

**Plant Layout Assignment**

 **(Subject:- Production & Operations Management)**

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**Floating nuclear power stations** *АТЭС ММ* - lit. floating [combined heat and power](http://en.wikipedia.org/wiki/Combined_heat_and_power) low-power nuclear station) are vessels projected by [Rosatom](http://en.wikipedia.org/wiki/Rosatom) that present self-contained, low-capacity, floating [nuclear power plants](http://en.wikipedia.org/wiki/Nuclear_power_plant). The stations are to be mass-built at [shipbuilding](http://en.wikipedia.org/wiki/Shipbuilding) facilities and then towed to the destination point in coastal waters near a city, a town or an industrial enterprise. Although the world's first floating nuclear power station was [MH-1A](http://en.wikipedia.org/wiki/MH-1A), the Rosatom project represents the first mass production of that kind of vessel. By 2015, at least seven of the vessels are supposed to be built.

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## History

The project of Russian floating nuclear power stations started in early 2000s. In 2000, the [Ministry for Atomic Energy of the Russian Federation (Rosatom)](http://en.wikipedia.org/wiki/Rosatom) chose [Severodvinsk](http://en.wikipedia.org/wiki/Severodvinsk) in [Arkhangelsk Oblast](http://en.wikipedia.org/wiki/Arkhangelsk_Oblast) as the place for building the first floating power generating station. [Sevmash](http://en.wikipedia.org/wiki/Sevmash) was appointed as general contractor. Construction of the first floating nuclear power station, [*Akademik Lomonosov*](http://en.wikipedia.org/wiki/Akademik_Lomonosov), started on 15 April 2007 at the Sevmash Submarine-Building Plant in Severodvinsk. However, in August 2008 construction works were transferred to the [Baltic Shipyard](http://en.wikipedia.org/wiki/Baltic_Shipyard) in [Saint Petersburg](http://en.wikipedia.org/wiki/Saint_Petersburg), which is responsible also for construction of the next vessels. *Akademik Lomonosov* was launched on 1 July 2010.

## Technical description

The floating nuclear power stations are non-self-propelled vessels with a length of 144.4 metres (474 ft), width of 30 metres (98 ft), height of 10 metres (33 ft), and draught of 5.6 metres (18 ft). The vessel has a displacement of 21,500 tonnes and a crew of 69 people.

Each vessel has two modified [KLT-40](http://en.wikipedia.org/wiki/KLT-40) [naval propulsion reactors](http://en.wikipedia.org/wiki/Soviet_naval_reactor) together providing up to 70 [MW](http://en.wikipedia.org/wiki/Watt) of electricity or 300 MW of heat, enough for a city with a population of 200,000 people. It could also be modified as a [desalination](http://en.wikipedia.org/wiki/Desalination) plant producing 240,000 cubic meters of fresh water a day. Another modification will be supplied by two ABV-6M reactors with a capacity of around 18 MWe (megawatts of electricity).Also, 325 MWe [VBER-300](http://en.wikipedia.org/wiki/VBER-300) and 55 MWe RITM-200 reactors have been mentioned as potential reactors to use for the floating nuclear power station.

##  Contractors

The hull and sections of vessels to be built by the [Baltic Shipyard](http://en.wikipedia.org/wiki/Baltic_Shipyard) in [Saint Petersburg](http://en.wikipedia.org/wiki/Saint_Petersburg). Reactors are designed by OKBM Afrikantov and are assembled by Nizhniy Novgorod Research and Development Institute Atomenergoproekt (both part of [Atomenergoprom](http://en.wikipedia.org/wiki/Atomenergoprom)). The reactor vessels are produced by [Izhorskiye Zavody](http://en.wikipedia.org/wiki/Izhorskiye_Zavody).[Kaluga Turbine Plant](http://en.wikipedia.org/wiki/Power_Machines) supplies the turbo-generators.

