

Integrated Coping Strategies for Beyond-Design-Basis External Events

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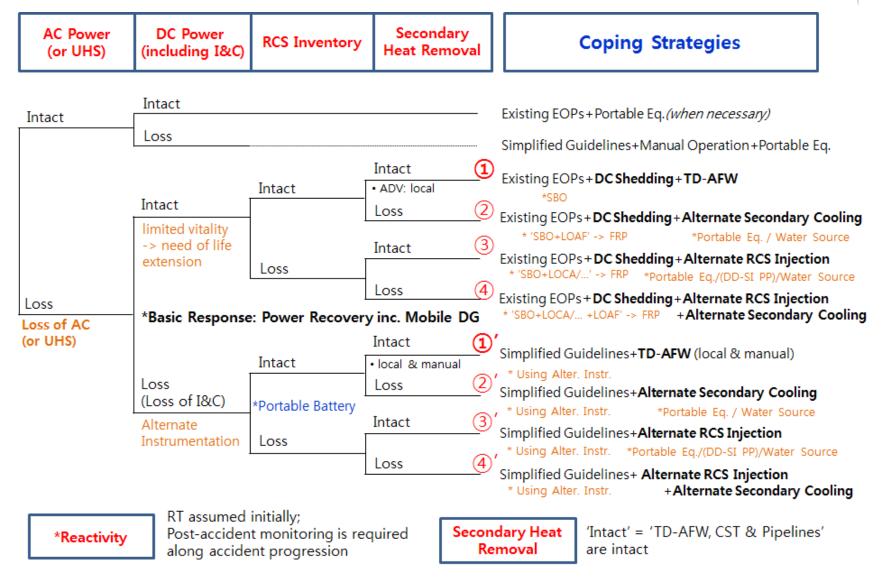
- Introduction
- The iROCS Approach for BDBEEs
  - iROCS: integrated, RObust Coping Strategies
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# Damage Conditions by the Earthquake and Tsunami at the Fukushima Daiichi

- Loss of Off-site Power (by the Earthquake)
- Loss of On-site Power
- Loss of Batteries
- Loss of Seawater Intake (Loss of Access to Ultimate Heat Sink)
  - Loss of Core Cooling
  - Core Uncovery, Fuel Melt, Hydrogen Generation
  - Hydrogen Explosion
  - Vessel/Containment Failure
  - Release of Fission Products



## Damage Conditions and Coping Strategies



#### iROCS' Coping Strategy for Damage KAERI Condition (1) and (2) \* Coping Strategy for Condition (1)\* Coping Strategy for Condition (2) EOP/ **FRP-01** SBO **Power Recovery inc. Mobile DGs Feedwater Makeup using Portable** Failure of 'TD-AFW' **RCS Cooling using TD-AFW Equipment or Fire Protection System;** (e.g., CST rupture, Crew fail.) - ADV: Local & Manual control Supply of External Water Source (e.g., (\*Communication needs for improvement) Pond or Seawater) \*Required Time: ~ 2hr or more -> Shedding of Unnecessary DCs SAMG Entry Condition (CET>650°C) SCDAP/RELAP5 MELCOR/MAAP CST Makeup (from demi. water/raw water \*Time to VF from CD: 30min ~ 2hr /fire protection water/or seawater) \*Time to VF from IE: 2hr ~ 4hr - MCR/Local Operation for Makeup - Communication Tool \*Delay in RCS Depressurization & **Injection -> Vessel Failure RCS Makeup** Using H.P. Portable Pump **Preparing RCS Injection at** (from RWST) **TD-AFW Failure** - Local/MCR Operation for Makeup - Communication Tool **RCS Depressurization** SAMG Entry + Need for dedicated equipment for RCS depressurization \*Ref. FLFX in US **RCS Injection using Portable Equip. CTMT Injection** (\*External Injection/Spray)



## 'Available Time vs. Required Time' under Early Failure of TD-AFW

#### Available Time from Accident Analysis Codes for SBO under TD-AFW Failure

	SCDAP/ RELAP5	MELCOR	MAAP5
Rx Trip	0	0	0
Core Uncovery	6,580 sec (1.8 hr)	6,556 sec (1.8 hr)	6,870 sec (1.9 hr)
Rx Vessel Failure	8,570 sec (2.3 hr)	15,237 sec (4.2 hr)	13,300 sec (3.6 hr)
Time from CU to RVF	0.5 hr	2.4 hr	1.7 hr

