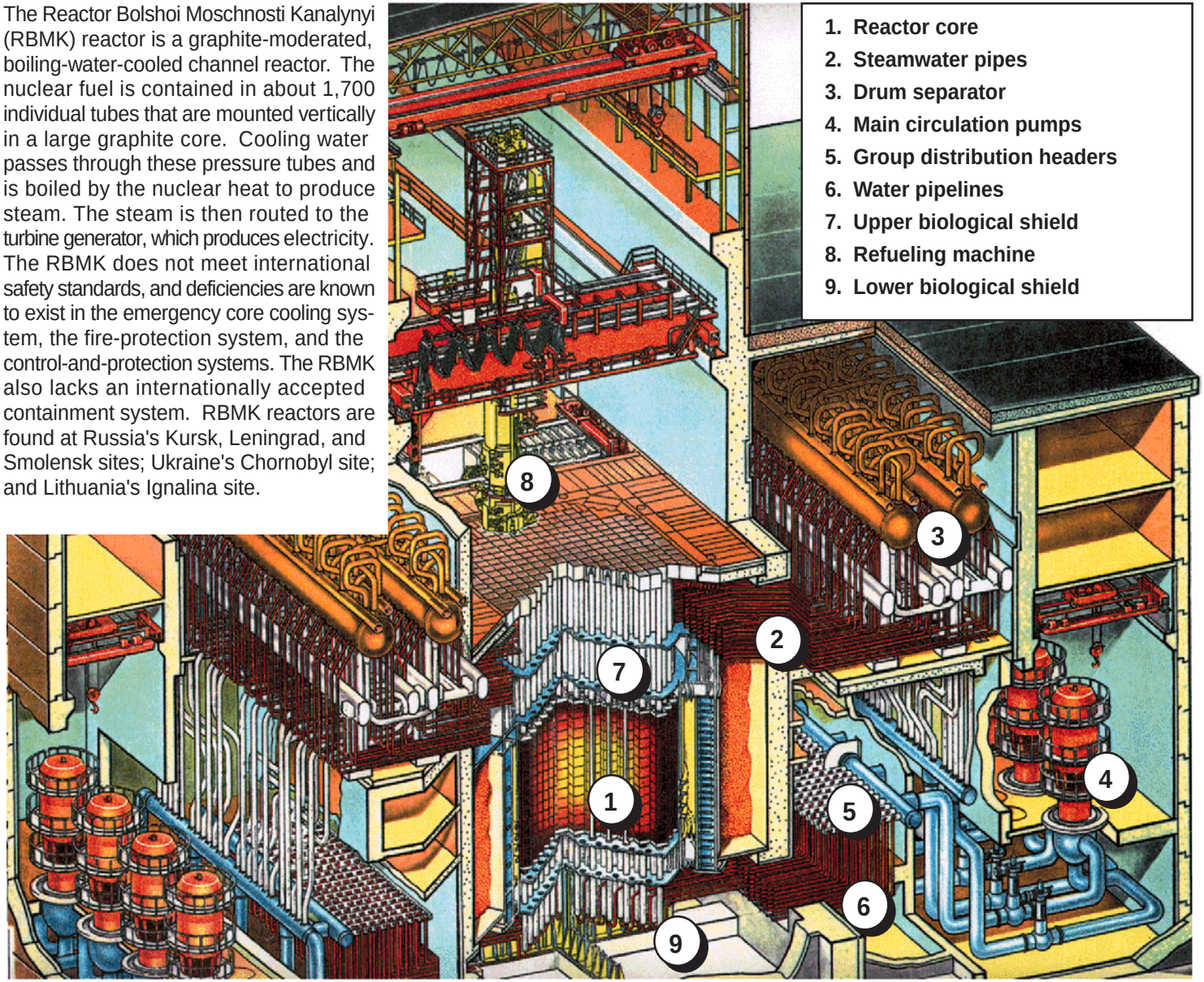
Appendix A

Illustrations and Descriptions of Reactor Types at Participating Nuclear Power Plants

RBMK Plant Layout

The Reactor Bolshoi Moschnosti Kanalynyi (RBMK) reactor is a graphite-moderated, boiling-water-cooled channel reactor. The nuclear fuel is contained in about 1,700 individual tubes that are mounted vertically in a large graphite core. Cooling water passes through these pressure tubes and is boiled by the nuclear heat to produce steam. The steam is then routed to the turbine generator, which produces electricity. The RBMK does not meet international safety standards, and deficiencies are known to exist in the emergency core cooling system, the fire-protection system, and the control-and-protection systems. The RBMK also lacks an internationally accepted containment system. RBMK reactors are found at Russia's Kursk, Leningrad, and Smolensk sites; Ukraine's Chornobyl site; and Lithuania's Ignalina site.



