



# Technology Transfer Produces Long-Term Safety Improvements

The United States is using technology transfer to bring about long-term safety improvements at Soviet-designed reactors, reducing the risk of another Chernobyl-like accident. The reactors are located in nine Eastern European and Asian countries. The host countries are Armenia, Bulgaria, Czech Republic, Hungary, Kazakhstan, Lithuania, Russia, Slovakia and Ukraine.



*Safety parameter display systems provide control room operators with information needed in an emergency. The United States works with host countries to develop and install the systems in Soviet-designed nuclear power plants.*

Technology transfer is not just the delivery of hardware—it is a range of methods to transfer information, procedures, and processes to increase the capabilities of host-country personnel to reduce risks. These methods include

- **information exchange**—Host-country personnel acquire technical know-how through training courses, workshops, and professional meetings.
- **technical collaboration**—U.S. and host-country specialists collaborate to produce safety equipment, conduct analyses, or establish safety procedures.
- **personnel exchange**—Host-country personnel visit or work at a U.S. nuclear power plant, observing technology, procedures, and a safety-oriented culture.
- **capability transfer**—A host-country organization acquires the complete ability to produce an item or perform a safety-related function.
- **licensing**—A host-country company pays a fee to a U.S. firm, acquiring the right to produce and sell nuclear safety materials or equipment.
- **joint venture**—A U.S. firm and a host-country organization create a joint company to produce and sell equipment or provide services to improve nuclear safety.

The technology transfer methods establish an in-country ability to sustain safety improvements and meet ongoing needs. U.S. technology transfer efforts have reached major milestones:

**Safety parameter display systems**—The United States is working with specialists in Russia and Ukraine to develop safety parameter display systems for Soviet-designed nuclear power plants. A safety parameter display system collects and displays critical safety information at a workstation in the control room and other locations in the plant. Information on the status of key conditions, such as reactor core cooling, is displayed in a clear format on a computer screen. The information displayed enables the nuclear power plant operators to assess plant conditions rapidly and take corrective action. The technology is being transferred to Russia and Ukraine so local contractors can design and build the systems.



*Two types of simulators were developed for training purposes at Soviet-designed nuclear power plants—analytical and full-scope simulators. U.S., Ukrainian and Russian organizations are working together to ensure each simulator replicates the configuration and behavior of each reactor.*

**Emergency operating instructions**—Through information exchange and capability transfer, host-country organizations have acquired the ability to write symptom-based emergency operating instructions for their nuclear power plants. Emergency operating instructions specify actions operators must take to stabilize a reactor and mitigate the consequences of an abnormal event. Symptom-based instructions enable operators to take such actions immediately, without first having to determine the cause of a problem. Russia's Novovoronezh plant and Ukraine's Chernobyl plant have been the first Soviet-designed plants to implement symptom-based instructions.

**Control room training simulators**—Through a joint venture, technical collaboration, and capability transfer, Russian and Ukrainian specialists are acquiring the ability to design and produce simulators for training control room operators. U.S. contractor GSE Power Systems, Inc., produced two simulators now operating at Ukraine's Khmelnytsky and Chernobyl plants. As GSE developed the simulators, Ukrainian specialists participated in 12 months of on-the-job training in simulator technology, with follow-up training in simulator use, maintenance, and software. Ukraine has built on this expertise by establishing the Engineering and Technical Center for the training of nuclear industry personnel to develop and maintain control room simulators throughout the country.

**Plant safety assessments**—A range of technology transfer methods supports the plant safety assessments under way at Kola, Kursk, Leningrad and Novovoronezh in Russia and at Khmelnytsky, Rivne, South Ukraine and Zaporizhzhya in Ukraine. In-depth assessments enable managers to determine the most significant risks and set priorities for safety upgrades. The assessments involve the development of computer models of the reactor, followed by complex analyses of reactor operations and emergency scenarios. Capability transfer—the complete ability of host-country specialists to conduct plant safety assessments—is the objective of U.S. efforts. To support this transfer, the United States has conducted training courses and transferred U.S.-developed computer codes.



