ENGINEERING SOLUTIONS BY GE-HITACHI

GEORGE DEPTA
Senior Services Project Manager
GE HITACHI NUCLEAR ENERGY

DOMINGO G. CÁRDENAS
Senior Nuclear Site Manager
GE Hitachi Nuclear Energy

Years ago, the "Nuclear Promise", coordinated by the Nuclear Energy Institute (NEI), was launched to continue safe generation of electricity more efficiently and economically. As part of the initiative, the industry is encouraged to analyze cost drivers common to all nuclear power plants and recommend programs and processes to improve their efficiency and effectiveness. The goal is to provide companies with innovative solutions that enable a significant reduction in operating expenses. Today, the competition among the different sources of electricity generation is tougher than ever, so those efforts still make a lot of sense.
To facilitate an efficient operation and maintenance of the fleet, Engineering and Technology solutions are key contributors. Finding the right balance between quality and economy requires a decisive, purposeful march towards constant improvement; something our industry knows well. GE-Hitachi technology strengths have led us to create several solutions that provide targeted reductions in operation and maintenance costs.
What follows are two examples of recently executed solutions in boiling water reactors.

EXECUTION OF EMERGENT UNDER VESSEL REPAIR

In 2016, a U.S. nuclear utility shut down one of its boiling water reactors (BWR) due to unidentified drywell leakage. Most of the leakage was related to a recirculation pump leak and one small control rod drive (CRD) O-ring leak. However, a local power range monitor (LPRM) in-core monitor housing (ICMH) leak was also identified. This leak was not coming from the flange, but from a location several inches above the ICMH flange in the heat affected zone of the weld (see Figure 1). GE Hitachi Nuclear Energy (GEH) was engaged and within three days submitted a proposal for implementing a repair.

Several teams were immediately mobilized to solve this customer's critical and time-sensitive problem. These teams had expertise in engineering analysis, fracture mechanics and Instrumentation & Controls. The work location was under vessel, several inches above the LPRM flange location which made access significantly limited and in a high dose rate area (See Figure 2). GEH performed the exchange of the leaky O-ring and with support from its welding partner, performed the weld overlay.

This emergent project was all completed during a non-scheduled outage for the customer and all activities were on critical path to re-start the reactor for reconnection to the grid. The financial cost of lost generation from untimely delays could have been significant. The repair was completed with the LPRM in-place, so no reactor disassembly was required. GEH had delivered a very significant first-of-a-kind repair in two weeks to a customer with significant need to generate electricity.

DEVELOPMENT OF SOFTWARE TO ADDRESS BWR MOISTURE CARRYOVER PROBLEM

Boiling water reactors (BWR) were originally designed with significant operational margins. Over time, advanced core and fuel designs, better understanding of operational safety margins through improved analysis techniques and operating strategies have improved plant performance. However, some BWR operators have observed an increase in moisture carry-over (MCO) in the steam lines. Although the BWRs are operating

SOLUCIONES DE INGENIERÍA GE HITACHI

En los últimos años, la "Promesa Nuclear" coordinada por el Instituto de Energía Nuclear (NEI), se lanzó para alcanzar una generación eléctrica de forma segura, eficiente y más económica. Como parte de la iniciativa, se animó a la industria nuclear a analizar los gastos comunes de toda su flota y así recomendar programas y procesos para la mejora de la eficiencia y efectividad de las mismas.
El objetivo de GE Hitachi es proporcionar a las empresas del sector una serie de soluciones innovadoras que permitan una reducción significativa de sus gastos de operación. Hoy en día, la competencia entre las diferentes fuentes de generación de electricidad es más dura que nunca, por lo que este esfuerzo tienen aún más sentido. Es por ello, que para facilitar una operación eficiente y un correcto mantenimiento de la Planta, las soluciones en Ingeniería y Tecnología son unos contribuyentes claves. Encontrar el equilibrio adecuado entre calidad e inversión requiere una marcha progresiva y decidida hacia la mejora constante; algo que nuestra industria conoce muy bien.
GE Hitachi con su tecnología ofrece varias soluciones únicas en el mercado las cuales proporcionan reducciones en los costes de operación y mantenimiento de las centrales nucleares. Recientemente se han implementado dos soluciones en reactores de agua en ebullición: Una reparación emergente en los In-Core Monitor Housings de vasija, y por otro lado el desarrollo de software pionero en la industria para abordar los problemas de arrastre de humedad en los reactores de agua en ebullición.