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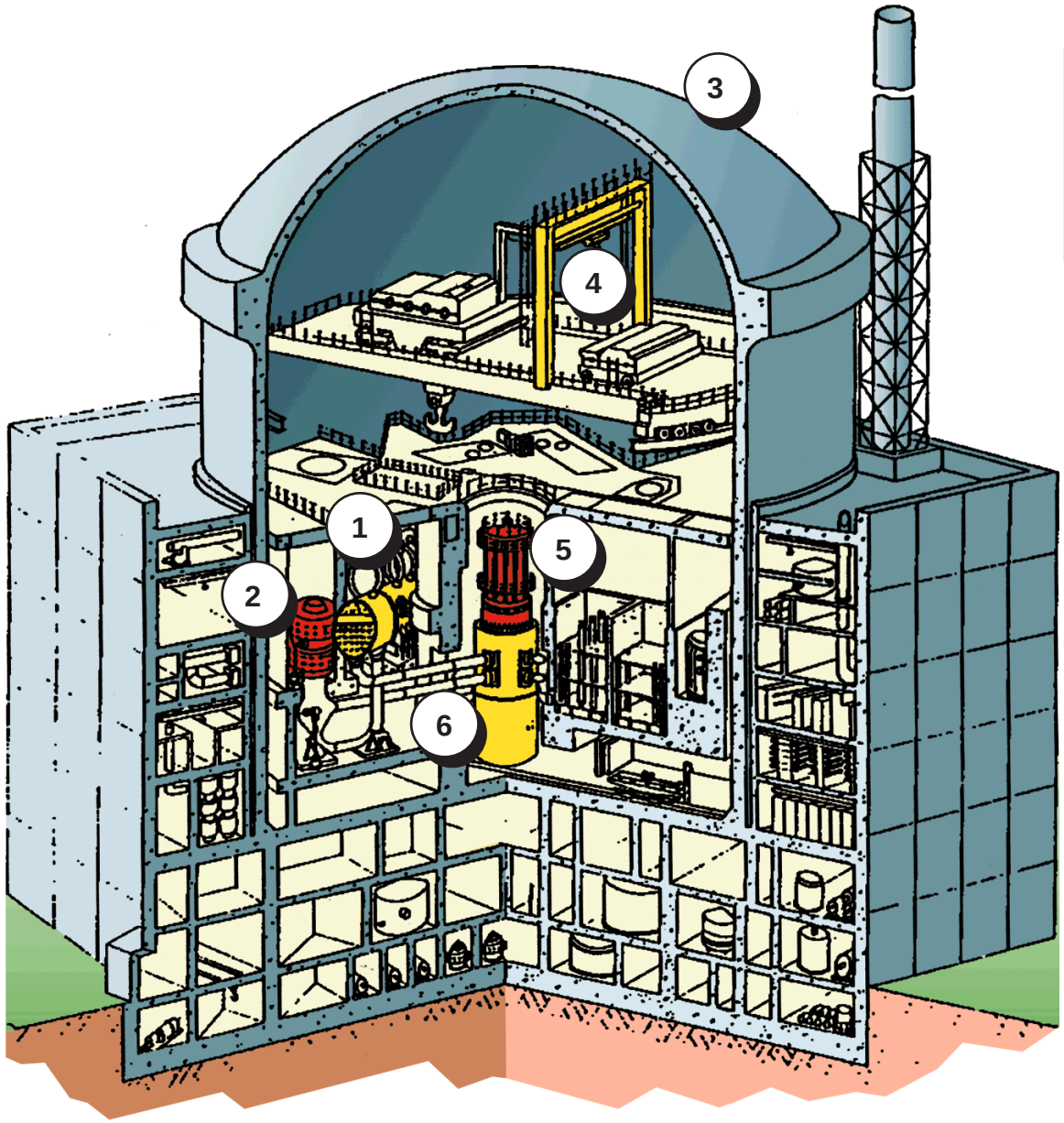
VVER-1000 Plant Layout



1. Horizontal steam generator
2. Reactor coolant pump
3. Containment building
4. Refueling crane
5. Control rod drive assemblies
6. Reactor vessel

The VVER reactor is a pressurized, light-water-cooled and -moderated reactor similar to Western pressurized water reactors (PWRs). There are three predominant models in operation—the VVER-1000 and two versions of the VVER-440.

