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# Is Armenia's Nuclear Plant The World's Most Dangerous?

By Marianne Lavelle and Josie Garthwaite  
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In the shadow of Mount Ararat, the beloved and sorrowful national symbol of Armenia, stands a 31-year-old nuclear plant that is no less an emblem of the country's resolve and its woe.

The Metsamor power station is one of a mere handful of remaining nuclear reactors of its kind that were built without primary containment structures. All five of these first-generation water-moderated Soviet units are past or near their original retirement ages, but one salient fact sets Armenia's reactor apart from the four in Russia.

Metsamor lies on some of Earth's most earthquake-prone terrain.

In the wake of Japan's quake-and-tsunami-triggered Fukushima Daiichi crisis, Armenia's government faces renewed questions from those who say the fateful combination of design and location make Metsamor among the most dangerous nuclear plants in the world.

Seven years ago, the European Union's envoy was quoted as calling the facility "a danger to the entire region," but Armenia later turned down the EU's offer of a 200 million euro (\$289 million) loan to finance Metsamor's shutdown. The United States government, which has called the plant "aging and dangerous," underwrote a study that urged construction of a new one.

Plans to replace Metsamor after 2016—with a new nuclear plant at the same location—are under way. But until then, Armenia has little choice but to keep Metsamor's turbines turning. As Armenians learned in the bone-chilling cold and dark days when the plant was closed down for several years, Metsamor provides more than 40 percent of power for a nation that is isolated from its neighbors and closed off from other sources of energy.

"People compare the potential risk with the potential shortage of electricity that might arise if the plant were closed," says Ara Tadevosyan, director of Mediamax, a major Armenian news agency.

"Having had this negative experience, people prefer to live with it, and believe that it will not be damaged in an earthquake."

## A Need for Nuclear

The 3 million people of landlocked Armenia are unique in their energy dependence on one aging nuclear power reactor. Regional conflicts that broke out in the dissolution of the Soviet Union left the smallest of its former republics at odds with its neighbors.

Azerbaijan to the east and Turkey to the west closed their borders with Armenia, cutting off most routes for oil and natural gas. The blockade, which remains in place to this day, heaped a new economic wound onto an old scar. Conflict with Turkey during World War I resulted in the massacre of more than one million Armenians; afterward, the Soviets ceded the Republic's western land to Turkey.

The snow-capped peak of Mount Ararat, still revered in Armenia as the

resting place of Noah's Ark, emblazoned on trinkets and storefronts throughout the land, is now in Turkey.

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The Metsamor Nuclear Power Plant is just 10 miles (16 kilometers) from the Turkish border—in an area that includes the fertile agricultural region of the Aras River valley. It's only 20 miles (36 kilometers) from the capital of Yerevan, home to one-third of the nation's population. And it is in the midst of a strong seismic zone that stretches in a broad swath from Turkey to the Arabian Sea near India.

On December 10, 1988, a 6.8-magnitude earthquake struck, killing 25,000 people and leaving 500,000 homeless. Some 60 miles (100 kilometers) from the epicenter, Metsamor, then with two operating reactors, survived the temblor without damage, according to Armenian officials and the International Atomic Energy Agency (IAEA). Because the devastating earthquake heightened concerns about the seismic hazard to the facility, the Soviet government shut the nuclear plant down.

Tadevosyan said that public attitudes toward Metsamor have been strongly shaped by the nation's experience living without it during the six-and-a-half years that followed.

"There were severe power shortages during the winter months," he recalled in a telephone interview from Yerevan. "We had a situation where you had one hour of power a day, and sometimes no power at all for a week. You can imagine—it was as cold in the apartment as it was in the street."

A pipeline to import Russian natural gas through neighboring Georgia in the north was built in 1993, but it was regularly interrupted by "sabotage and separatist strife in that country," as the World Bank noted in a 2006 report.

In 1995, the government of then-independent Armenia decided to restart the younger of the two reactors. Richard Wilson, nuclear physics professor emeritus at Harvard University, was part of a delegation of outside experts in Armenia at the time. He recalls that the Russians who came from the airport to help reopen the reactor were cheered from the side of the road upon their arrival.

When the unit restarted, "It became a source of energy and a source of hope for Armenia," explained Tadevosyan. "It was a symbol that dark times are over: 'We have electricity.' And it is still seen as such today."

