

# Core Protection Calculator System

## Background

The Core Protection Calculator System (CPCS) is the first implementation of digital computers in a nuclear power plant safety protection system. The system is based on first principles to calculate the important safety parameters online so that the plant is within the specified acceptable fuel design limit (SAFDL). This approach provides the theoretical optimum safety margin.

## Description

The objective of the CPCS is to initiate a reactor trip when required, so that SAFDL is not violated during any conditions of normal operation, nor as a consequence of an anticipated operational occurrence. The fuel design limits for the CPCS are:

- The departure from nucleate boiling ratio (DNBR) in the limiting coolant channel in the core shall be maintained so that DNB is avoided.
- The peak linear heat rate in the limiting fuel pin in the core shall be maintained so that centerline fuel melting is avoided.

## Benefits

The CPCS established the groundwork for implementing digital computers in the safety protection system in a nuclear power plant. The benefits of the CPCS are:

- **Margin Gain.** The CPCS initiates reactor trip when required, so that SAFDL will not be violated during any conditions of normal operation, nor as a consequence of an anticipated operational occurrence. CPCS provides significant margin gain in calculating the fuel design limits online, thus the ability to increase plant output power.
- **Software Flexibility.** Adding a trip function in the software is more cost effective than implementing it with hardware.
- **Licensed System.** The operating history of the CPCS establishes the procedures to change the algorithms, software and hardware that had been reviewed and approved by the U.S. Nuclear Regulatory Commission (NRC). The Common Q™ platform passed the NRC Standard Review Plan review criteria. The software life cycle process was also approved by the NRC.
- **Computer Technology.** The Common Q CPCS includes self-diagnostics of all major hardware components provided by the new computer technology. Many pages of CPCS status information, alarm history and failure conditions are available on display or archive.

- Research and Development. Westinghouse's R&D program gains additional margin with CPCS by calculating the core power more accurately with incore detectors. This enhances the availability of the plant during most design basis events with reactor power cutback feature.

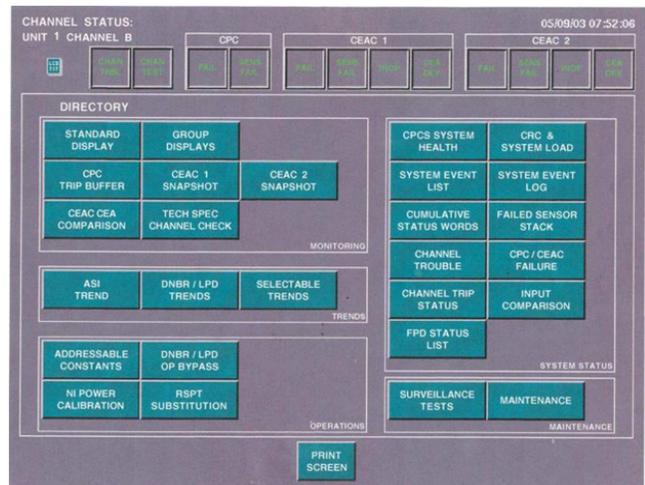
## Experience

The first-of-its-kind system was installed in a nuclear power plant in the United States in 1980. Extensive efforts were made by Combustion Engineering\* and NRC staff to gain licensing approval of the CPCS.

Based on accumulated operating experience, numerous improvements have been made to enhance the performance of the CPCS. The CPCS software provides the flexibility to readily accommodate these design changes. As of 2012, CPCS is implemented in 23 nuclear power plants in operation or under construction in the United States and Asia.



Four-channel core protection calculator system and input/output simulator



Operator module directory page

\* Combustion Engineering Nuclear Power Division was acquired by ABB and subsequently integrated into Westinghouse Electric Company LLC in 2000.

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