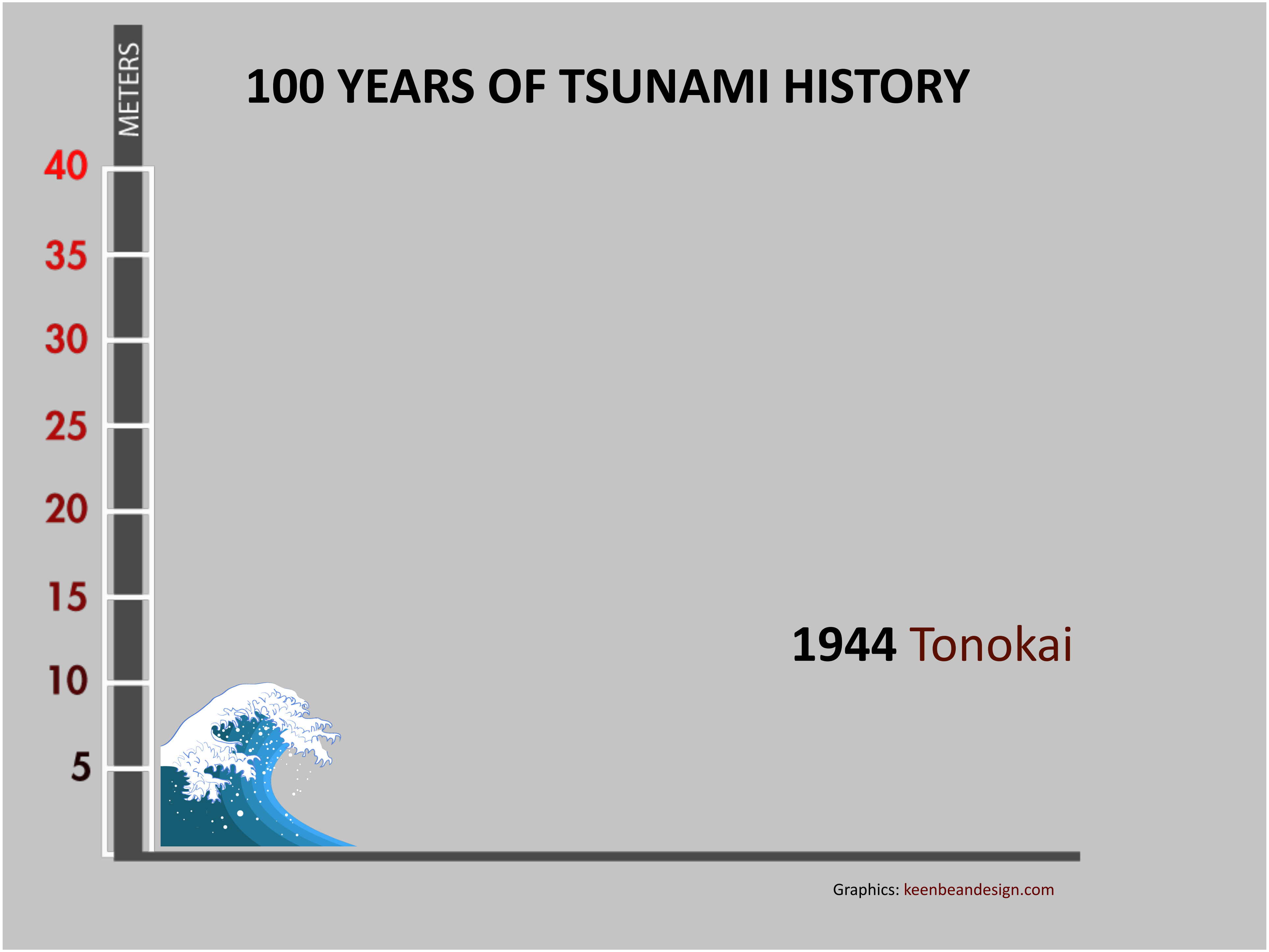
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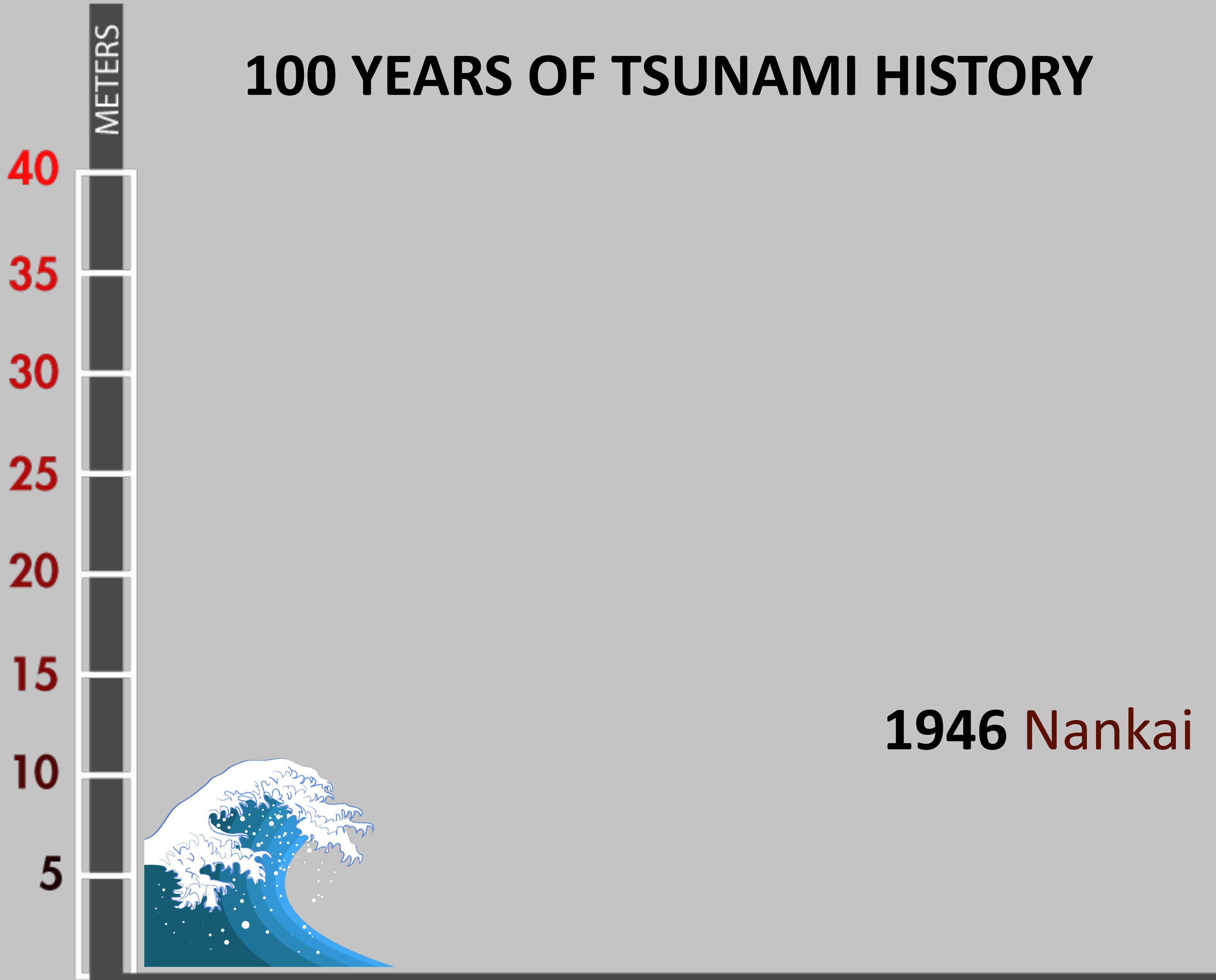
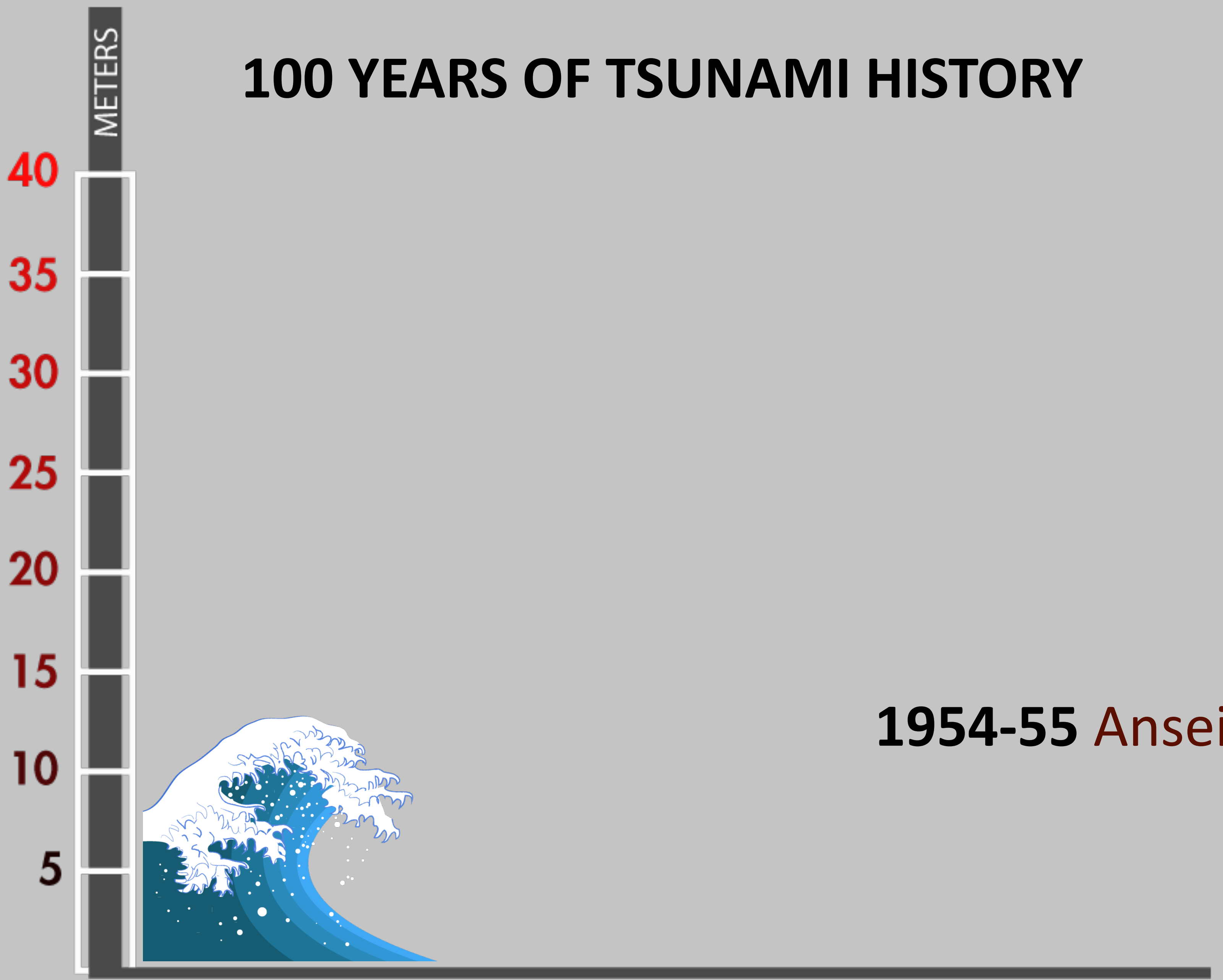
1944 Tonokai
Graphics: keenbeandesign.com