Figure 1. Location of the ICMH leak.

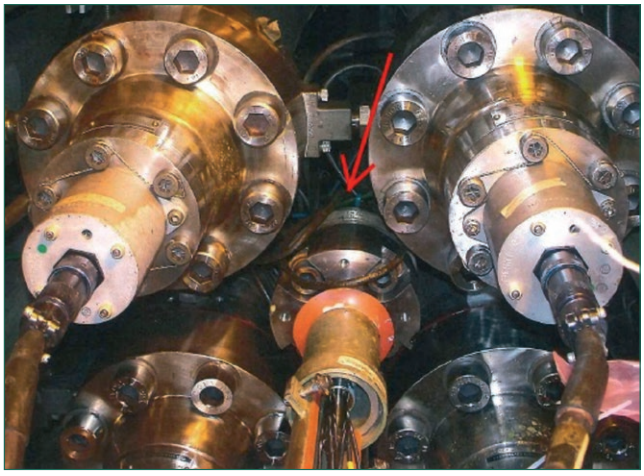

Figure 2. Location of where the work was performed.

safely at these new conditions, the increased MCO has resulted in increased radiation levels in the balance of plant (BOP) and the potential for long-term degradation of the steam turbine components.

In 2009, there was a growing BWR fleet concern that economic incentives to reduce fuel cycle batch size were not fully considering plant radiological ALARA (as low as reasonably achievable) issues. In this regard, several utilities experiencing increased radiation levels were seeking improved analysis tools to optimize the core design with the goal of minimizing MCO and the impact on BOP radiation levels and turbine performance.

In one specific case, a U.S utility fleet operator requested bids from their fuel vendors to develop an analysis tool that can relate increases in BOP radiation levels to core performance metrics. Industry fuel vendors, including GE Hitachi Nuclear Energy (GEH) set out on independent paths to develop such a tool. Through a rapid response program, a GEH design team made significant progress and provided a demonstration of the new tool to the customer in just five months following project kick-off.

The new analysis tool, BWRCO0XP software or simply the "MCO Tool," was part of an effort to expand GEH services to meet changing customer requirements as the performance of the BWR fleet improves or changes with new operating requirements. The tool provides a method to predict MCO trends, which allows customers to take measures to prevent turbine degradation and mitigate radioactivity levels in the BOP. The tool can be used as part of a surveillance program to monitor the MCO and anticipate MCO trends prior to performing control rod maneuvers. The MCO Tool can also be used during the design process to evaluate the impact of different core designs on MCO as part of the design optimization process. Reduction in MCO is designed to reduce unnecessary wear on the turbine and transported radioactivity to the BOP, including both the turbine building and other areas generally considered radioactive hot spots. This reduction in radioactivity throughout the plant allows for lower dose accumulation during normal operation and refueling outages.

Software Features

- Incorporates both conservative (design-basis) and best-estimate (plant performance) modeling.
- Executed via a user-friendly Graphical User Interface (GUI) (Figure 1).
- Designed to run in both single analysis and batch mode operations.
- Streamlined prediction capability by incorporating multiple BWR Core Simulator outputs.
- Comprehensive User's Manual and 24/7 customer support.

Key Benefits

- Total transported source term reduced as compared to previous cycles.
- Co-60 carryover reduced relative to previous cycles.
- Total accumulated outage dose reduction due to reduced source term.
- Downstream equipment degradation reduced.
- Core configuration personnel can present a modified core design considering the potential of MCO impact.■

Figure 3. MCO Tool Graphical User Interface.