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# Technology to Prevent Reactor Trip in the Event of a 12 Finger CEA Drop

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**A technology to prevent accidental reactor trip in the event of a 12 finger CEA drop during normal operation in OPR1000 and APR1400 nuclear power plants.**

## Description

### ● Background

- During normal operations, several trips have occurred in domestic OPR1000 plants by false signals or actual drops of 12 finger CEA
- Sudden transient state occurs by reactor trip during normal operation
- Since return to normal operation takes long time once the reactor is tripped, the rate of plant operation significantly drops

### ● Purpose and Necessity

- To prevent accidental reactor trip that may be caused by CPCS when a single 12 CEA drops
- To improve plant safety and utilization by preventing accidental reactor trips by CPCS

### ● Principle

- Development of two methodologies for preventing reactor trip
- Methodology 1 : CPCS penalty factor elimination and power reduction
- Methodology 2 : Power reduction by Reactor Power Cutback System(RPCS) actuation

< Reactor behavior due to CEA deviation>

| Deviation type | Classification | CPCS Algorithm | Results |
|---|---|---|---|
| Single CEA insertion deviation in a subgroup | Actual deviation of a 12 finger CEA | Impose about 30% penalty factor | If reactor is operating at more than 80% power, reactor will be tripped |
| | Deviation of a 12 finger CEA by false signal | Impose about 30% penalty factor after 7 seconds of time delay | If reactor is operating at more than 80% power, reactor will be tripped after 7 seconds |
| | Deviation of a 4 finger CEA (Actual or false signal) | No CPCS penalty factor (Always impose about 18% penalty factor on COLSS POL) | No reactor trip |
| Single CEA withdrawal deviation in a subgroup | N/A | Impose about 800% penalty factor (including 12 CEA, 4CEA and Part Strength CEA) | Reactor will be tripped regardless of power level |
| Multiple CEA deviation in a subgroup | 2 CEAs drop or subgroup drop | Impose about 800% penalty factor (including 12 CEA, 4CEA and Part Strength CEA) | Reactor will be tripped regardless of power level |

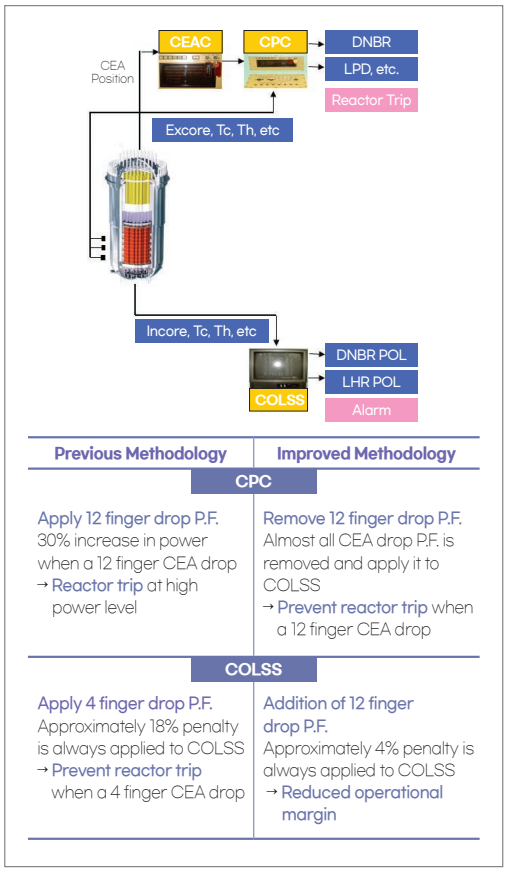
< Methodology 1 >

**Principle of the technology**

- Removes CPCS penalty factor
- Transfers penalty factor to COLSS ROPM
- Turbine runback operation : stable at 80% power level

**Scope of application**

- Applicable to CPCS hardware platforms (Legacy & Common-Q) for OPR1000/APR1400



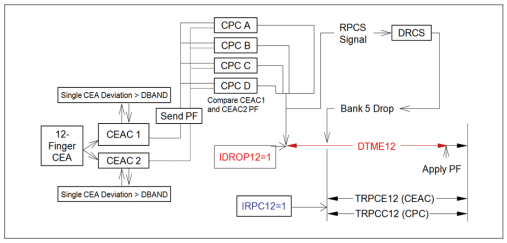

< Methodology 2 >

**Principle of the technology**

- Applies CEA drop penalty factor after a certain time delay in case of a 12 finger CEA drop
- RPCS actuation(BK5 free drop) when a 12 finger CEA drop; stable at 50% power level

**Scope of application**

- Applicable to RCOPS hardware platforms
- Application of other CPCS platforms (Legacy & Common-Q) needs further review




## Distinctiveness

### ● Characteristics

- **Methodology 1**
  - COLSS operating margin is expected to be reduced, but it does not affect normal operation of plants as it takes advantage of the improved thermal margin of PLUS7 fuel
  - Reactor core is stabilized at high-power level(near 80% power level), making it easier to return to the normal operation
  - There are practical applications already applied to OPR1000 plants that prevented the reactor shutdown when a 12 finger CEA dropped, thus the technology has been proven to be sufficient, and it improved the plant utilization

- **Methodology 2**
  - CPCS penalty factor is applied in case of the drop of a 12 finger CEA
  - No loss of thermal margin

### ● Benefits

- Economic benefit from improving the utilization for the period required for recovery from shutdown to normal operation of the plants
- Improve safety by preventing core transient situations caused by sudden trip of the reactor

## Experience

- This technology was applied to all of OPR1000 plants operating in Korea and will be applied to domestic APR1400(SKN 3&4) plants
- Power plants under construction are undergoing design process to apply the technology

## Deliverables

- Technical service

**Technology Readiness Level (TRL)**

Actual system proven through operation

**Business Model**

Technology Transfer
Licensing
Joint Search
Service Execution
Others