100 YEARS OF TSUNAMI HISTORY

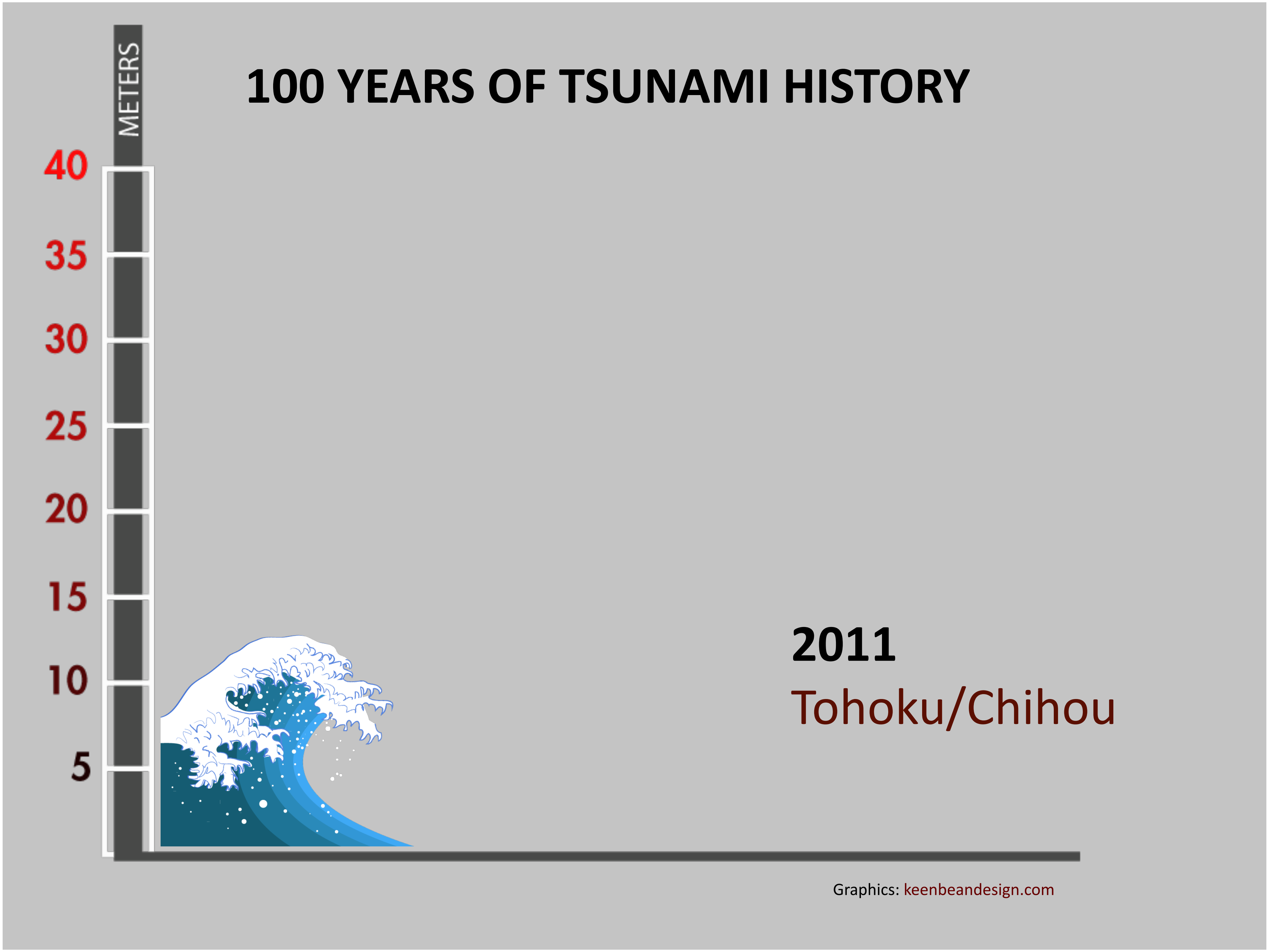


Graphics: keenbeandesign.com

100 YEARS OF TSUNAMI HISTORY



Graphics: keenbeandesign.com


100 YEARS OF TSUNAMI HISTORY
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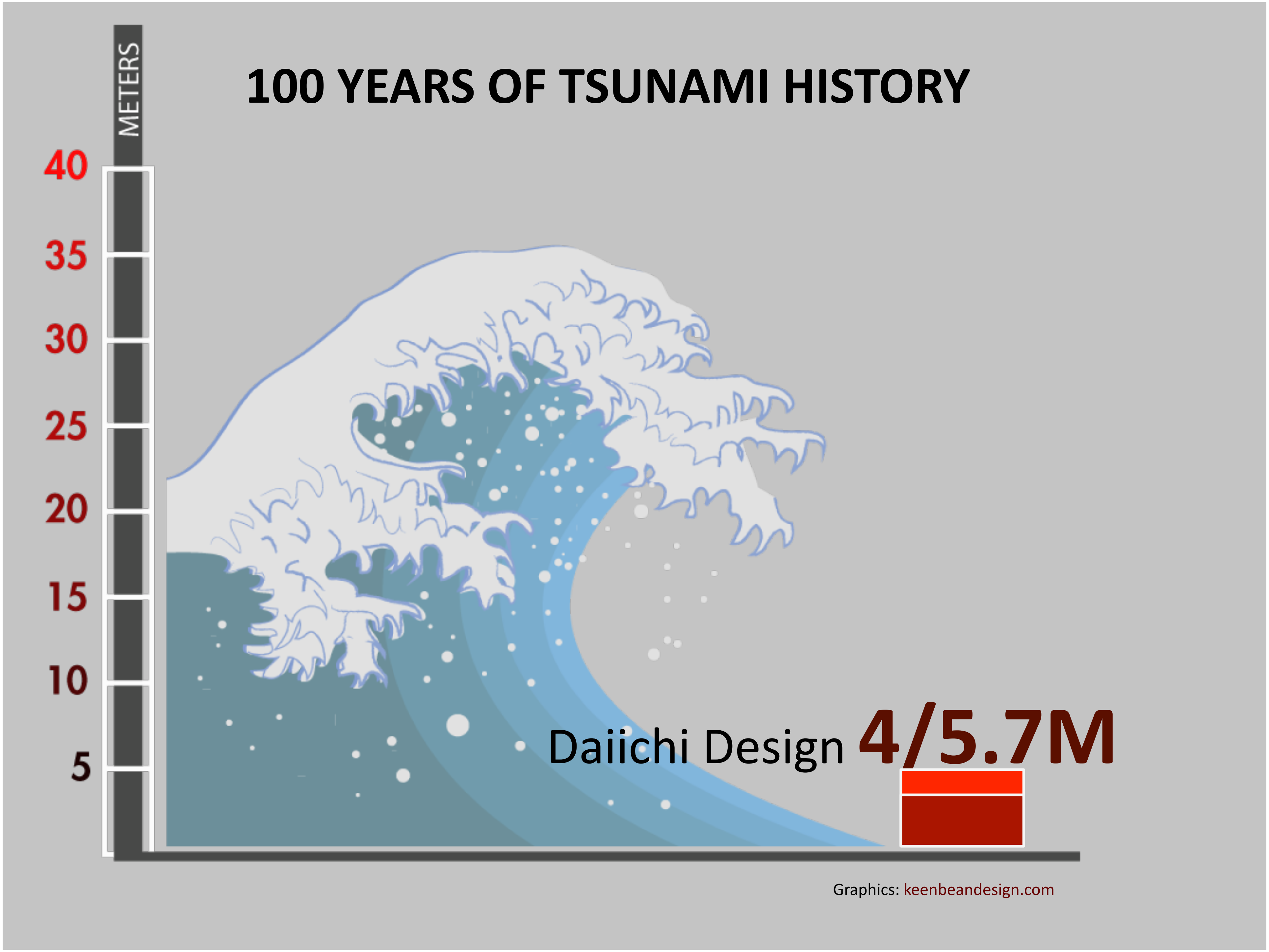
2011
Tohoku/Chihou
Graphics: keenbeandesign.com



METERS
100 YEARS OF TSUNAMI HISTORY
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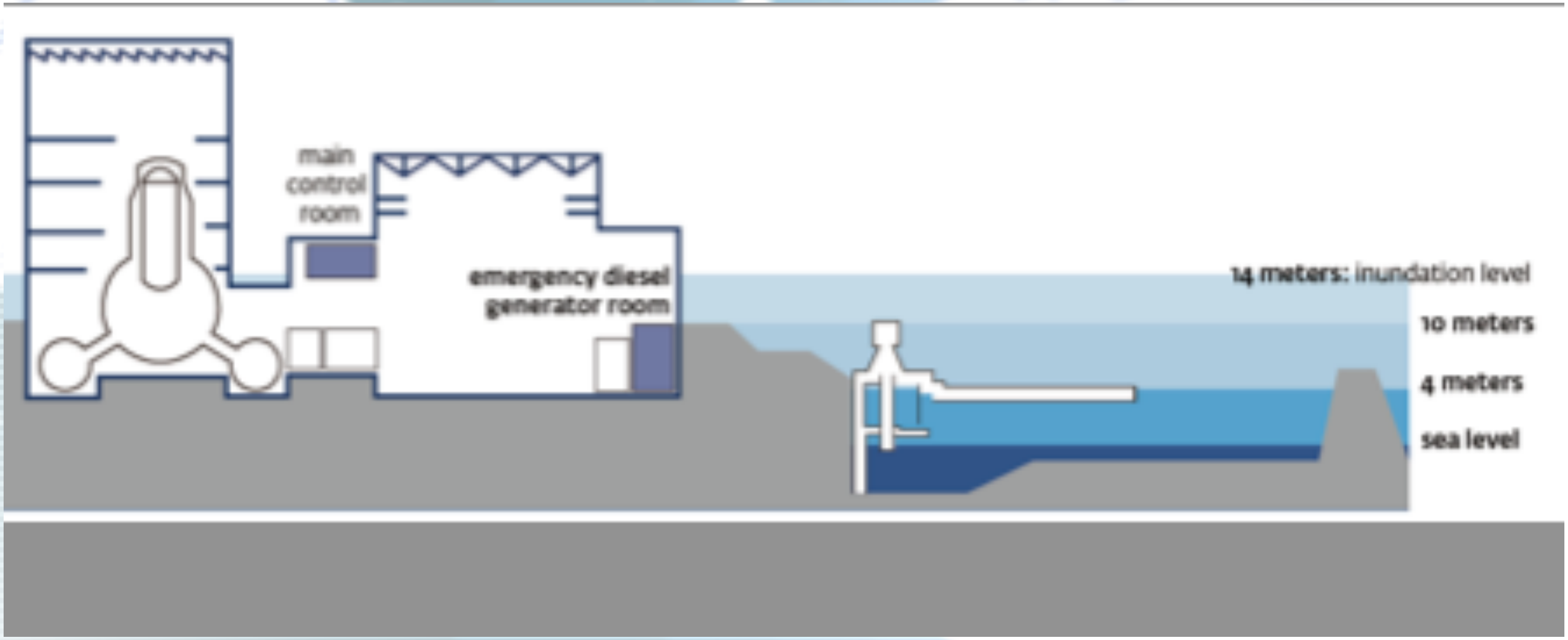
Daiichi Design 4/5.7M
Graphics: keenbeandesign.com

In 1968, Backup Diesels Were Placed In The Basement With No Flood Protection

Emergency Service Water Pumps Were Not Designed To Be Flooded

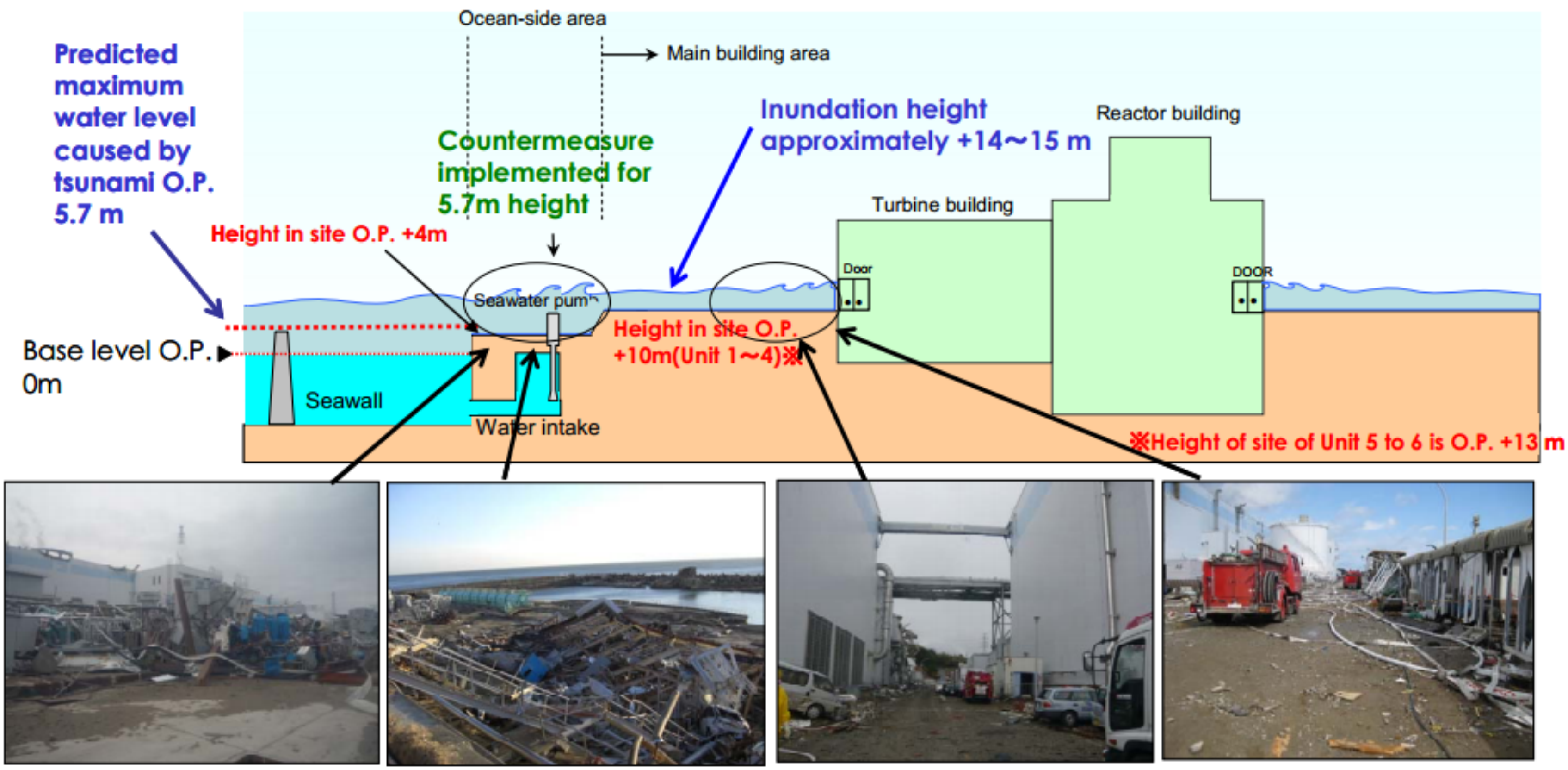


Loss of the Ultimate Heat Sink (LoUHS)

Tsunami Wave Topping Seawall

Tsunami wave topping the 5.7 meter high seawall at Fukushima Daiichi on 11 March 2011, in front of the two diesel generator fuel tanks. [Source: TEPCO Photo]

Tsunami Damage Causes Loss of the Ultimate Heat Sink (LoUHS).