##  Fueling

The floating power stations need to be refueled every three years while saving up to 200,000 metric tons of coal and 100,000 tons of fuel oil a year. The reactors are supposed to have a lifespan of 40 years. Every 12 years, the whole plant will be towed home and overhauled at the wharf where it was constructed. The disposal of the nuclear waste will be organized by the manufacturer and supported by the infrastructure of the Russian nuclear industry. Thus, virtually no radiation traces are expected at the place where the power station produced its energy.

## Safety

Environmental groups are concerned that floating plants will be more vulnerable to accidents and terrorism than land-based stations. They point to a history of naval and nuclear accidents in Russia and the former Soviet Union, including the [Chernobyl disaster](http://en.wikipedia.org/wiki/Chernobyl_disaster) of 1986. Russia does have 50 years of experience operating a fleet of [nuclear powered icebreakers](http://en.wikipedia.org/wiki/Nuclear_powered_icebreaker) that are also used for scientific and Arctic tourism expeditions. The Russians have commented that a [nuclear reactor that sinks](http://en.wikipedia.org/wiki/List_of_sunken_nuclear_submarines), such as the similar reactor involved in the [*Kursk*](http://en.wikipedia.org/wiki/Russian_submarine_Kursk_explosion) explosion, can be raised and probably put back into operation. At this time, it is not known what, if any, [containment structure](http://en.wikipedia.org/wiki/Containment_building) or associated missile shield will be built on the ship. The manufacturers believe that an airliner striking the ship would not destroy the reactor. According to MosNews, a Russian news outlet, there is no way an airliner striking the ship would destroy the reactor.

A 2004 book on Russian floating nuclear power stations was written by a number of authors, including "[Vladimir Kuznetsov](http://en.wikipedia.org/wiki/Vladimir_Kuznetsov), formerly of the Russian Federal Inspectorate for Nuclear and Radiation Safety; [Alexey Yablokov](http://en.wikipedia.org/w/index.php?title=Alexey_Yablokov&action=edit&redlink=1), a biologist, former environmental advisor to the Russian president and president of the Center for Russian Environmental Policy; [Yevgeney Simonov](http://en.wikipedia.org/w/index.php?title=Yevgeney_Simonov&action=edit&redlink=1), senior engineer at the Obninsk nuclear power plant; [Vladimir Desyatov](http://en.wikipedia.org/w/index.php?title=Vladimir_Desyatov&action=edit&redlink=1), an engineer who worked in nuclear submarine construction; and [Alexander Nitikin](http://en.wikipedia.org/w/index.php?title=Alexander_Nitikin&action=edit&redlink=1)." The book concludes that such stations are impossible to protect against terrorism, that safety cannot be guaranteed ("The only question is how serious the emergency and its consequences."), and that an accident would be uniquely difficult to contain. Besides that, the book argues that such stations would be uneconomic.

## Locations

Floating nuclear power stations are planned to be used mainly in the Russian [Arctic](http://en.wikipedia.org/wiki/Arctic). Five of these will be used by [Gazprom](http://en.wikipedia.org/wiki/Gazprom) for offshore oil and gas field development and for operations on the [Kola](http://en.wikipedia.org/wiki/Kola_Peninsula) and [Yamal](http://en.wikipedia.org/wiki/Yamal_Peninsula) peninsulas. Other locations include [Dudinka](http://en.wikipedia.org/wiki/Dudinka) on the [Taymyr Peninsula](http://en.wikipedia.org/wiki/Taymyr_Peninsula), [Vilyuchinsk](http://en.wikipedia.org/wiki/Vilyuchinsk) on the [Kamchatka Peninsula](http://en.wikipedia.org/wiki/Kamchatka_Peninsula) and [Pevek](http://en.wikipedia.org/wiki/Pevek) on the [Chukchi Peninsula](http://en.wikipedia.org/wiki/Chukchi_Peninsula). In 2007, Rosatom signed an agreement with the [Sakha Republic](http://en.wikipedia.org/wiki/Sakha_Republic) to build a floating plant for its northern parts, using smaller ABV reactors.