The VVER-1000 is the largest and newest of the VVERs. This third-generation design produces about 1,000 megawatts of electricity and meets most international safety standards. The VVER-1000 employs safety systems common in Western plants, including emergency core cooling systems and a containment structure. The VVER-1000 can be found at Russia's Balakovo, Kalinin, and Novovoronezh sites; Ukraine's Khmelnytskyy, Rivne, South Ukraine, and Zaporizhzhya sites; and Bulgaria's Kozloduy site.

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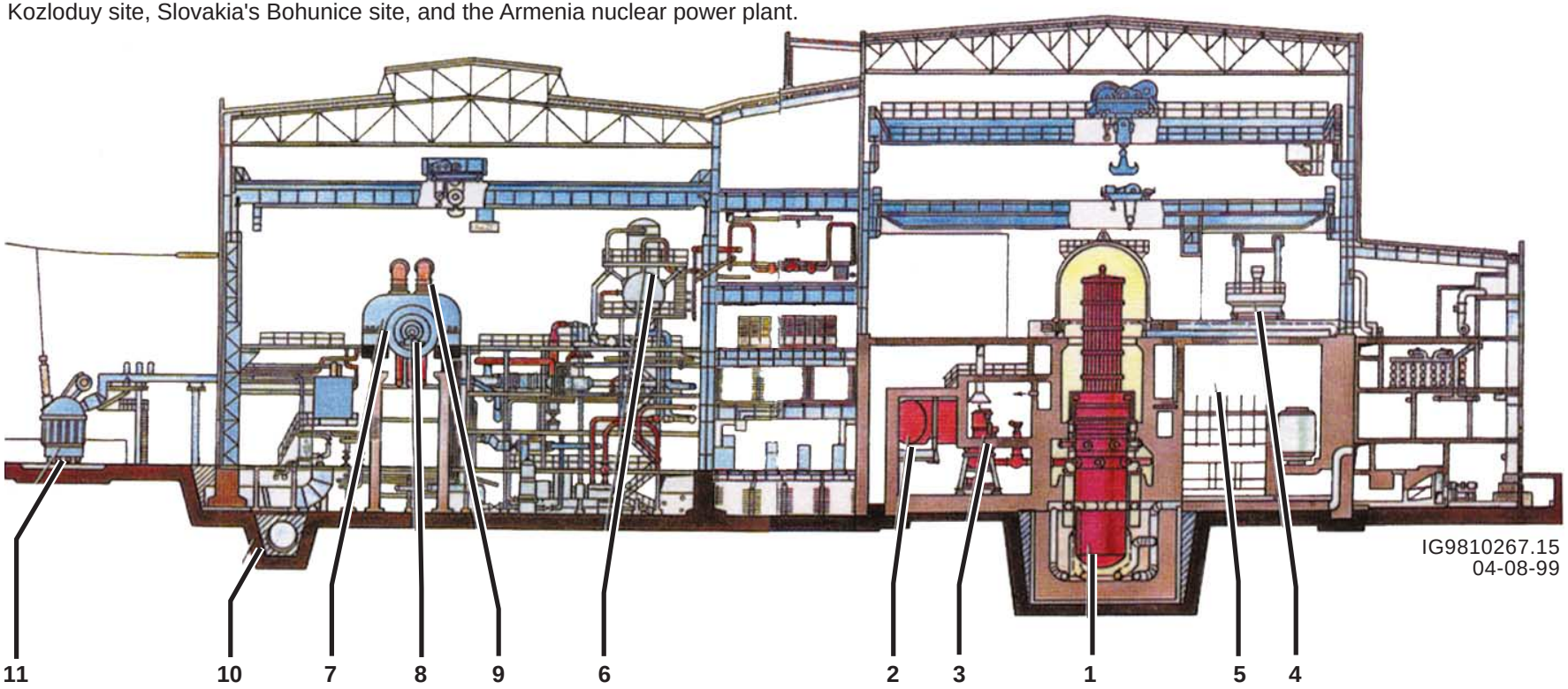
VVER-440/230 Plant Layout

The VVER is a pressurized, light-water-cooled and -moderated reactor similar to Western pressurized water reactors (PWRs). There are three predominant models in operation—the VVER-1000 and two versions of the VVER-440.