SECTION 2

Before Operation: Political Issues

General Electric (GE)

Progress Is Our Most Important Product.

In 1961 GE's CEO proclaimed:

"We're going to ram this nuclear thing through."

Atomic Energy Commission (AEC) #1

AEC's Advisory Committee on Reactor Safeguards (ACRS)

Dr. David Okrent said that General Electric made it plain in the 1966 meetings that it would not remain in the business of nuclear reactors if it were forced to redesign its nuclear reactors to better account for core meltdown scenarios.

Atomic Energy Commission (AEC) #2

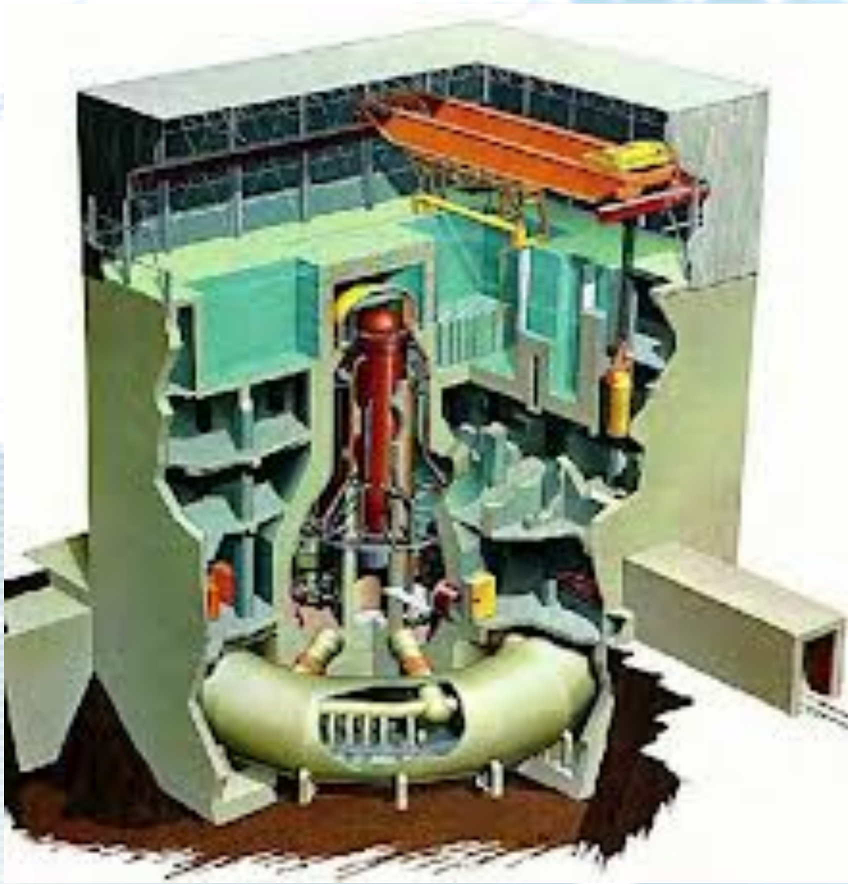
AEC Chartered Mission To Regulate And Promote Nuclear Power

AEC's Advisory Committee on Reactor Safeguards (ACRS)

Dr. David Okrent said that GE's comment "was a kind of threat I think".

Dr. Glenn Seaborg admits, "I don't think we had the power to stop them."

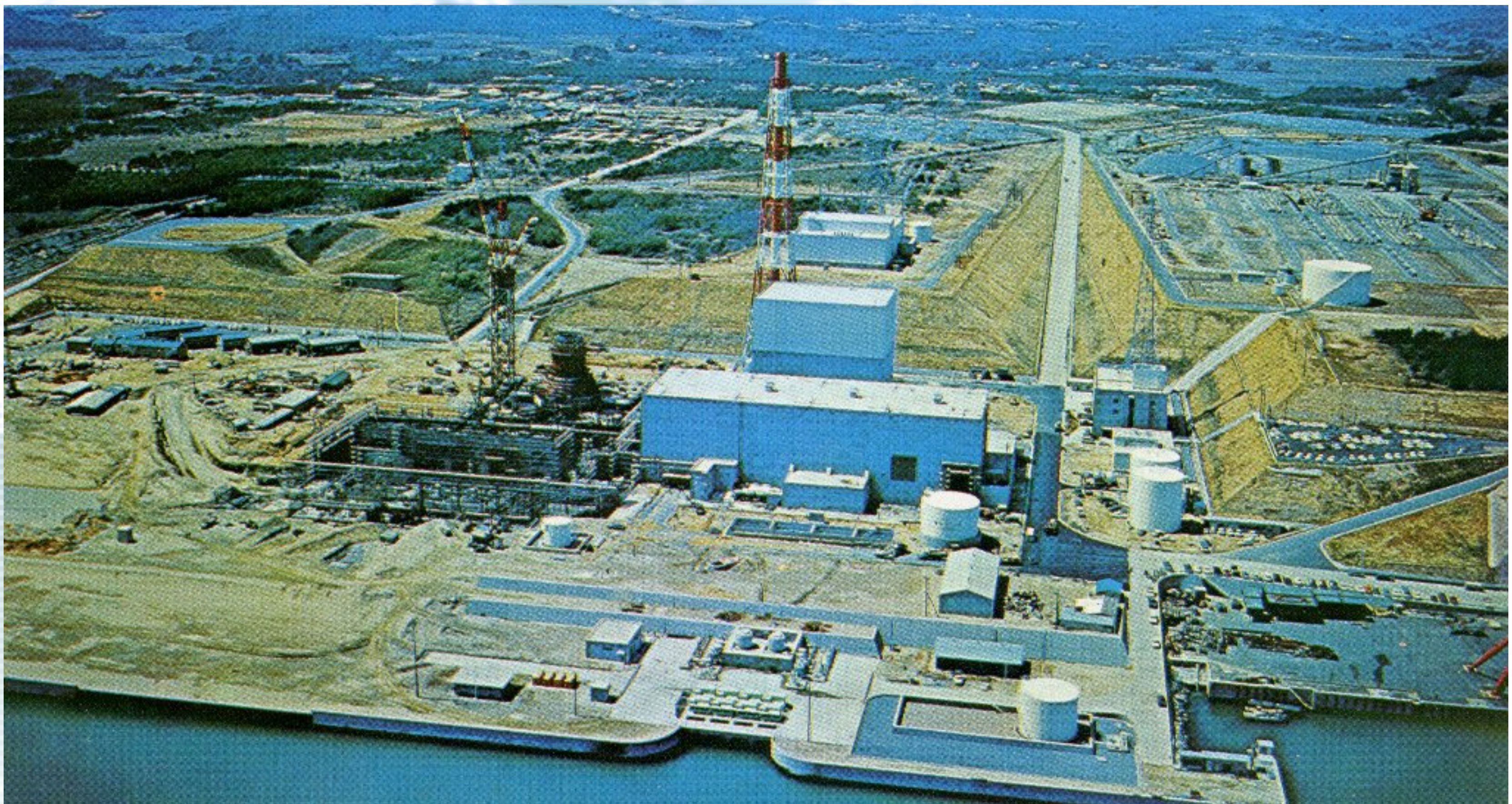
Atomic Energy Commission (AEC) #3



On September 25, 1972, Senior AEC official Joseph Hendrie wrote that the option of banning the Mark 1 pressure suppression containment systems was “an attractive one in some ways,” the “conventional wisdom” accepting this containment model had reached a point where admission of its defective and unreasonably dangerous design **“could well be the end of nuclear power,” creating “more turmoil than I can stand thinking about.”** [Emphasis Added]

When Operation Of The First Fukushima Daiichi Reactor Produced Power in 1970;

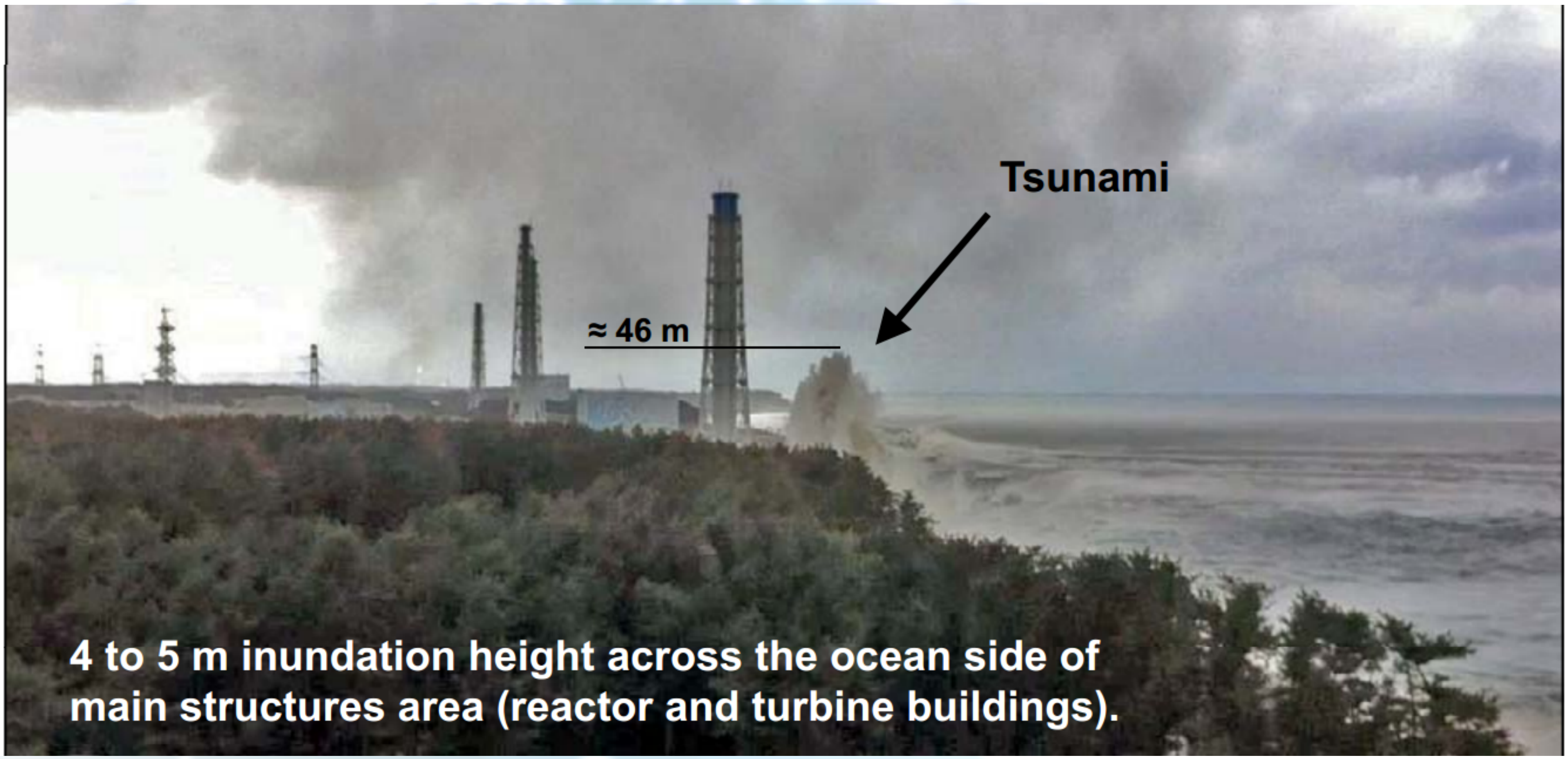
It Was An Accident Waiting To Happen.