According to Rosatom, 15 countries, including China, Indonesia, Malaysia, Algeria, Namibia, Cape Verde and Argentina, have shown interest in hiring such a device.

Russia is presently building the world’s first [Floating Nuclear Power Plant (FNPP)](http://en.rian.ru/infographics/20080305/100707901.html) of 70 MW ‘Academic Lomonosov’. The project was launched in 2007 and is expected [to be commissioned in 2011.](http://en.rian.ru/russia/20070927/81397620.html) Five such plants are expected to be operational by 2020. The [FNPP](http://en.wikipedia.org/wiki/Russian_floating_nuclear_power_station) under the Russian flag would operate in coastal states that had signed the necessary agreements. The [FNPP](http://www.timesonline.co.uk/tol/news/world/europe/article1662889.ece) would drop anchor in a safe place protected from potential natural disasters and operate with the assistance of local engineering services available on shore.

**The interesting features of Floating Nuclear Power Plant are:**

* under construction at [Severodvinsk](http://maps.google.com/maps?f=q&hl=en&geocode=&q=Severodvinsk,russia&mrt=loc&ie=UTF8&ll=65.730626,31.728516&spn=8.556297,41.132813&z=5), Sevmash Shipyard located at northern White Sea which is the main facility of the State Nuclear Shipbuilding Centre.
* to generate 1/15th of the power produced by a standard Russian nuclear power plant.
* to be equipped with two power units using KLT- 40S reactors.
* reactors will be loaded with nuclear fuel once every three years.
* cost of electricity: just 5 or 6 cents per kilowatt.
* the first plant would cost around 10 billion Rubles ($ 0.42 billion).
* the remaining plants would cost around 5 to 6 billion Rubles ($ 0.2 to 0.25 billion) each.
* designed to be protected from the following potential terrorist threats using fingerprint and iris identification technologies.
	+ unauthorized access to fissile materials onboard the plant
	+ against possible subversive attempts by terrorist divers
	+ nothing would destroy the reactor even if an airliner as big as a Boeing crashes on the plant
* will also be able to supply heat and [desalinate seawater](http://www.marinebuzz.com/2007/12/11/ship-as-a-seawater-desalination-vessel/).
* on desalination mode, will be able to produce 240,000 cubic meters of fresh water a day.
* will save up to 200,000 metric tons of coal and 100,000 tons of fuel oil a year.
* will have a life span of 40 years.
* every 12 years the plant will be taken to Russia for overhaul.

More than 20 countries have shown interest in this project. Cooperation in this project with India,China,Indonesia and many African,Latin American countries are in pipeline. Depending on the agreement it may involve technology transfer or sale of only products of the plant: like electric power, heat and fresh water.

**Longitudinal section of a FNPP.**



**1.** Living area. **2.** Nuclear Power Plant operating room. **3.** Reactors. **4.** Steam Turbine installation. **5.** Power Generation area. **6.** Storage area for spent fuel

**How safe is this Floating Nuclear Power Plant ?**

A report from [Green Cross Russia (GCR),](http://www.green-cross.ru/index_eng.htm%22%20%5Ct%20%22_blank) a public, non-governmental organization which promotes protection of the environment, highlights the following:

A. In terms of number of accidents or malfunctions:

Here is a chart showing number of malfunctions during the period 1994-2002 *on board atomic icebreakers which is alarming:*



yellow = malfunctions leading to a start of the emergency response systems; violet = all other incidents.

The possibilities of such accidents or malfunctions in FNPP may not be lesser than these past records.

B. Impact of Human Error

Human errors in FNPP can not be ruled out and this may lead to

* the FNPP sitting on a bank with a tilt of e.g. 30 degrees and make it more difficult to use cold seawater to cool the reactor.
* the overturning of the entire FNPP leading to damage to the reactor core equipment and making it impossible to insert the absorber rods.
* the sinking of the FNPP itself.

C. Impact of natural disasters

With increasing number of cyclones,earthquakes and tsunami, the damage to FNPP can not be ruled out. Subsequent impact of nuclear radiation would be phenomenal.