



Defense in Depth

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What is Defense in Depth?

Defense in Depth is a safety philosophy that guides the design, construction, inspection, operation, and regulation of all nuclear facilities. The central tenet of Defense in Depth is to protect the health and safety of the public and plant workers. Other objectives include protecting the environment and ensuring the operational readiness of the facility. Successful Defense in Depth requires creating, maintaining, and updating multiple independent and redundant layers of protection to compensate for potential human and mechanical failures so that no single layer, no matter how robust, is exclusively relied upon.

How is Defense in Depth Achieved?

Defense in Depth is an on-going approach toward ensuring public health and safety. This approach recognizes that imperfections, failures, and unanticipated events will occur and must be accommodated in the design, operation, and regulation of nuclear facilities. Defense in Depth is implemented through a number of measures, including robust physical barriers, redundant and diverse safety systems, strong physical security, and emergency response readiness.

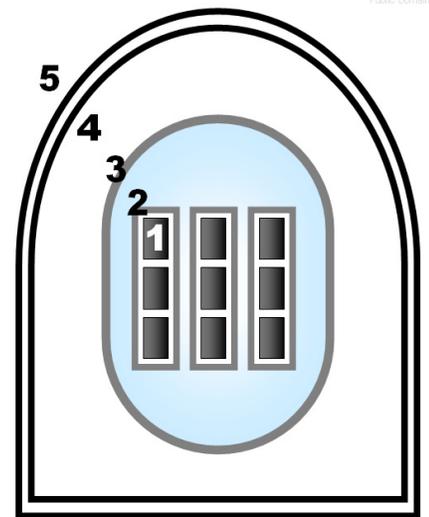
Design and Construction

Defense in Depth requires a high-quality process for the design, procurement, fabrication, construction, inspection, testing, and licensing of a nuclear facility. Federal, state, and local laws regulate every step in this process.

Multiple Barriers

Facility designers include multiple, successive barriers to prevent the release of radioactive material. In nuclear power plants licensed in the U.S., multiple physical barriers are present. The primary barriers are the fuel (1) and cladding (2), which is designed to contain radioactive material under the extreme conditions inside the reactor core. The secondary barrier is the reactor vessel (3), which contains the coolant used to carry away heat for generating electricity. The final barrier is the primary containment building (4,5), which is designed to mitigate the release of radioactive material in the event that *both* the primary and secondary barriers are compromised. The primary containment is designed to withstand the most severe, credible event — either internal or external — for the location of the plant.

Pekka Tormala '16
Public Domain



Multiple barriers

Redundancy and Diversity

Engineered systems that are classified as being important for safety have very robust designs to ensure reliability. Nevertheless, in the event of a component failure, Defense in Depth requires that multiple backup systems are available to replace the safety-related function of the failed component. In addition, backup systems are designed based on different physical principals or mechanisms to limit the possibilities of common-mode failures.

Maintenance and Operations

Facility testing and maintenance procedures are implemented to ensure that each individual system operates to provide its intended function. For safety-related systems, normal plant operations are not permitted unless sufficient backup capabilities are available. In addition to supporting Defense in Depth, proper maintenance and operating procedures help ensure reliable, economic operation of the facility.

Physical Security

Even prior to 9/11, physical security has been an important component of Defense in Depth. A post-9/11 review of physical security emphasized the tightly interconnected nature of facility safety, physical security, and emergency preparedness. Although major changes were not required, enhancements have been made to improve access controls, training requirements, security exercises, and defensive capabilities.

Emergency Preparedness

Emergency preparedness includes communications, sheltering, evacuation, and response plans. Nuclear facilities coordinate with local, state, and Federal authorities to ensure that emergency preparedness plans are well defined and periodically tested through training exercises. Emergency preparedness plans are a licensing requirement for all nuclear facilities regulated by the Nuclear Regulatory Commission.

Additional Resources

Regulatory Overview:

<http://www.nrc.gov/about-nrc/regulatory.html>

Defense in Depth:

<http://www.nrc.gov/reading-rm/basic-ref/glossary/defense-in-depth.html>

<http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2004/s-04-009.pdf>

<http://www.iaea.org/ns/nusafe/tutorial/design/defdep.htm>

http://www-pub.iaea.org/MTCD/publications/PDF/Pub1013e_web.pdf

Emergency Preparedness and Response:

<http://www.nrc.gov/about-nrc/emerg-preparedness.html>