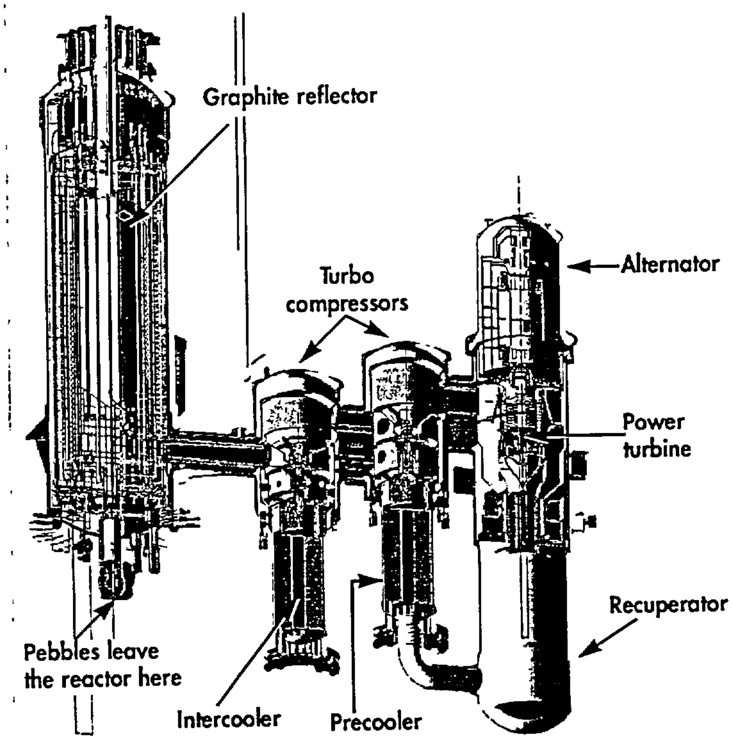
PBMR

HOW THE PBMR WORKS



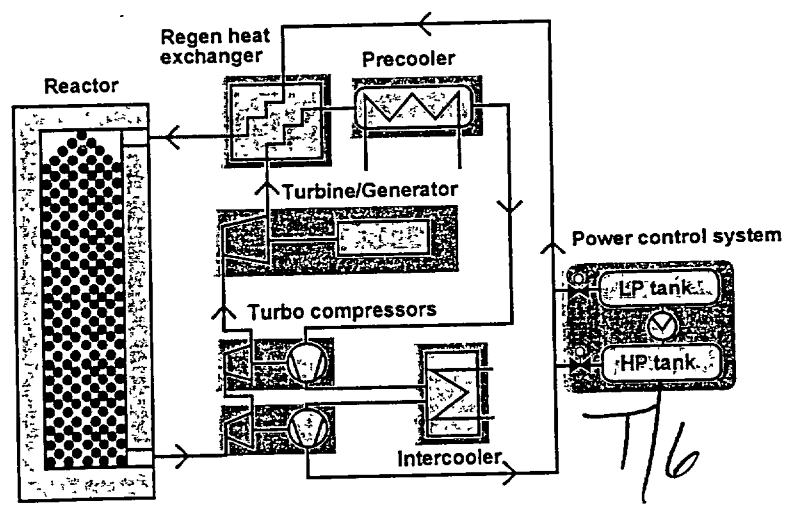
The PBMR is a helium-cooled, graphite-moderated High-Temperature Reactor (HTR)

The PBMR consists of a vertical steel pressure vessel, 6m in diameter and about 20m high It is lined with a 10cm thick layer of graphite bricks, which serves as a reflector and a passive heat transfer medium The graphite brick lining is drilled with vertical holes to house the control rods.

The PBMR uses silicon carbide coated particles of enriched uranium oxide encased in graphite to form a fuel sphere or pebble about the size of a tennis ball Helium is used as the coolant and energy transfer medium to a closed cycle gas turbine and generator system When fully loaded, the core would contain 310 000 fuel spheres The balance are pure graphite spheres which serve the function of an additional nuclear moderator

To remove the heat generated by the nuclear reaction, helium coolant enters the reactor vessel at a temperature of about 500°C and a pressure of 70 bar. It then moves down between the hot fuel spheres, after which it leaves the bottom of the vessel having been heated to a temperature of about 900°C

The hot gas then enters the first of three gas turbines in series, the first two of which drive compressors and the third of which drives the electrical generator. The coolant leaves the last turbine at about 530°C and 26 bar, after which it is cooled, recompressed, reheated and returned to the reactor vessel.



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The process cycle used is a standard Brayton cycle with a closed circuit water-cooled inter-cooler and pre-cooler A high efficiency recuperator is used after the power turbine generator to recuperate the thermal energy Lower energy helium is passed through the pre-cooler and intercooler and the low and high pressure compressors before it is returned through the recuperator to the reactor core

The significance of the high pressure and high temperature of the helium coolant lies in its superior thermal efficiency By comparison, the steam turbines for Light Water Reactors (LWRs) operate at such low temperatures and pressures that they are more costly to build and less productive than the turbines for a fossil-fired plant, where temperatures and pressures may be three times as high

While a typical LWR has a thermal efficiency (heat in, power out) of 33 percent, a heat efficiency of about 42 percent is anticipated in the basic PBMR design Increases in fuel performances leading to higher operating temperatures, offer the prospect of up to 50 percent efficiency.

On-line refueling is another key feature of the PBMR. While the unit remains at full power and the reactivity of the initial core subsides, fresh fuel elements are added at the top of the reactor.

The aim is to operate uninterrupted for six years before scheduled maintenance. However, for the first demonstration module a certain amount of interim shut-downs will be required for planned evaluation of component/system performance. During a shut-down there are a variety of options to consider, namely system shut-down in a thermally hot condition or in a cold condition.

Shut-down will be done by inserting the control rods Start-up is affected by making the reactor critical and using nuclear heat-up of the core and removing this heat in the core conditioning system. At a specified temperature, the Brayton cycle is initiated by means of an external blower system, whereafter the core conditioning system is shut down and the heat removed by the coolers in the power conversion unit.

Plant Specifications

Maximum sent-out power	100-115MW
Continuous stable power range	0-100%
Ramp rate (0-100%)	10%/min
Load rejection without trip	100%
Cost	US$1000/kWe
Construction lead-time	24 months
General overhauls	30 days per 6 years
Outage rate	2% planned and 3% forced
O&M and fuel costs	US$4-5/MWh
Emergency planning zone	<400 meters
Plant operating life time	40 years