The VVER-440/230 was the initial civilian model of the Soviet PWR. It is similar to Western PWRs in that it uses low-enriched uranium oxide fuel, placed in thin metal-clad rods, to generate heat. The fuel rods are cooled by pressurized light water. The steam to run the turbine generator is produced when pressurized, heated water from the reactor is pumped through steam generators where it transfers its heat to a separate secondary coolant.

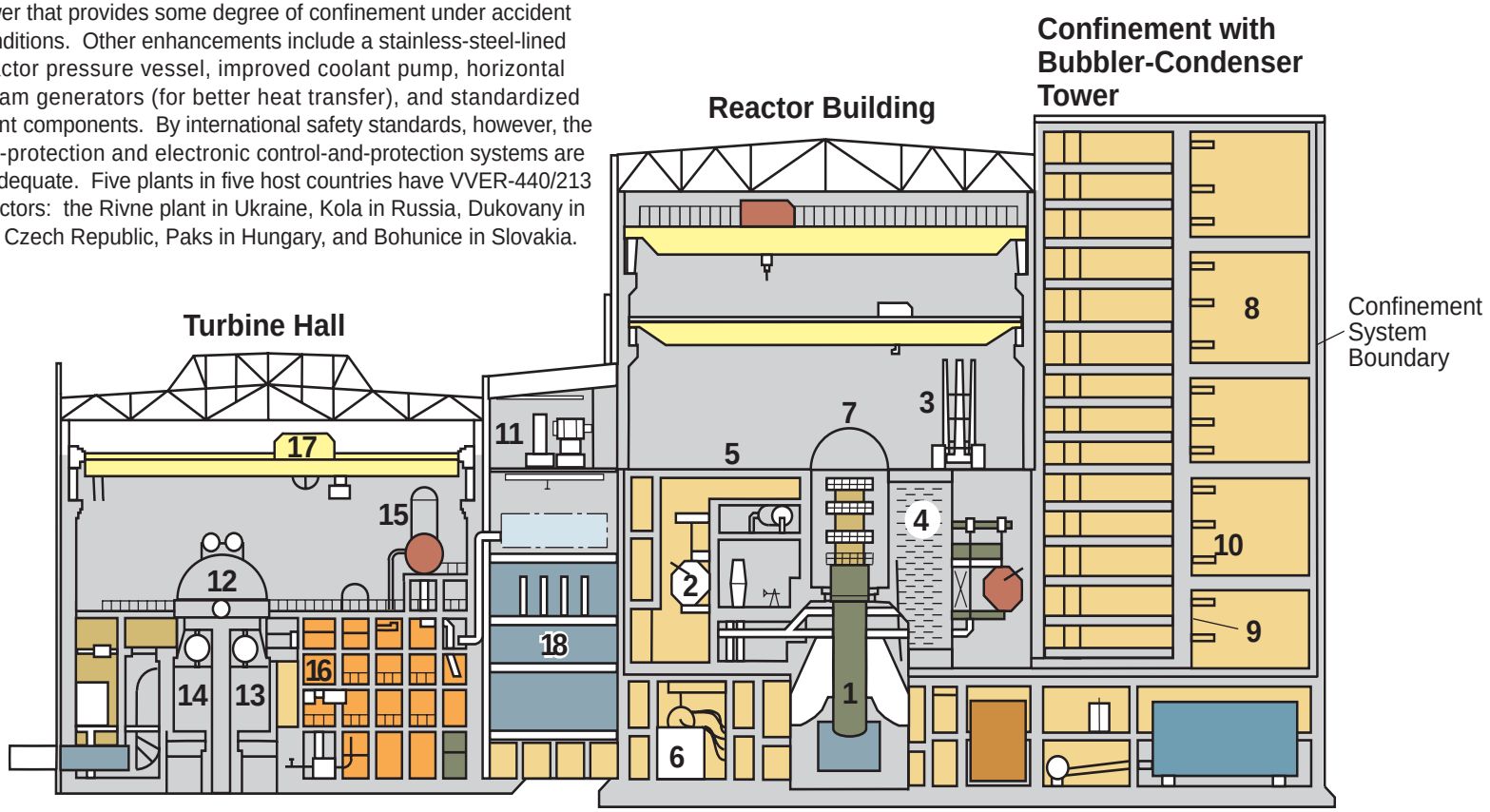
The steam is routed to the turbine generator, which produces about 440 megawatts of electricity. The VVER-440/230, although similar to Western PWRs, lacks a number of safety features, including fire-protection systems, emergency core cooling systems, and a strong containment structure. The 440/230 reactor can be found at Russia's Kola and Novovoronezh sites, Bulgaria's Kozloduy site, Slovakia's Bohunice site, and the Armenia nuclear power plant.

