



ARGONNE-TRAINED ARTIFICIAL INTELLIGENCE PREDICTS AND FIXES CRITICAL PROBLEM IN U.S. NUCLEAR PLANTS

THE CHALLENGE

Boiling water reactors in U.S. nuclear plants were originally designed to handle a level of moisture carryover (MCO) that allowed for the stable, cost-effective delivery of peaceful nuclear energy. However, changes in plant operations and new efficiencies in nuclear core design have led to increased levels of MCO that can damage turbines and elevate radiation exposure to on-site personnel.

To address this problem, plant operators need to understand the conditions that contribute to MCO.

Artificial intelligence (AI) and machine learning open the door for scientists from the U.S. Department of Energy’s Argonne National Laboratory to predict equipment performance and to run virtual scenarios without raising radiation exposure risk or expending expensive, high-value components. This captures digitally how early, undetectable microstructural wear-and-tear, or an upset event, might affect a specific physical power grid. The models can then build in predictable

maintenance schedules to help plant operators avoid later, larger problems.

THE INNOVATION

Partnering with Exelon (Chicago), the largest regulated electric utility in the U.S., Argonne scientists built a neural-network-based model for predicting MCO using existing data from operational plants—namely, nine years’ worth of MCO values graphed against corresponding exposure levels to personnel—and preliminary features related to nuclear fuel loading and flow selected through physics and engineering analyses.

The team programmed a computer to learn mapping between controllable process variables and MCO. Argonne’s scientists were able to predict when plant operators should preventatively fix MCO problems.

Argonne’s work provides the framework for Exelon to design an “app” for use by fuels managers and plant operations personnel to better manage MCO during a power generation cycle at stations in Illinois, New York and Pennsylvania.

THE IMPACT

- Using AI to understand and refine highly complex boiling-water-reactor plant operations paves the way for U.S. nuclear plant managers to improve plant operating efficiencies without compromising employee health.
- Argonne’s computer models make potential failures in processes and incremental damage of parts more apparent, predictable, and most importantly, fixable.
- With focused early attention to virtual problems before they occur in the real world, the U.S. energy sector is more competitively positioned to maximize the value of nuclear energy.

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