Fortifying an Old War Horse

Armenian officials say modifications made to the reactor over the past 15 years have made it safer. Before Metsamor was reopened, Armenia airlifted more than 500 tons of equipment to the site (most of it from Russia), for upgrades, according to the Nuclear Energy Institute, an industry group in the United States.

In the years since the restart, the IAEA says close to 1,400 safety improvements have been made. Those included "seismic-resistant" storage batteries, reinforcement of the reactor building, electrical cabinets and cooling towers. The United States provided equipment for a seismic-resistant, spray-pond cooling system. Fire safety was viewed as a critical deficiency at the plant, so extensive upgrades were made, including 140 new fire doors.

The result, officials say, is a reactor that is much safer than the original unit that went into service at the site on January 10, 1980.

When construction began in 1969, Metsamor was a VVER 440, Model 230, an example of one of the earliest pressurized-water nuclear plant designs, developed by the Soviets between 1956 and 1970. It was not the same design as Chernobyl, which used solid graphite instead of water to moderate-or slow down-the fission reaction. (The graphite fire contributed to the world's worst nuclear disaster, and 11 of these early graphite-moderated reactors continue to operate in Russia.)

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The VVER 440, in contrast, used water both to moderate and to cool the fuel, as in Western designs. (Its initials, in Russian, stand for "water-water-power-reactor.")

In fact, the VVER system, with multiple cooling loops, was seen as "more forgiving" than Western plants, according to archived documents from the International Nuclear Safety Program, a former U.S.

Department of Energy program aimed at aiding in safety improvements at Soviet plants. VVER 440 units would be able to stand a power loss for a longer period of time than Western plants because of the large coolant volume.

After Japan's nuclear crisis erupted, the head of the Armenian State Committee on Nuclear Safety Regulation, Ashot Martirosian, pointed to Metsamor's cooling system as one reason Armenians should rest assured.

"Such an emergency situation cannot arise here," he told Radio Free Europe.

(Related: "Japan Battles to Avert Nuclear Disaster" and "Pictures-A Rare Look Inside Fukushima Daiichi")

Nuclear engineering expert Robert Kalantari, whose Framingham, Massachusetts, firm, Engineering Planning and Management, consults for U.S. and Canadian regulatory authorities, says Metsamor is like any other nuclear plant in operation worldwide. Although its safety features are different, all have to be able to be shut down safely during a so-called "design basis accident," the kind of accident anticipated in its design. He said he is confident that Metsamor could operate safely in such an accident, and that it could cope even with accidents beyond its design basis.

"Metsamor is no less safe than any other reactor in operation throughout the world," Kalantari said. "Armenia as an independent country cannot survive without [Metsamor], which is a functioning, safe, and reliable source of energy for the country."

#### Lack of Containment

But the VVER 440s share one characteristic with Chernobyl that has been a continuing concern to many who live nearby: They have no containment structure.

Instead, VVER 440s rely on an "accident localization system," designed to handle small ruptures. In the event of a large rupture, the system would vent directly to the atmosphere. "They cannot cope with large primary circuit breaks," the NEI's 1997 Source Book on Soviet nuclear plants concluded. "As with most Soviet-designed plants, electricity production by the VVER-440 Model V230s came at the expense of safety."

Antonia Wenisch of the Austrian Institute of Applied Ecology in Vienna, calls Metsamor "among the most dangerous" nuclear plants still in operation. A rupture "would almost certainly immediately and massively fail the confinement," she said in an email. "From that point, there is an open reactor building, a core with no water in it, and accident progression with no mitigation at all."

Despite the upgrades to the plant, she said, "the overall safety has not improved sufficiently." She points to Armenia's own most recent report for the international convention on nuclear safety, which estimates the risk of "core damage frequency" to be nearly two incidents every 10,000 years. She said that number should be less than one. The average risk at U.S. nuclear power plants is 2 such incidents every 50,000 years, according to a report by the U.S. Electric Power Research Institute.

Over the past decade, the European Union, living in close proximity to the old Soviet plants, used leverage where it could to get some of them shuttered. Four VVER 440 units in Bulgaria and two in Slovakia were closed as a condition of those countries joining the European Union.

But four of the units remain in operation in Russia—two in the northern city of Murmansk, on the Kola Peninsula near the Barents Sea, and two at Novovoronezh, in the Voronezh region in the west (the area of last summer's devastating Russian forest fires). Metsamor is the only VVER 440, Model 230, operating outside of Russia.