原子力発電所　上のしゃしんは，けんせつ中の福島１号原子力発電所です。出力は，46万きろわっと。

Fast Forward 40 Years

Tsunami Hitting Fukushima Daiichi

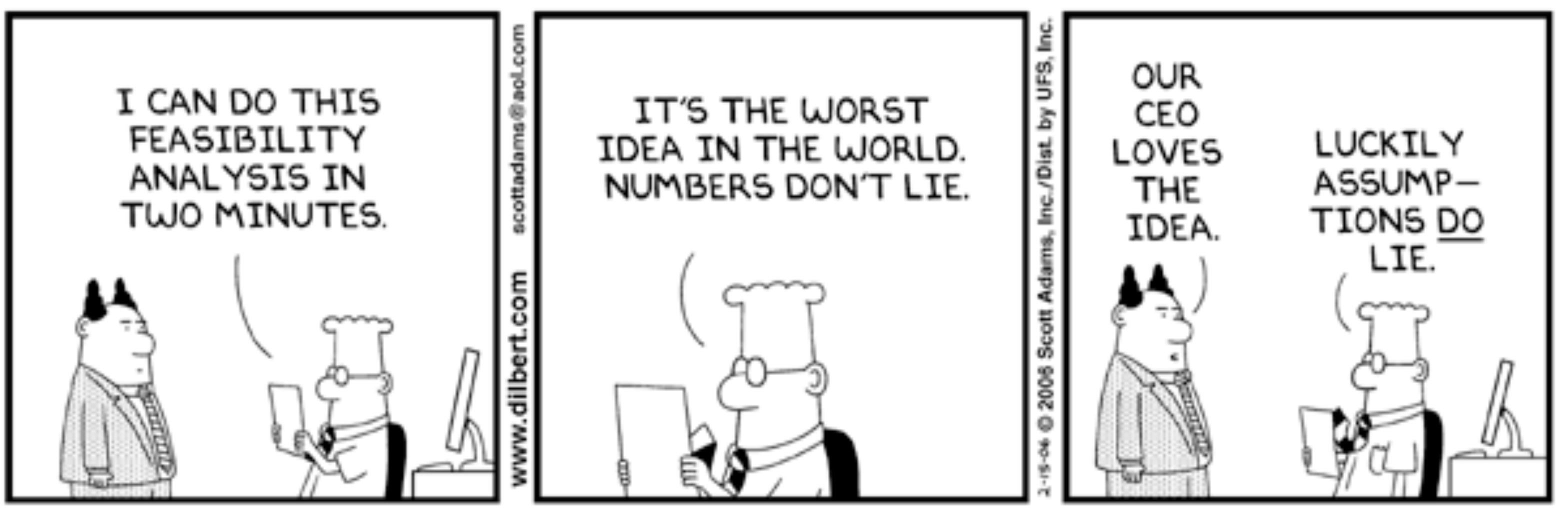


SECTION 3:

Radiological Releases

How Bad Was It?

The Secret Is In The Assumptions



Assumption 1: Containments Maintain Their Integrity

- Not true as proved by the Fukushima Daiichi triple meltdown and extensive radiation releases.
- There was a detonation shock wave at Unit 3.

NRC Chuck Casto, March 16, 2011:

"…of course, that Mark 1 containment is the worst one of all the containments we have, and it's literally, you know, this NUREG tells you that in a station blackout you're going to lose containment. There's no doubt about it."