1. Reactor
2. Steam generator
3. Main circulation pump
4. Refueling machine
5. Spent fuel cooling pond
6. Deaerator
7. Steam turbine
8. Generator
9. Steam pipelines
10. Cooling water pipelines
11. Transformer



VVER-440/213 Plant Layout

The VVER-440/213, the second-generation VVER design, operates in the same way as the first-generation 230 model (see page A.3), but its design incorporates a few key features that somewhat increase its level of safety. The enhancements include systems for emergency core cooling and auxiliary feedwater, plus a "bubbler condenser" tower that provides some degree of confinement under accident conditions. Other enhancements include a stainless-steel-lined reactor pressure vessel, improved coolant pump, horizontal steam generators (for better heat transfer), and standardized plant components. By international safety standards, however, the fire-protection and electronic control-and-protection systems are inadequate. Five plants in five host countries have VVER-440/213 reactors: the Rivne plant in Ukraine, Kola in Russia, Dukovany in the Czech Republic, Paks in Hungary, and Bohunice in Slovakia.



1. Reactor pressure vessel
2. Steam generator
3. Refueling machine
4. Spent fuel pit
5. Confinement system
6. Make-up feedwater system
7. Protective cover
8. Confinement system
9. Sparging system
10. Check valves
11. Intake air unit
12. Turbine
13. Condenser
14. Turbine block
15. Feedwater tank with degasifier
16. Preheater
17. Turbine hall crane
18. Electrical instrumentation and control compartments

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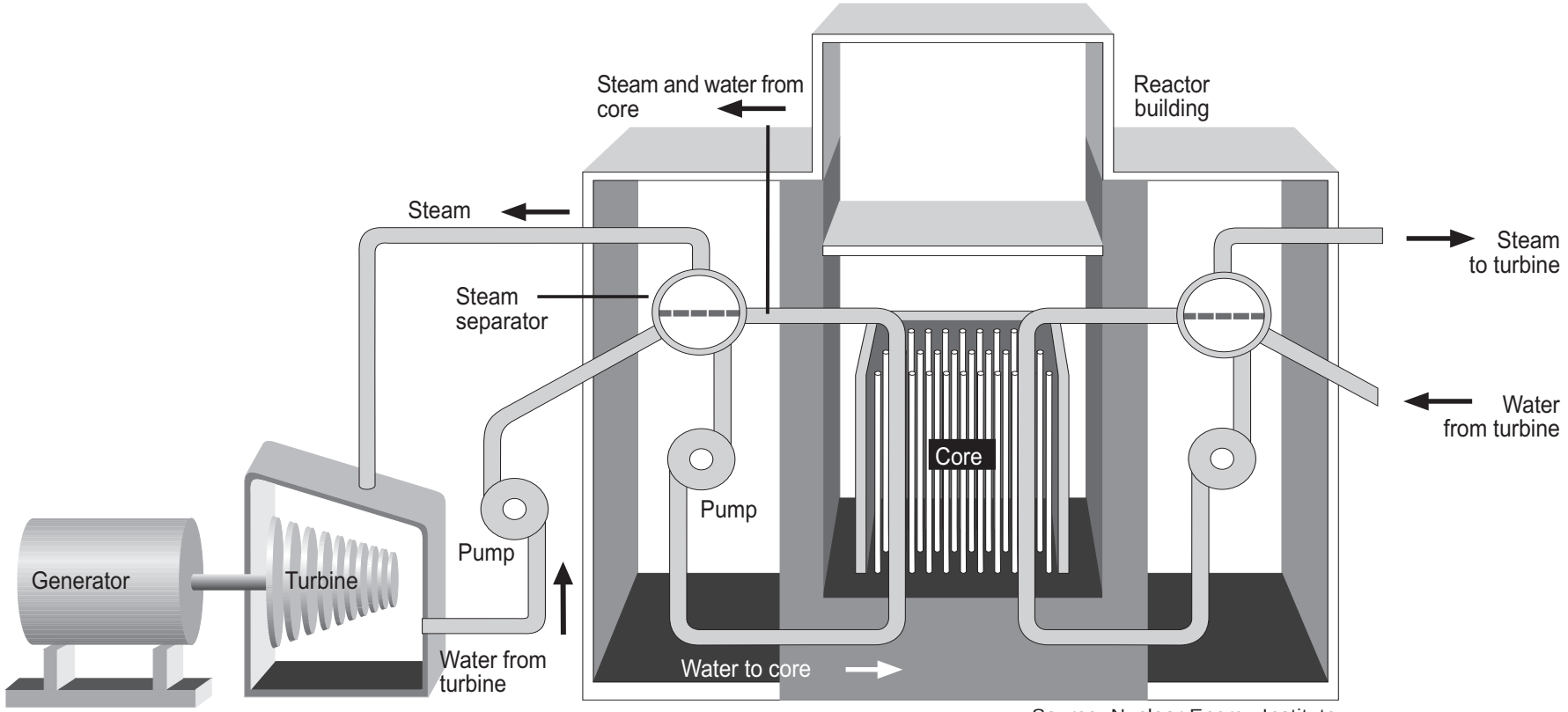
RBMK Reactor Design