*Storing spent nuclear fuel in a dry environment significantly reduces costs and environmental risks. The U.S. is providing the information necessary to manufacture, use and monitor dry-cask storage systems, such as this transporter and storage unit.*

**Safety materials and equipment**—Through information exchange, capability transfers, a licensing agreement, and a joint venture, host-country organizations are acquiring the ability to produce and sell nuclear safety materials and equipment.

- **Fire doors.** Personnel from Askenn Concern (a Ukrainian company) and Atomremmash (a Russian company) worked with U.S. specialists to acquire the skills for manufacturing highly effective fire doors for nuclear power plants. The companies have since produced more than 800 fire doors for four plants. In Ukraine, Chornobyl received 250 fire doors and Zaporizhzhya received 125. Smolensk in Russia received 400. The plant in Armenia received 120.
- **Control and protection system modules.** A Lithuanian company has acquired the ability to produce replacement modules for the electronic control-and-protection system at Lithuania's Ignalina plant. The system monitors key reactor conditions and shuts down the reactor if these conditions become abnormal. U.S.-based Scientech and its subsidiary, NUS Instruments, taught personnel at a Lithuanian company (the Center for Electromagnetic Compatibility) to produce the modules.

- **Fire protection and sealant materials.** U.S.-based Promatec has supplied sealants and fire-retardant materials for projects at Russia's Kola and Smolensk plants and Ukraine's Chornobyl plant. Promatec since has licensed a Russian company to sell Promatec products. Fire risks at other nuclear power plants have been reduced as a result of the licensee's success in selling Promatec products to other plants.

**Spent-fuel storage**—To acquire the ability to manufacture, use, and monitor a dry-cask system for storing spent fuel at Ukraine's Zaporizhzhya plant. Ukrainian personnel participated in training, technical collaboration, and capability transfer efforts. The United States transferred U.S.-developed computer codes for storage system calculations to Ukraine's nuclear regulatory agency, the Ministry of Environmental Protection and Nuclear Safety.

**Personnel training centers**—Through information exchange and capability transfer, Russia and Ukraine have established pilot centers for training nuclear personnel. More than 3,000 employees from Soviet-designed reactors have participated in courses at the centers. Host-country instructors now are expanding the training program by teaching instructors at other Soviet-designed plants to develop on-site training courses.

**International Chornobyl Center**—The United States has used information and personnel exchange, technical collaboration, and capability transfer to support Ukraine's establishment of the International Chornobyl Center for Nuclear Safety, Radioactive Waste and Radioecology. The center is spearheading Ukraine's effort to build in-country expertise in safe nuclear power operations. Specialists from the United States and other countries are collaborating with center specialists to conduct technical analyses.

**Regulatory infrastructure**—Through training and the exchange of information on regulatory experience, Russian regulators are increasing their capabilities for effective oversight of nuclear power plants. Regulatory personnel have participated in U.S.-led workshops on quality assurance, safety analysis, inspection techniques, criticality safety, transportation of nuclear materials, and decontamination and decommissioning of nuclear facilities. The United States is providing computer codes to Russian regulators, including MSC/NASTRAN, a safety analysis code, MELCOR, an accident analysis code, and RELAP5, a thermal-hydraulics code.

**International Nuclear Safety Centers**—Personnel exchange and technical collaboration are the foundation for the International Nuclear Safety Centers, established by the United States and Russia in 1996 and 1997. Located in Chicago and Moscow, the corresponding centers have undertaken joint research and technology development projects that focus on nuclear power engineering for nuclear safety.

**Development of safety procedures**—U.S. experts have used information exchange and capability transfer to enable host-country personnel to establish written day-to-day operating procedures, improve their quality assurance programs, develop event reporting and analysis procedures, and initiate configuration management systems.