ML12052A108

U.S.NRC

What Does A Meltdown Look Like?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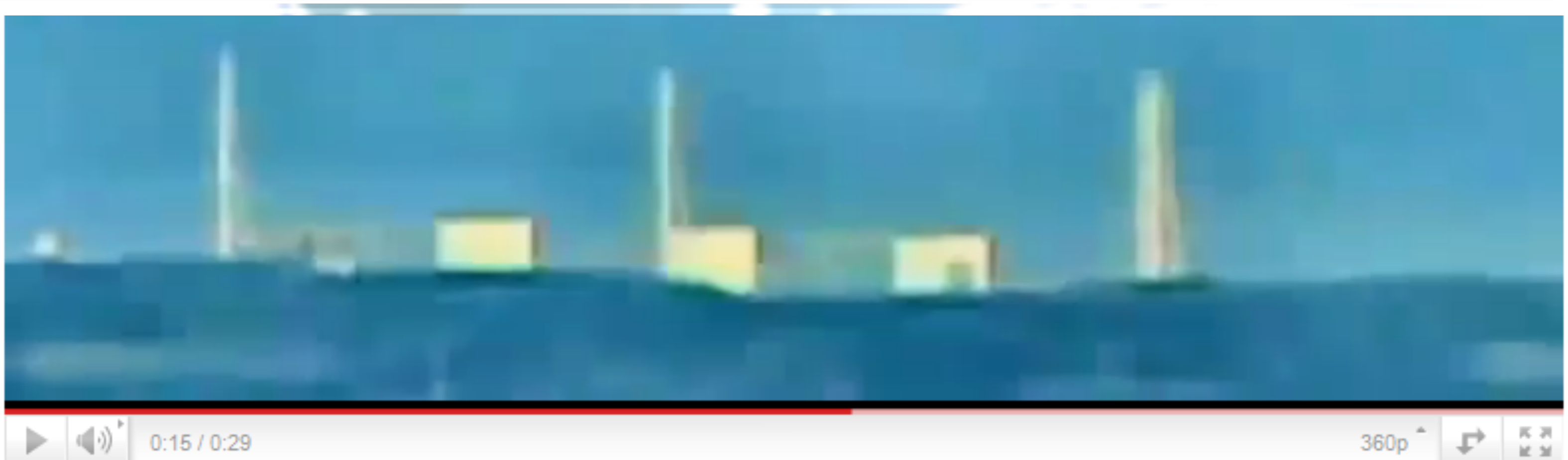
360p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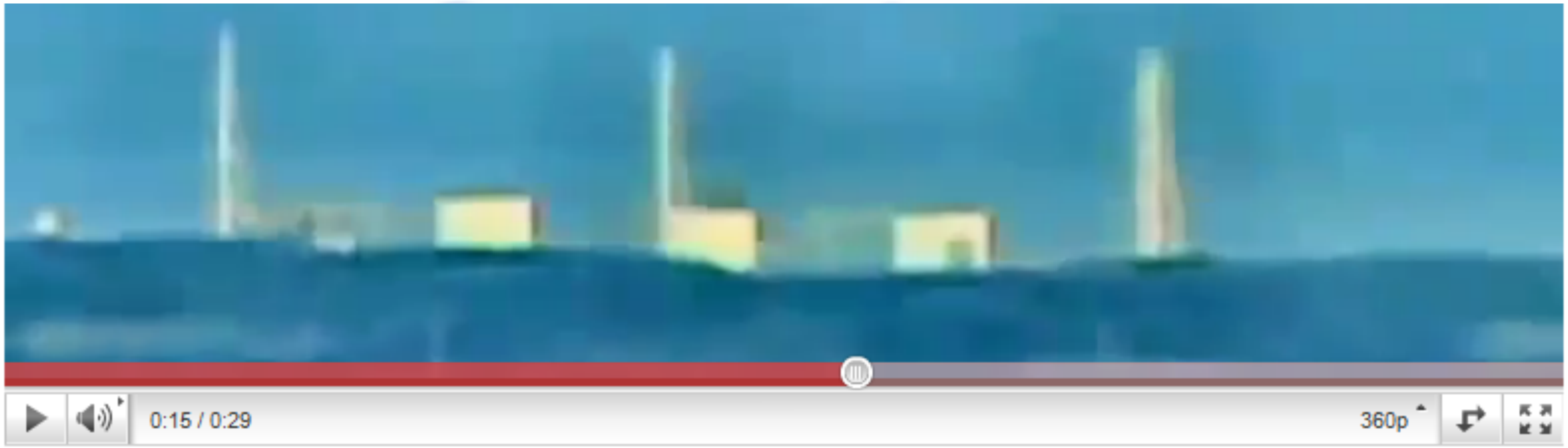
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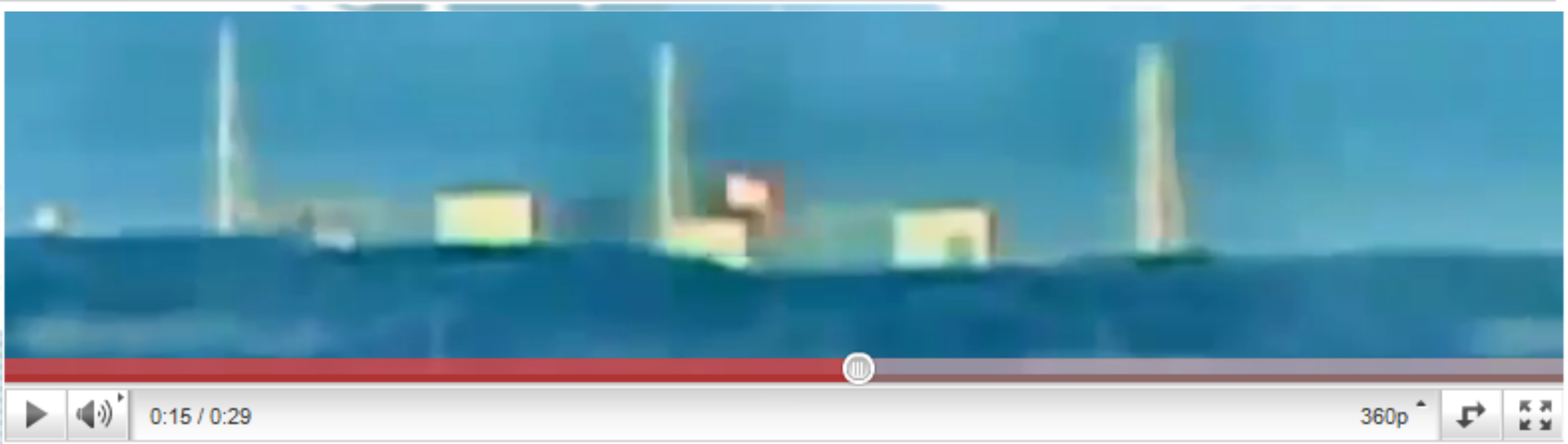
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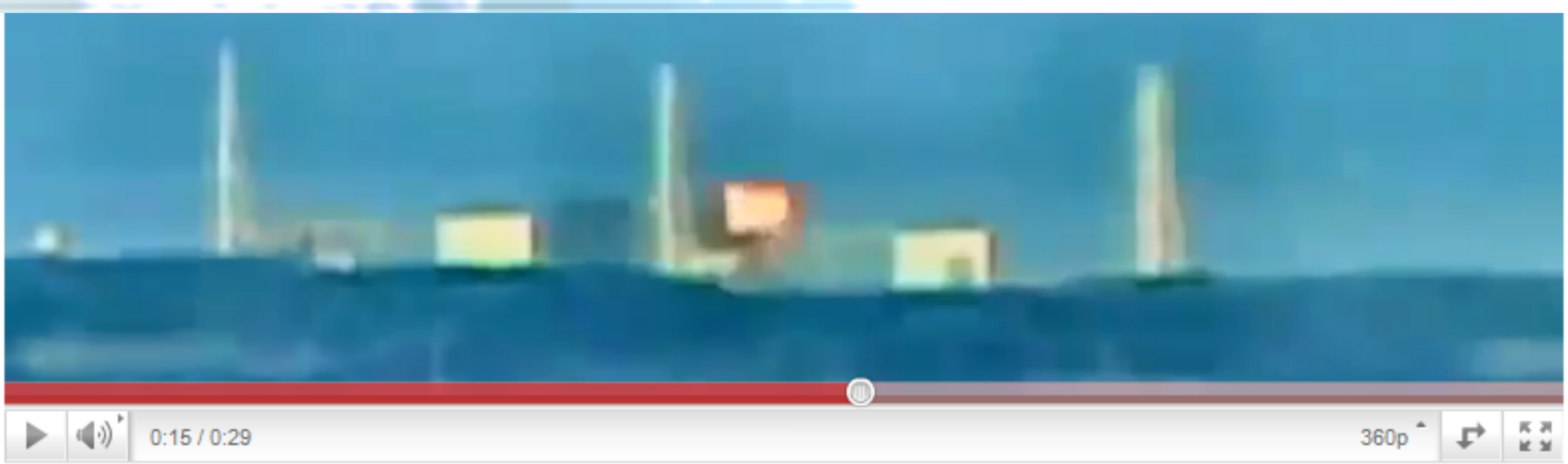
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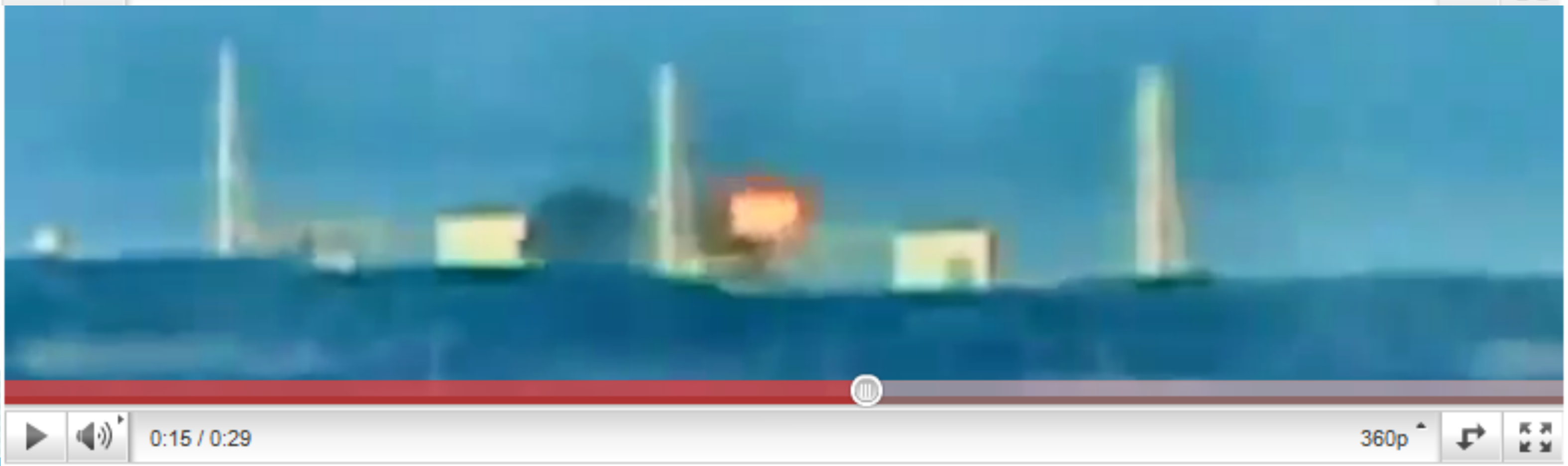
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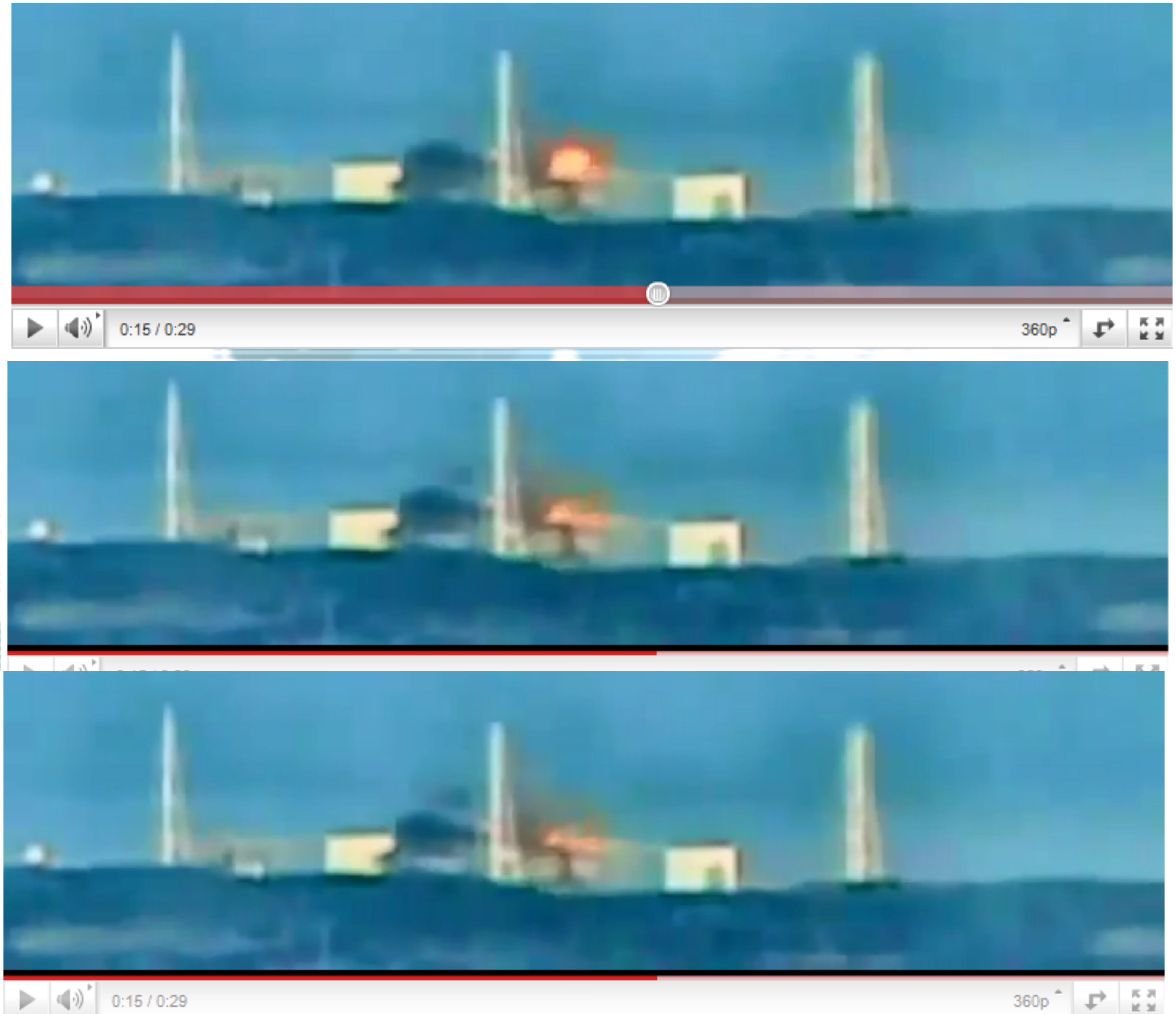
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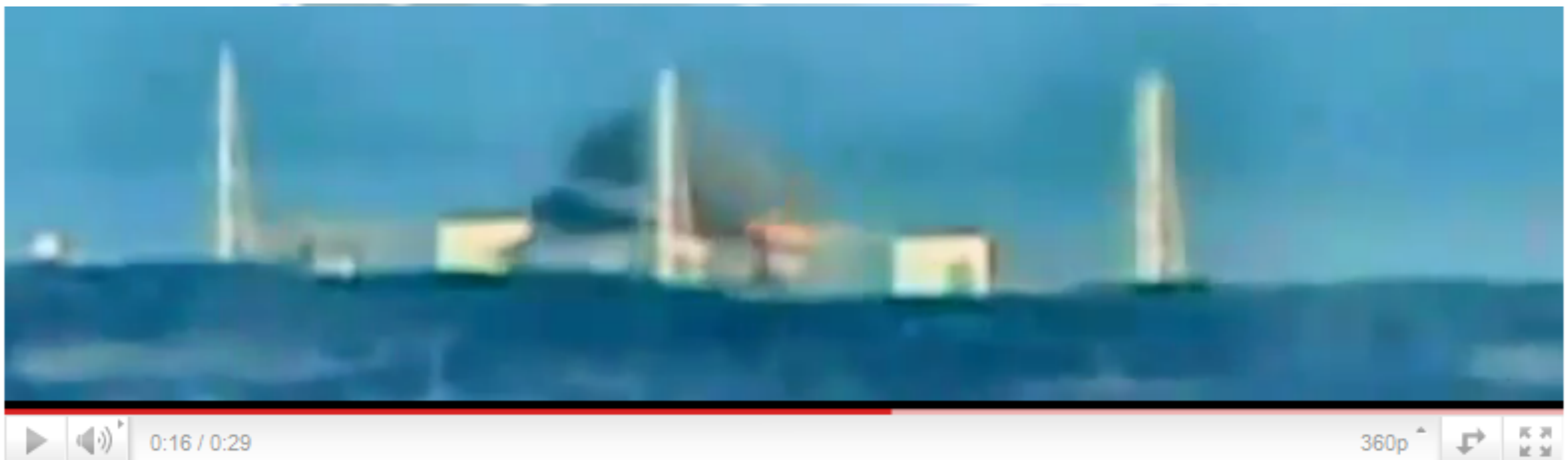