#### Required Time to Deploy Portable Equipment:

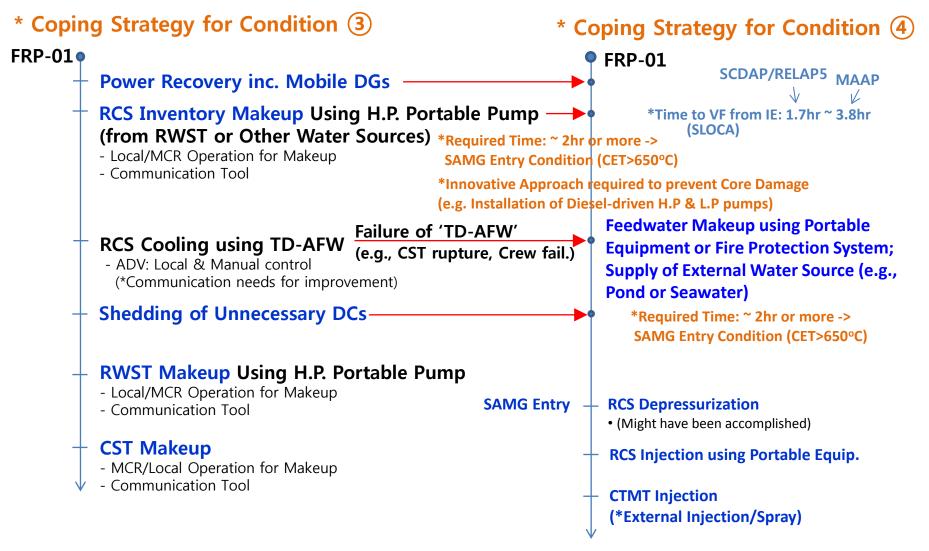
 2hr or more (depends on degree of plant damage)

Failure to maintain Reactor Vessel Integrity, If RCS Depressurization and Injection Strategy is to be Initiated after SAMG Entry Condition is met

Ref. SAMG Entry Condition (CET > 650°C)

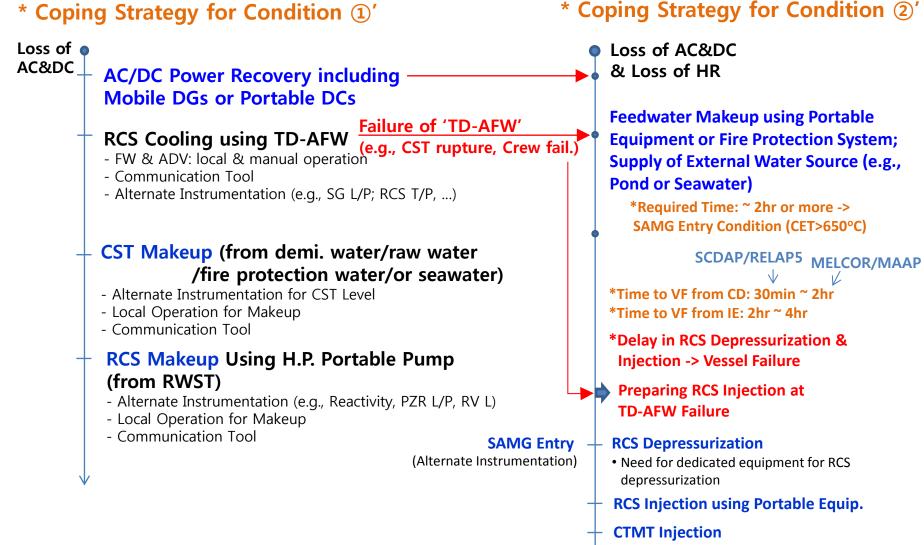
## iROCS' Coping Strategy for Damage Condition ③ and ④

KAERI



## iROCS' Coping Strategy for Damage Condition 1' and 2'





(\*External Injection/Spray)



# **Concluding Remarks**

- **iROCS**: **i**ntegrated, **RO**bust **C**oping **S**trategies
  - Possible Plant Damage Conditions
  - Integrative Use of EOP and SAMG
  - Robust Strategies Required
- Verification and Validation of **iROCS** will be further pursued.