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ENG-03

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

SAFETY
ANALYSIS
DEPT.

HaeNam Yang
T. 042-869-3739
E. hnyang
@knfc.co.kr

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.

* 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

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

< Methodology 1 >

Principle of the technology

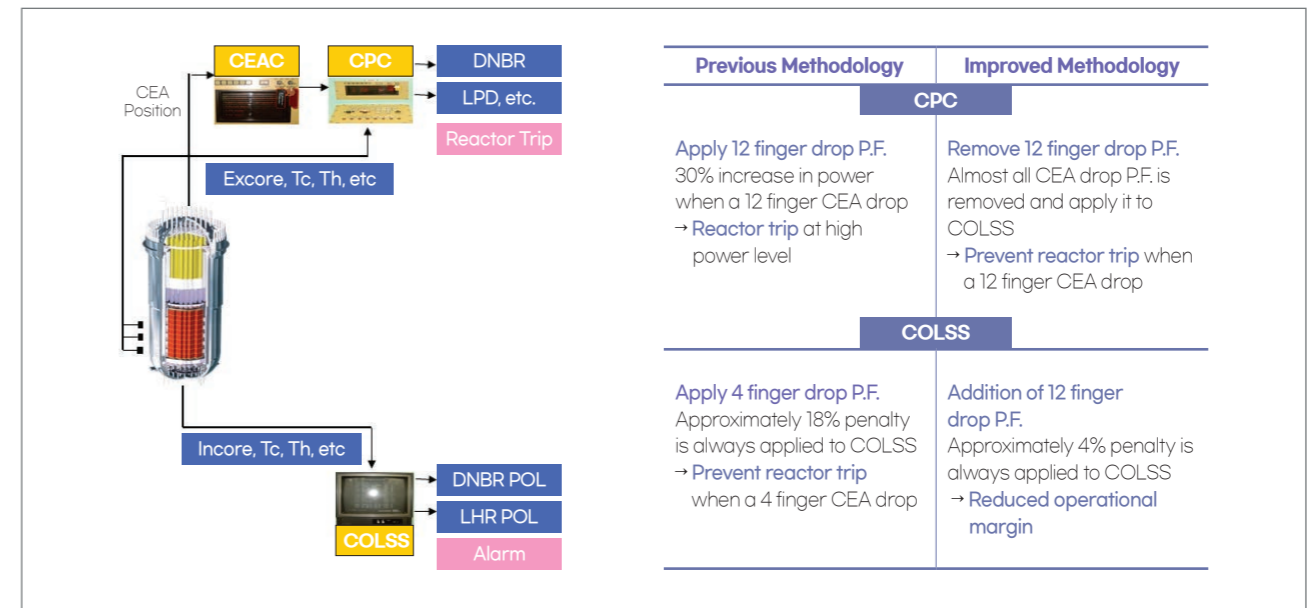
- Removes CPCS penalty factor
- Transfers penalty factor to COLSS ROM
- Turbine runback operation : stable at 80% power level

Scope of application

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

< 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



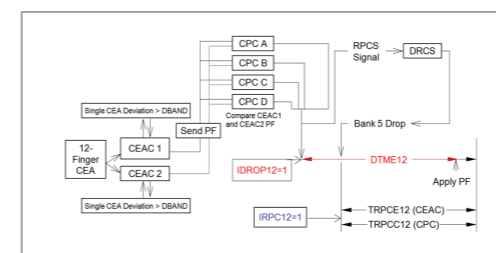
< Methodology 2 >

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



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

TECHNOLOGY READINESS LEVEL(TRL)

- Actual system proven through operation

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

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

BUSINESS MODEL

Technology Transfer

Licensing

Joint search

Service Execution

Others