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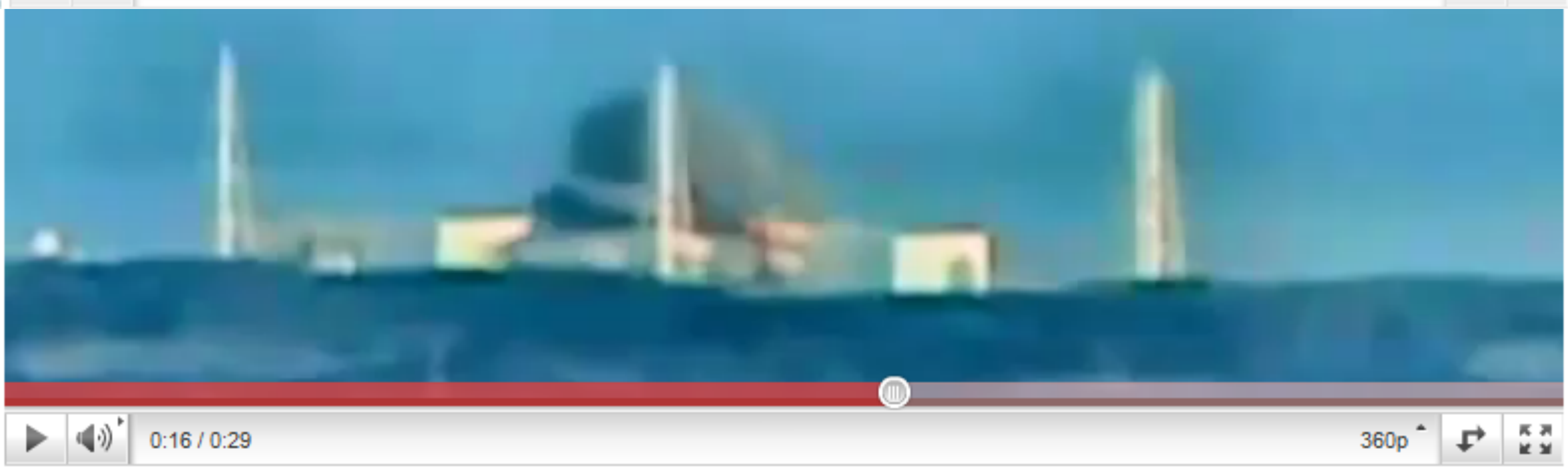
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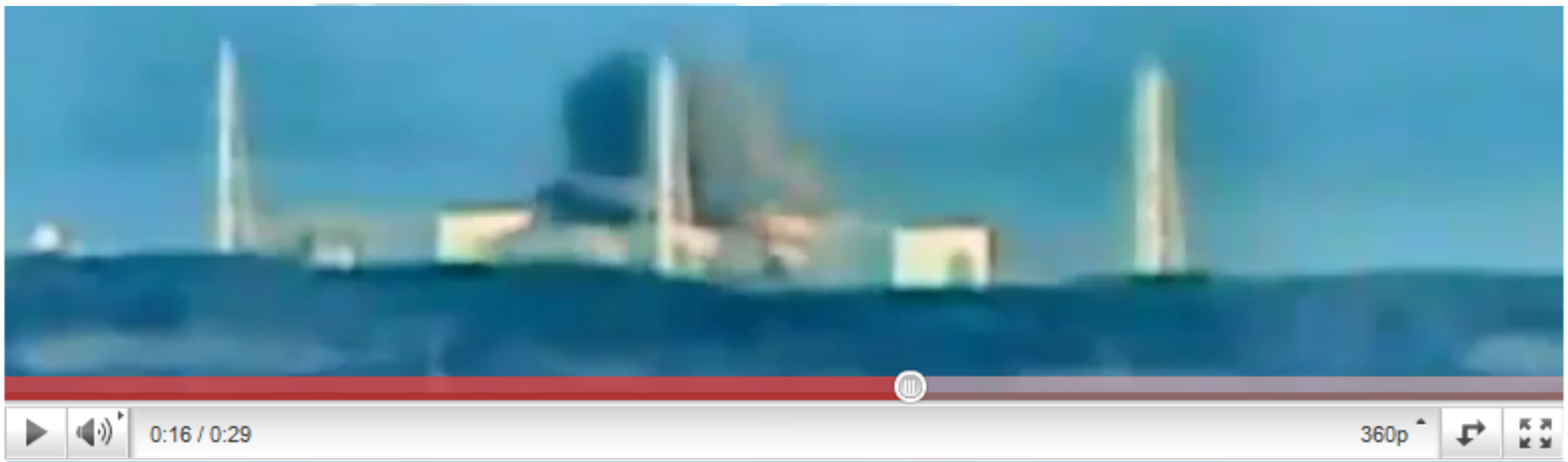
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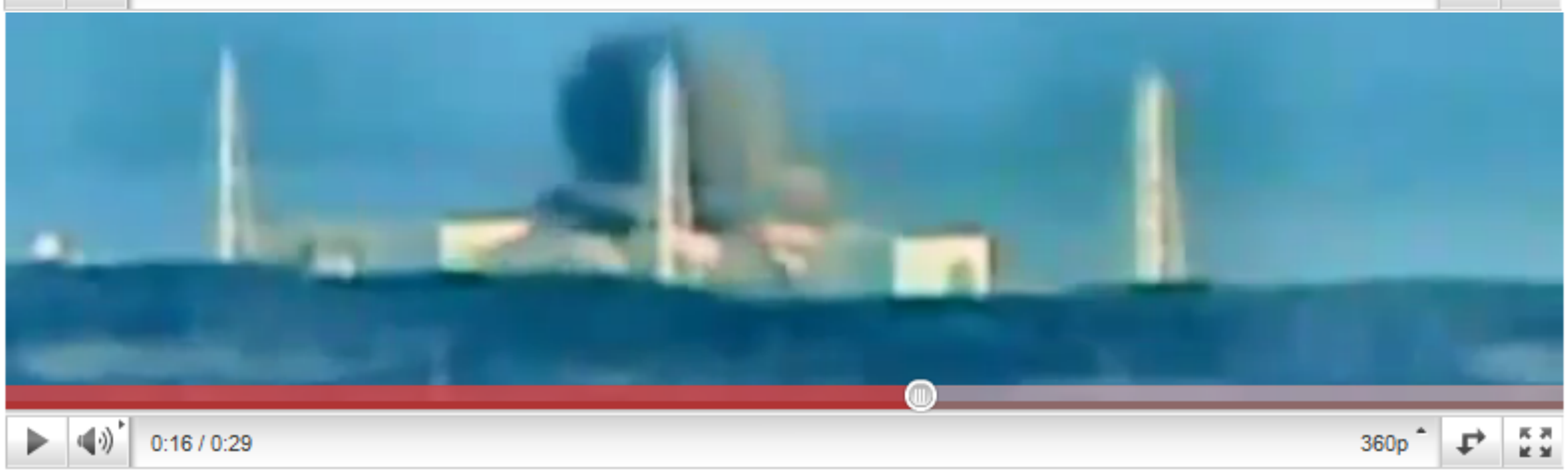
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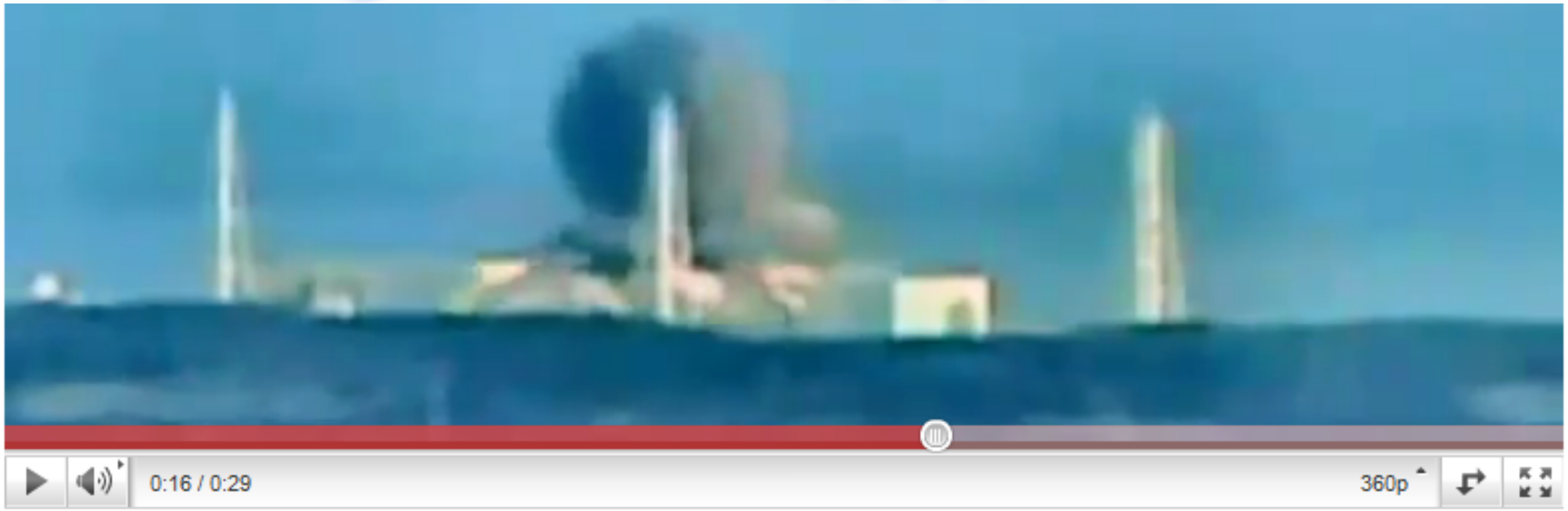
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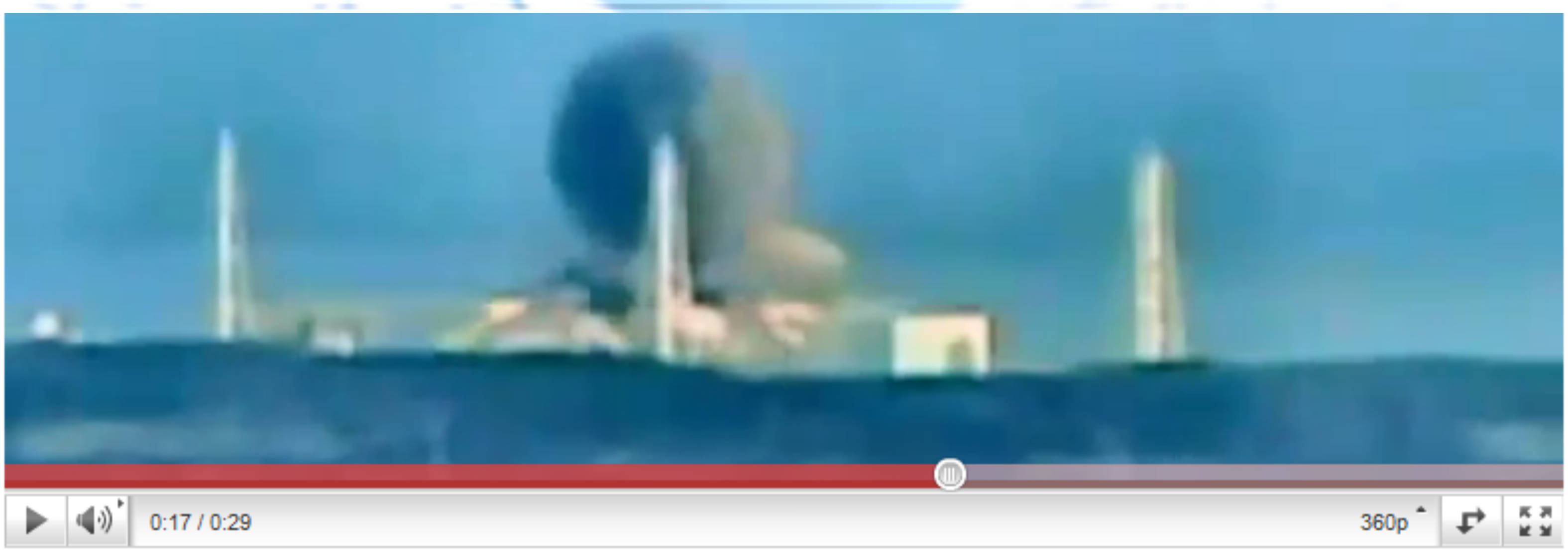
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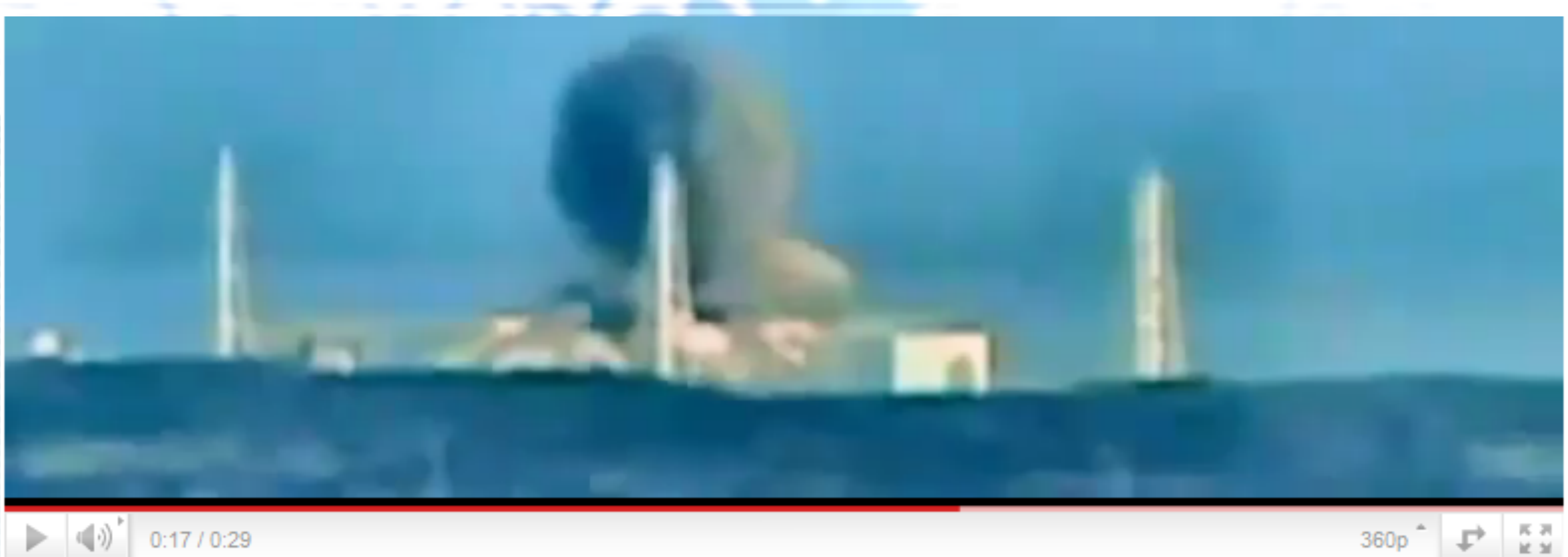
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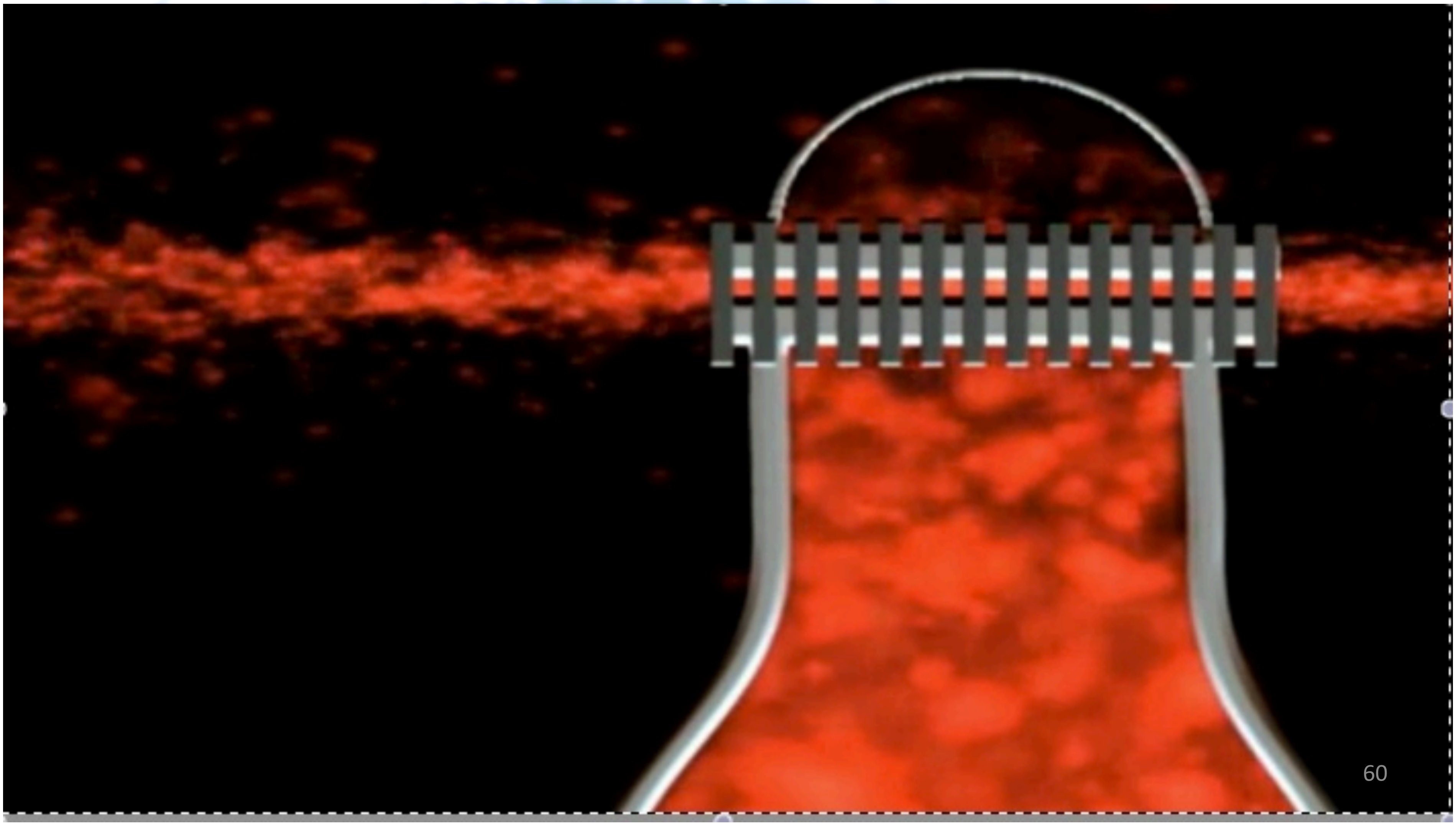
Assumption 2:
Containment Leakage



