Nuclear Effects of the Tohoku Earthquake and Tsunami

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Physics & Astronomy
Trick Question:
Which nuclear reactor provides the Earth with the most energy?
Question: Which nuclear reactor provides the Earth with the most energy?
Fusion
(combining small atoms)

Hydrogen  Helium  Energy

("nuclear" means from the atom's nucleus)

\[ E = M c^2 \]
Sunlight received by Earth = 174,000,000 nuclear reactors (174 petawatts)
Fusion Reactors on Earth
May provide sustained energy 20 years from now

H fusion reaction is difficult to sustain...

National Ignition Facility (NIF) at LLNL
Livermore, CA

ITER Experiment
France
Today’s Nuclear Reactors rely on **Fission**
(Breaking up large atoms)

...has a lot of energy...
A Fission Chain Reaction

...which came from...

1st neutron generation

2nd neutron generation

3rd neutron generation
Giant Exploding stars create Uranium ... a Supernova
Uranium can be found in U.S.
(A large portion is on Native American Reservations) and elsewhere
Nuclear reactors make electricity by boiling water. 

Put Uranium Here

Containment Structure

Reactor Vessel

Control Rods -- to stop the chain reaction

A constant supply of water is **required** to cool reactor when not in use.
Fukushima Nuclear Complex
(World’s most powerful, until 2011)

Dai-Ichi: 6 Reactors

Total Power:
9,000 MW
(~San Onofre x 4)

Dai-ni: 4 Reactors

<----------6 miles-------->
Reactors 4, 3, 2, 1 Before Quake  (Reactors 5 & 6 not shown)

Apparently, all reactors shut down properly following the quake. However, cooling systems failed, causing meltdowns in all 4 reactors.
Buildings Housing Reactors #1, #3, & #4  Exploded/Burned

For video of event search for: “Fukushima Daiichi No.3 explosion”
Reactor Unit 3

Before Explosion
Unit 4:

Spent Fuel Pool caught fire. It held both spent and **active** fuel. No containment structure.

Fuel rods damaged; possible “criticality”
Reactor #2:
Internal explosion.
Likely Containment Breach
Highly radioactive water released
Is the radiation here? At what level?
Radiation Monitoring at Thornton Hall Air Intake
Counts per minute, SFSU
(preliminary data: Not Calibrated to dose)
Results of detailed monitoring at UCB: http://www.nuc.berkeley.edu/
When Will it end?
Latest Updates (4/16)

TEPCO:
“Six to nine months required to shut reactors down.”

New Iodine-131 leak discovered in sea. (6,500 times above limit)

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Half-Life</th>
<th>90% gone time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iodine-131</td>
<td>8 days</td>
<td>27 days</td>
</tr>
<tr>
<td>Cesium-137</td>
<td>30 years</td>
<td>100 years</td>
</tr>
<tr>
<td>Strontium-90</td>
<td>29 years</td>
<td>96 years</td>
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</tbody>
</table>

This talk will be available at: physics.sfsu.edu/~chris
Spent Fuel Pools
Contain more Uranium/Plutonium than reactor cores

Boiling Water Type Reactor

Reactor Vessel

Spent Fuel Pools

BWR Design by GE