Source: Nuclear Energy Institute
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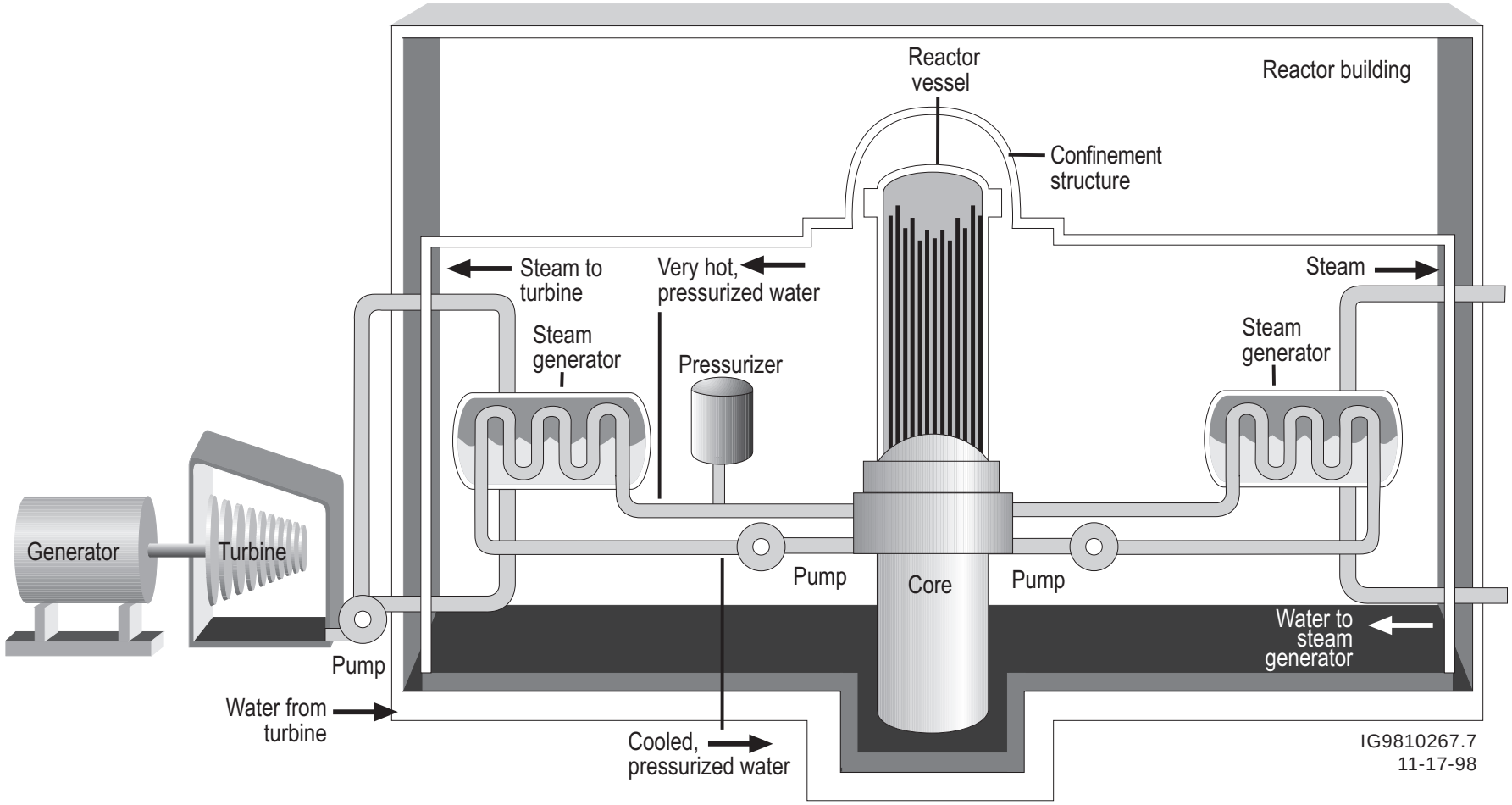
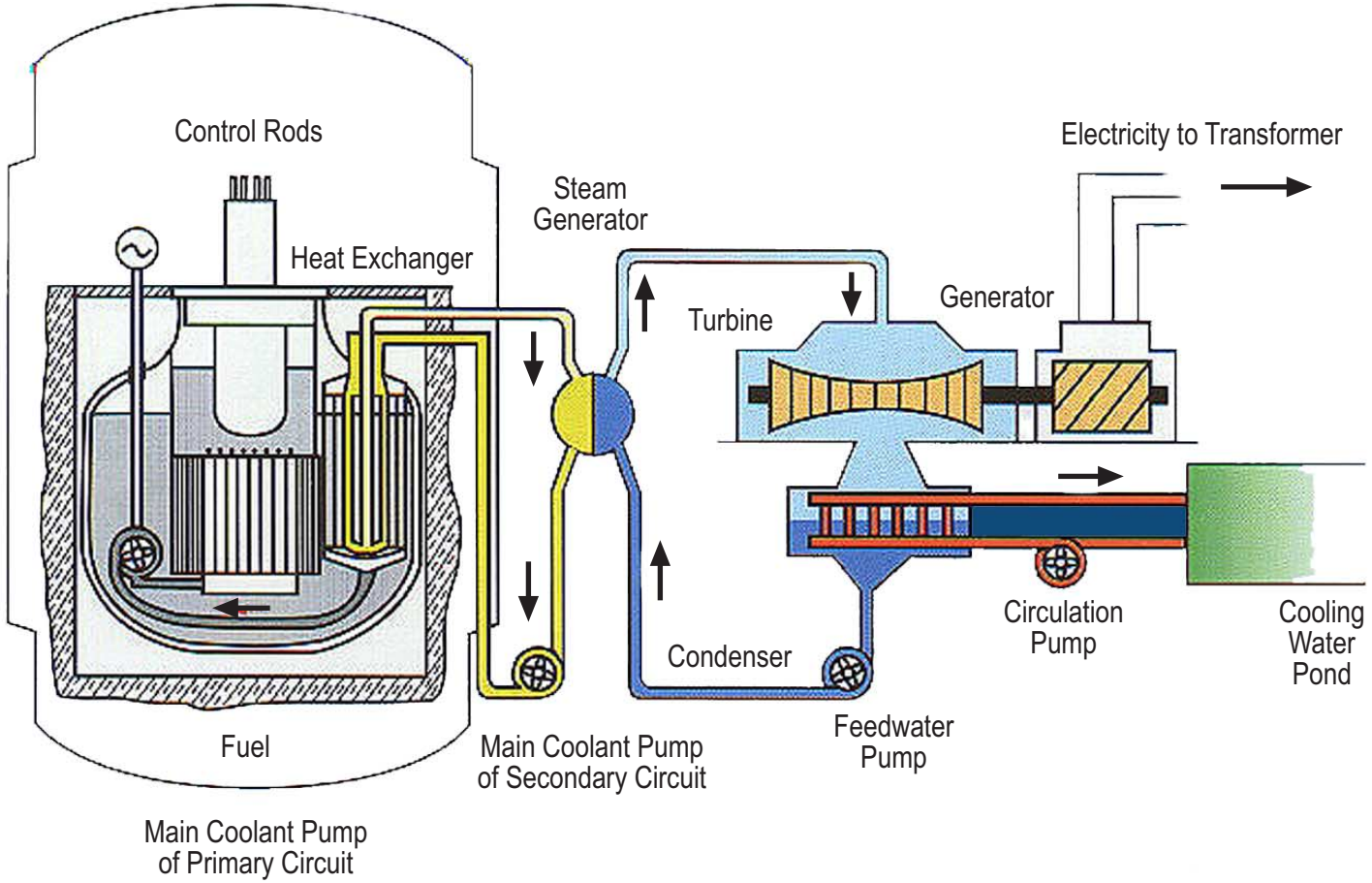
VVER Reactor Design