The Containments Leaked Before The Vents Were Opened

- What was the containment leak rate?
- NRC assumes 1% per day as design basis.
- Mr. Reis, NRC Representative (telephone call): **“The original data we got was actually 300 percent and we assumed what that meant was three containment turnovers per day.”** [Emphasis Added]

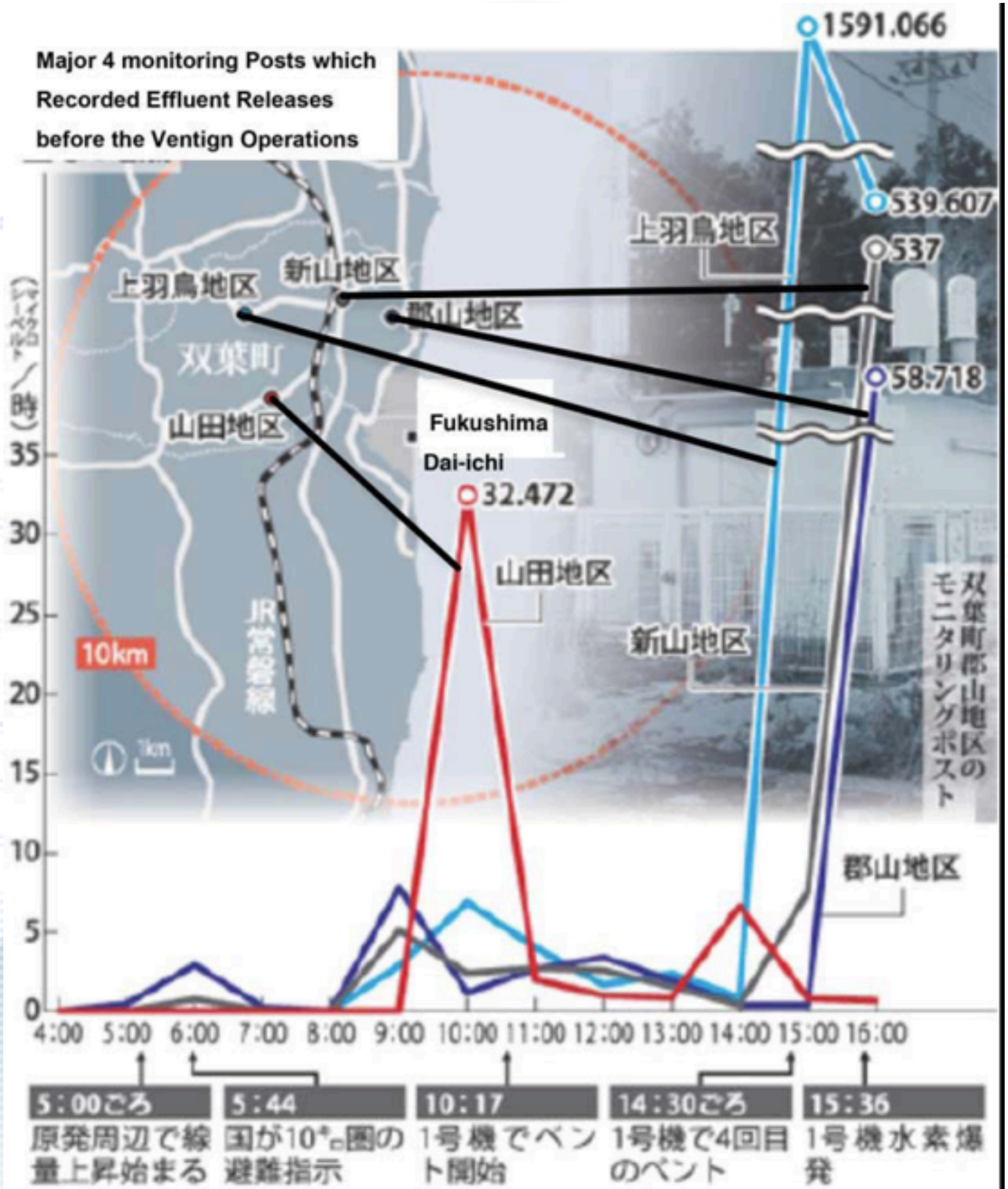
Assumption 3: Noble Gas Releases

- Xenon 400,000 times normal found in Chiba air immediately after Fukushima nuke accident.
- The average amount of xenon-133 in the atmosphere was 1,300 Becquerels per cubic meter of air in Chiba between March 14 and 22.

Fukushima Prefecture Data

Four Monitors Indicate That Radiation Levels Rose Long Before TEPCO Opened Vents

- Background – 0.04 and 0.05 microsieverts (μsv)/hr
- March 12 5 am – 0.48 μsv/hr – 10 x background
- March 12 6 am – 2.94 μsv/hr – 60 x background
- March 12 9 am – 7.8 μsv/hr – 150 x background
- March 12 10 am – 32.47 μsv/hr – 720 x background.
- March 12 2:15 pm – Containment vents open for first time
- March 12 3 pm – 1,591 μsv/hr – 30,000 x background
- NOTE: Only 4 stations operable – these likely are not the highest exposure values



Major 4 monitoring Posts which
Recorded Effluent Releases
before the Ventign Operations
1591.066
539.607
537
58.718
32.472
上羽鳥地区
新山地区
郡山地区
双葉町
山田地区
Fukushima
Dai-ichi
10km
JR常磐線
1km
双葉町郡山地区のモニタリングポスト
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30
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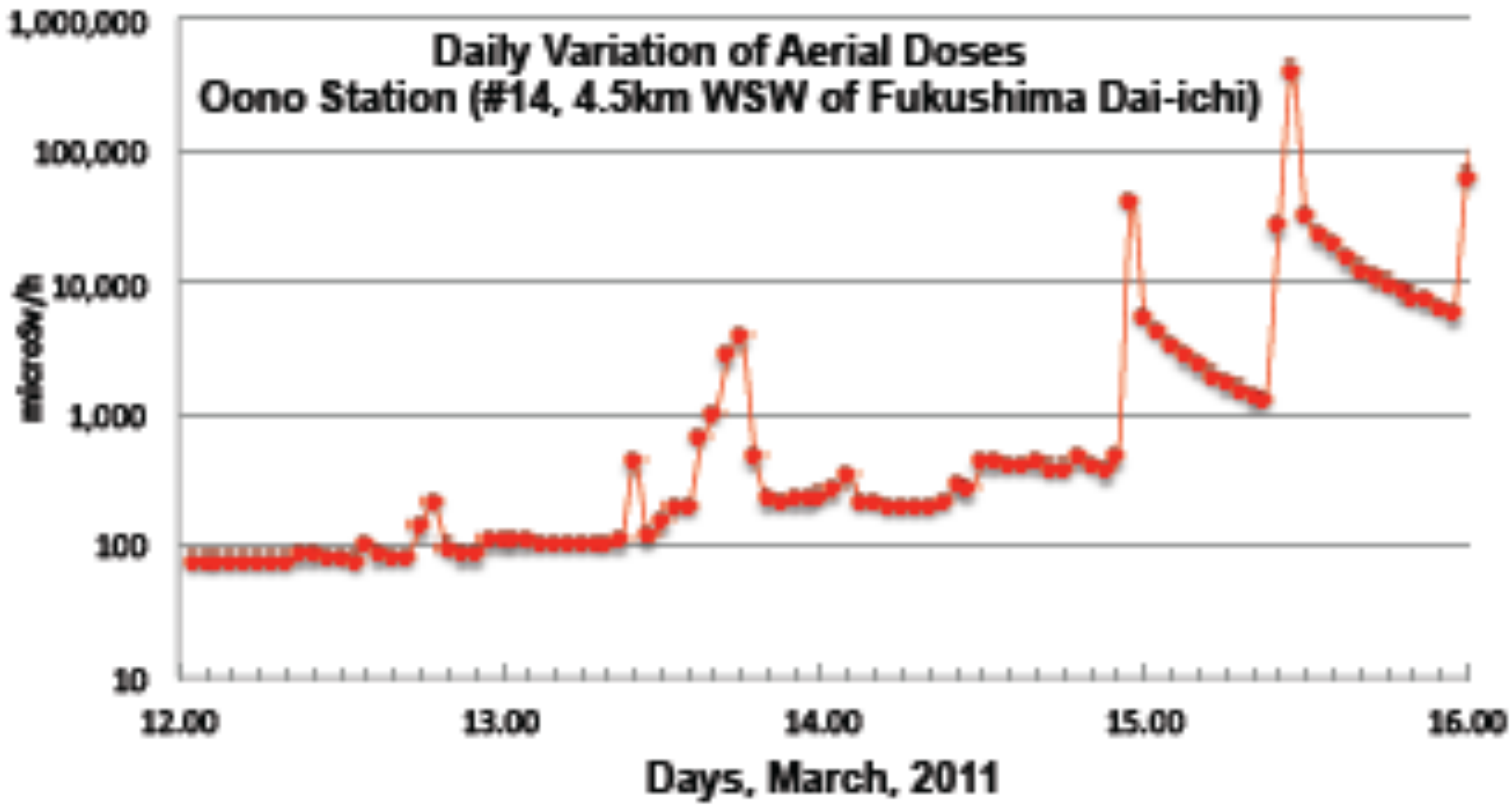
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
5:00ごろ
原発周辺で線量上昇始まる
5:44
国が10㌔圏の避難指示
10:17
1号機でベント開始
14:30ごろ
1号機で4回目のベント
15:36
1号機水素爆発