(Related: "Wildfire Pictures—Russia Burns, Moscow Chokes")

Since it failed to persuade Armenia to close the plant, the EU has focused on providing aid for improving its safety, spending more than 59 million euros (\$85 million) on such projects as well as for renewable energy, and regional energy cooperation efforts.

Armenia has made efforts to obtain other sources of fuel, such as a natural gas pipeline from its southern neighbor Iran, which opened in 2007. But the amount of fuel to be imported remains in question. The conduit poses potential competition to Russia, a country on which Armenia remains highly reliant, for everything from nuclear fuel to grain. A U.S. Agency for International Development (USAID)-funded study concluded that a new nuclear plant was Armenia's lowest-cost energy option.

#### Plans for the Future

Armenia intends to break ground on a \$5 billion reactor project next year—a larger, and more advanced Russian VVER 1000. The government is going forward with a conference late this month to seek help from potential investors and engineering contractors. The planned reactor would have a containment vessel, but it would be located in the same seismic area as the current Metsamor plant.

Hakob Sanasaryan, a chemist who is chairman of the Greens Union of Armenia, says that although he believes the Metsamor reactor's old design makes it less safe than newer plants, it is the location that is his greatest concern.

Speaking by telephone through an interpreter, he said his group opposes the plan to build a new plant at a place of such high seismic hazard, within Armenia's prime agricultural region, and so close to the country's most populous city. If the government were to reconsider that project in the

wake of Japan's crisis, Sanasaryan said, it would be "the only good thing that might possibly come out of these tragic events."

Sanasaryan would like to see Armenia further develop its hydroelectric resources, or more thermal energy from geothermal sources or natural gas. He also has great hope for the country's solar energy potential.

"We have existing infrastructure," he says. "If it were exploited better, it could satisfy Armenia's energy needs."

But another Armenian environmentalist, Karine Danielyan, president of Armenia's Association for Sustainable Human Development, laments that there has been insufficient effort over the past 15 years to create a renewable energy base. Danielyan, a former Armenian environment minister, wrote in an email that she is keenly aware of the harm that resulted from the energy shortages during Metsamor's closure. In addition to increased mortality due to the cold, deforestation accelerated rapidly as citizens scavenged for wood to heat their homes. The sharp increase of water flow to ramp up hydroelectricity caused severe stress to the nation's largest lake, Lake Sevan, where efforts at ecological restoration are a continuing battle.

Although she calls herself "an opponent of nuclear power engineering," Danielyan said she was compelled to join the call to improve safety at Metsamor and restart the plant in 1995. Now, she says, the country faces the need to construct another nuclear plant. "Unfortunately, now Armenia has not another alternative," she says.

<http://news.nationalgeographic.com/news/energy/2011/04/110412-most-dangerous-nuclear-plant-armenia/>

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Armenia's 31-year old only nuclear power plant located in Metsamor is one of the few remnants of the old soviet nuclear reactors built without primary containment structures. Only a few of these first generation water-moderated reactors are still in use today, being past or near their original retirement ages, but what sets the Metsamor facility apart from all the others is the fact that it's located in a potentially hazardous seismic zone. The United States government, which has called the plant "aging and dangerous," underwrote a study that urged construction of a new one. Metsamor is located right in the middle of one of the world's most active and strong seismic zones that stretches in a broad swath from Turkey to the Arabian Sea near India. About 20 miles from Armenia's capital city of Yerevan sits the antiquated Metsamor nuclear power plant. The plant (located in a town also called Metsamor) has long been a cause for concern for at least two reasons: It was built without containment vessels, and it sits in a seismic zone. In fact, it was closed in 1989 after a devastating earthquake hit nearby. In 2011, National Geographic even suggested that it might be the world's most dangerous nuclear plant. According to a 1995 Washington Post article, the plant was reopened because Armenia was desperate to have energy after its neighbor, Azerbaijan. In the shadow of Mount Ararat, the beloved and sorrowful national symbol of Armenia, stands a 31-year-old nuclear plant that is no less an emblem of the country's resolve and its woe. The Metsamor power station is one of a mere handful of remaining nuclear reactors of its kind that were built without primary containment structures. All five of these first-generation water-moderated Soviet units are past or near their original retirement ages, but one salient fact sets Armenia's reactor apart from the four in Russia. Metsamor lies on some of Earth's most earthquake-prone terrain.