(VVER-440/230)



BN-600 Reactor Design



Source: Institute of Physics and Power Engineering, Obninsk, Russia

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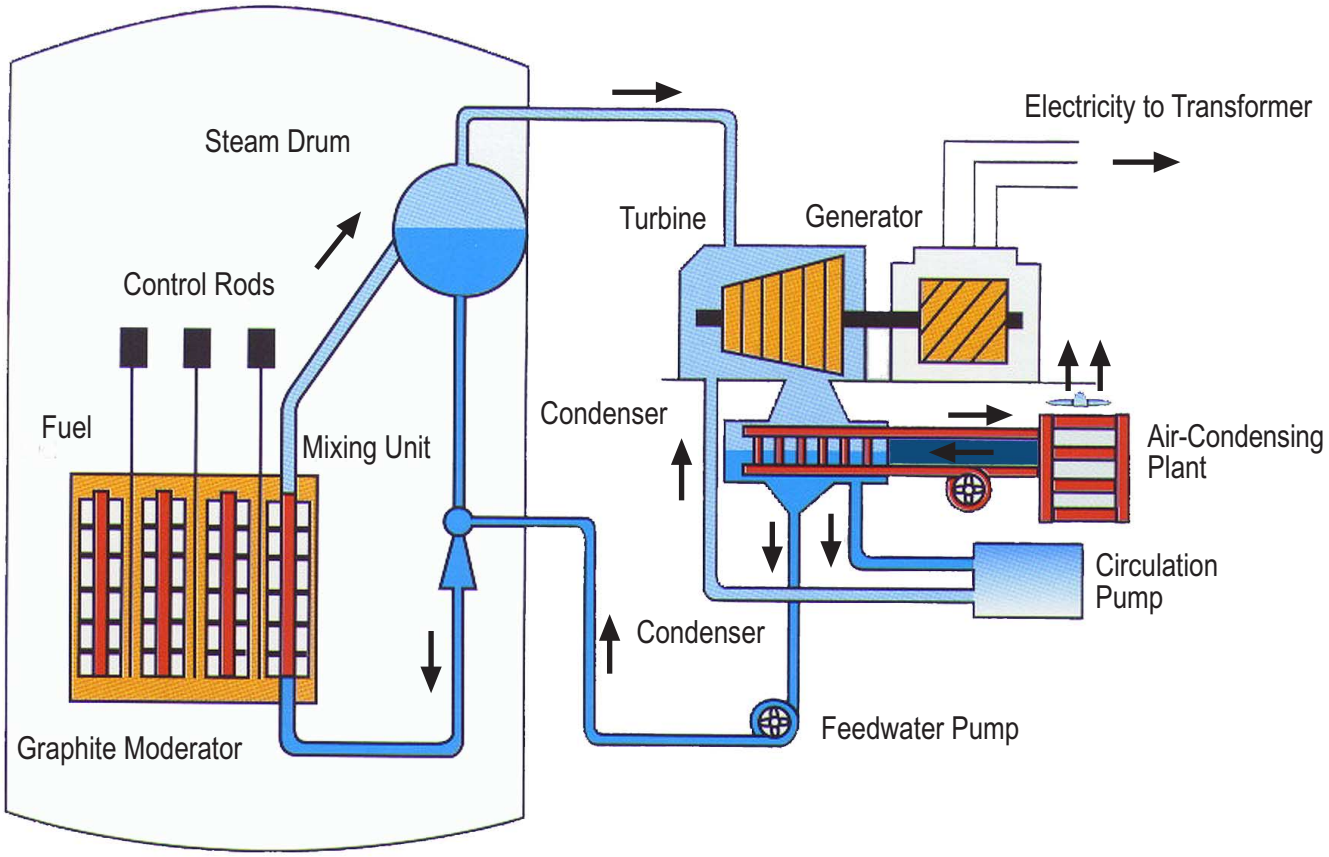
LWGR Reactor Design
(Model EGP-6 Channel-Type)



Source: Institute of Physics and Power Engineering, Obninsk, Russia

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