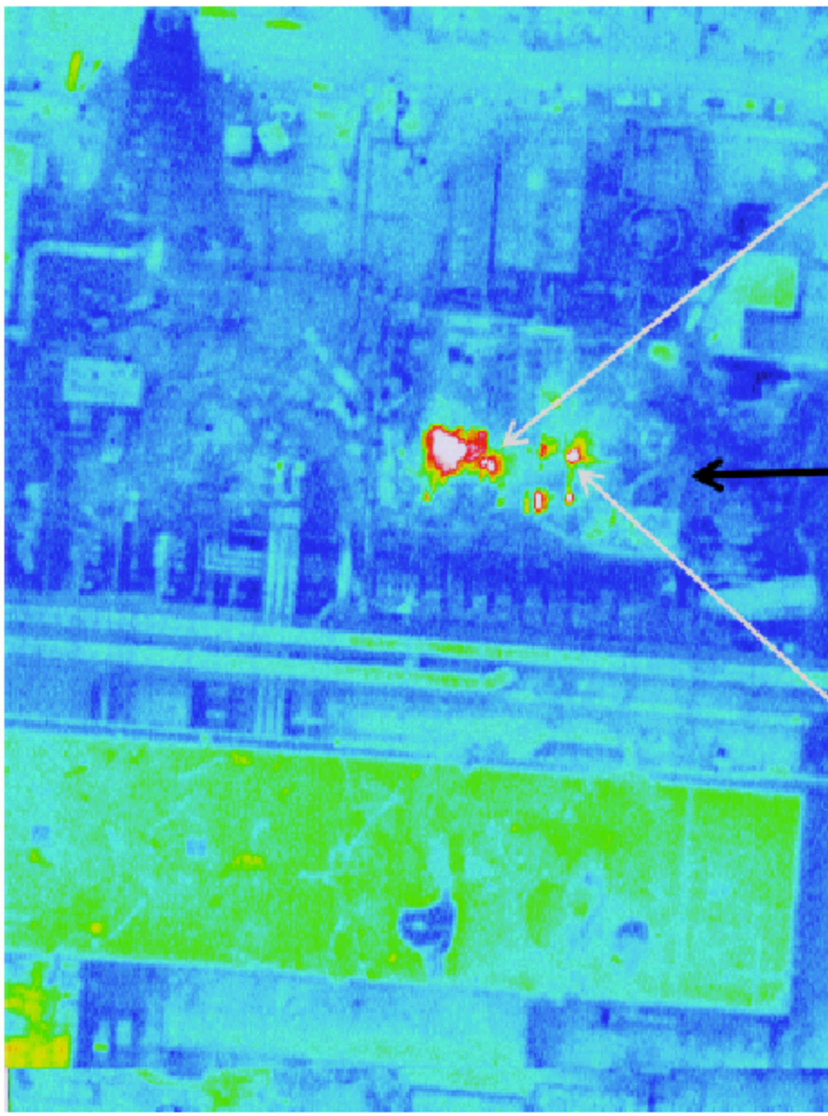
No Correlation Between Exposure Peaks, Explosions, And Venting



Assumption 4: Decontamination Factor for Cesium

- DF = 100 for water below 100C.
- DF = 1.0 for water at or above boiling.
- The suppression pools at Fukushima Daiichi boiled.
- At Fukushima Daiichi, no cesium retention in suppression pool water.

128ºC Thermal Flare Proves Hot Radioactive Gases, Not Steam, Were Released



N

使用済燃料貯蔵プール上： 62℃

3号炉

格納容器上:128℃

防衛省技術研究本部撮影

Fukushima Unit 3 Thermal Image
March 20, 2011

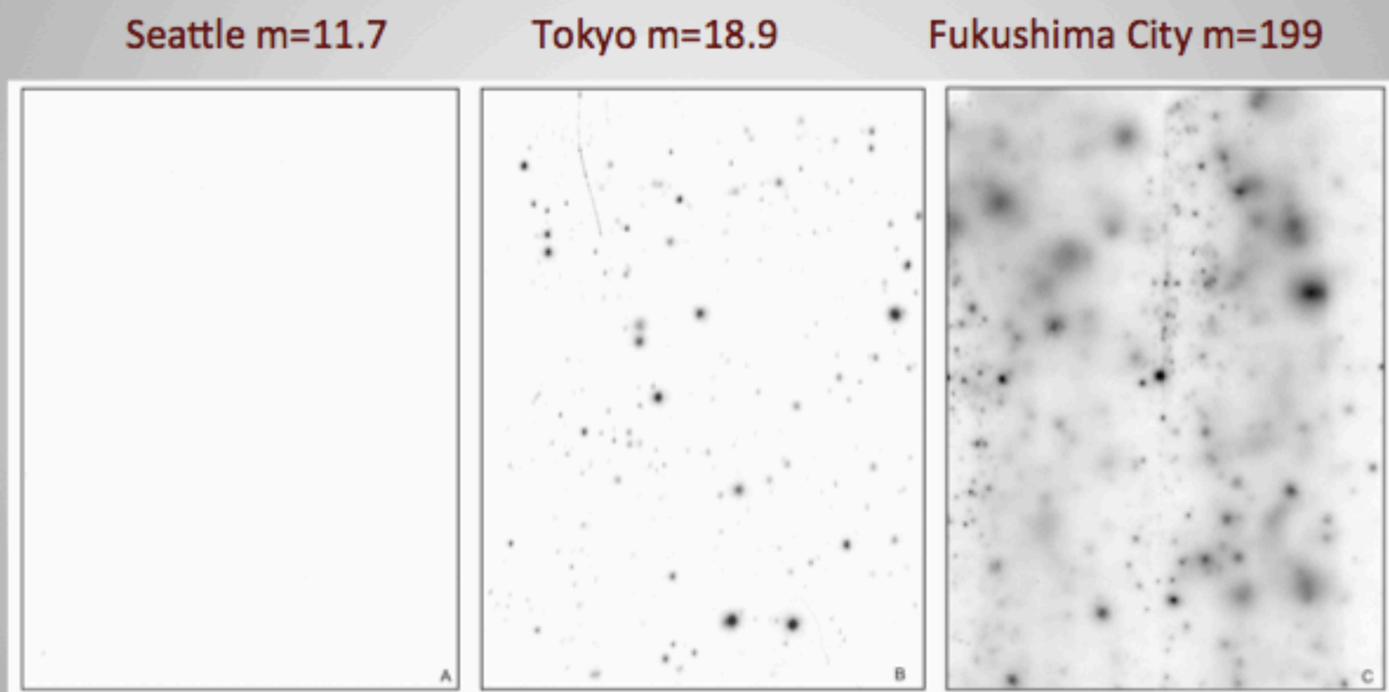
Assumption 5: Hot Particles

Soil Samples: 7,000 Bq/kg In Tokyo Qualifies As Radioactive Waste in US

location	Spectrum	wgt. (g)	time (s)		pk ht. Cs134	pk ht. Cs137	pk ht. Co60	present(Y/N) U235		pCi/g Cs134	pCi/g Cs137	pCi/g Co60
Shibuya District #1	678	8.8	600		417	507	72	negative		137	167	40
Kamakura #2	677	20.4	600		154	157	58	positive		17.9	18	14.1
Chiyoda-Ku playground #3	675	33.6	600		371	437	-	trace		26	31	ND
Chiyoda-Ku roof #4	674	15.4	600		305	307	-	trace		47	47	ND
Hibiya Park #5	676	39.1	600		318	373	72	trace		19	23	9.1
40.1 nCi Cs137			600		-	16882	-	negative		**Results are wet wgts.**		
48.2 nCi Co60			600		-	-	9736	negative				

Autoradiographs – car air filters

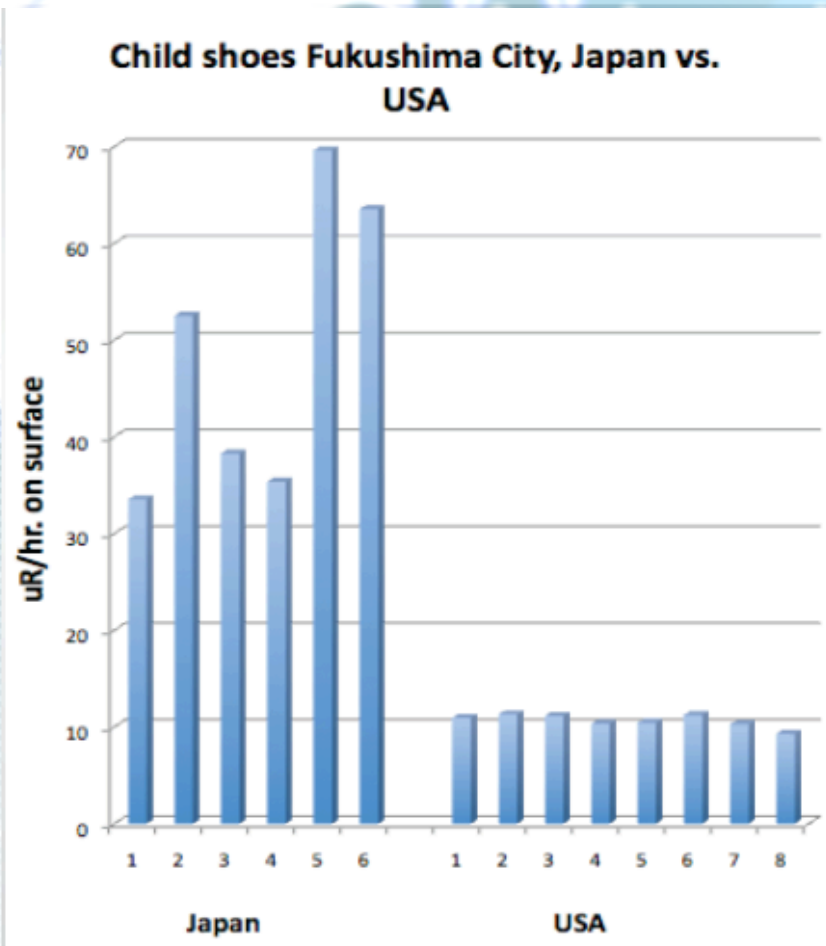
April 2011, X-ray film image and uR/hr.



Radiation Exposure To The Population In Japan After The Earthquake,

Marco Kaltofen, MS, PE (Civil, MA)
Department of Civil and Environmental Engineering
Worcester Polytechnic Institute, Worcester, MA.

Presented October 31, 2011 at the 139th Annual Meeting of the American Public Health Association, Washington, DC



Chernobyl Cesium 137 Inventory and Release–UNSCEAR

Cesium 137		
Total Inventory	290 PBq	2.9 x 1017
30% of Inventory Released	85 PBq	8.5 x 1016

Fukushima Daiichi Cesium 137 Inventory

Cesium 137 Inventory in Reactor Cores			
Unit 1	240 PBq	2.4 x 1017	82.7 % of Chernobyl
Unit 2	259 PBq	2.59 x 1017	89.3% of Chernobyl
Unit 3	259 PBq	2.59 x 1017	89.3% of Chernobyl
Total Cesium Inventory in Units 1 - 3	758 PBq	7.58 x 1017	> 260% of Chernobyl

SECTION 4:

Conclusions

Public Health Consequences? The Assumptions:

- Radiation Available to be released
- Timing of releases – Noble Gases First
- Containment Leakage – 1% or 300%?
- Decontamination factors for cesium /strontium/ iodine – 1% or 100%?
- Meteorology/terrain –sea coast/inland
- Population density and emergency plans
- Liquid Releases 10 x Chernobyl


Tokyo City
Capital since 1603
Population: 35+ Million
GDP: US$ 1.479 Trillion
"Our existence as a sovereign nation was at stake"
Prime Minister, Kan Naoto
When do the risks of a technology become untenable?

Sooner or later, in any foolproof system,
the fools are going to exceed the proofs!

Arnie Gundersen

Credits:

- Wave Graphics by keenbeandesign.com, Cody Mix
- Explosion Sequence, Geoff Sutton, UK
- Containment Leak Graphics, Polaris Mediaworks, Kevin Hurley
- Radiation Exposure To The Population In Japan After The Earthquake, Marco Kaltofen, MS, PE (Civil, MA) Department of Civil and Environmental Engineering Worcester Polytechnic Institute, Worcester, MA. Presented October 31, 2011 At the 139th Annual Meeting of the American Public Health Association, Washington, DC
- Tokyo Graphic, Dr John Downer, Stanton Nuclear Fellow, Center for International Security And Cooperation (CISAC); Stanford University, CA

Arnie Gundersen, Chief Engineer
Fairewinds Associates, Inc

Nuclear Engineering, Safety, and Reliability Expert
42-years of nuclear industry experience and oversight

ME NE	Master of Engineering Nuclear Engineering Rensselaer Polytechnic Institute, 1972 U.S. Atomic Energy Commission Fellowship Thesis: Cooling Tower Plume Rise
BS NE	Bachelor of Science Nuclear Engineering Rensselaer Polytechnic Institute, 1971, Cum Laude James J. Kerrigan Scholar
RO	Licensed Reactor Operator U.S. Atomic Energy Commission License # OP-3014