

Human Factors Considerations for Remote and Autonomous Operation of Nuclear Facilities

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Advanced nuclear reactor technologies present new opportunities and new challenges for regulators like the U.S. Nuclear Regulatory Commission (NRC) and the nuclear industry worldwide. Novel approaches to the conduct of operations are anticipated, including remotely operated facilities and increased reliance on automated operations for safety significant plant functions. The operation of first-of-a-kind technologies can be challenging due to a lack of operating experience and potential for significant changes to traditional operational concepts. As part of this research effort, we seek to gather research findings and lessons from experience in other high-risk domains that may serve as surrogates for similar concepts anticipated in nuclear (e.g., oil and gas, maritime, aviation, and aerospace). Key enablers for remote operation in surrogate industries are high levels of automation and alarm filtering. The diversity in advanced reactor technologies is reflected in many design and operational characteristics. Examples include greater reliance on simpler designs, involving fewer systems and moving parts, and design features that make them inherently safe, such as natural physical processes (e.g., gravity is an example of passive safety) that do not require automatic or human intervention. Some may rely on much higher levels of automation, including potentially a fully autonomous mode, and may not require much, if any, human monitoring, control, and intervention, and some may not have a control room in the traditional sense. Reactor monitoring and control may be accomplished from simple panels either locally or remotely. The role and responsibilities for personnel and automation are also expected to vary greatly in the next generation of reactors based on the use of automation and incorporation of passive safety features and inherent safety characteristics. Changes to the role of the human through increased automation and use of multi-unit, remote operational concepts introduce human factors complexities including those related to the role of operator, situation awareness, workload, response time, communication, teamwork, and vigilance.