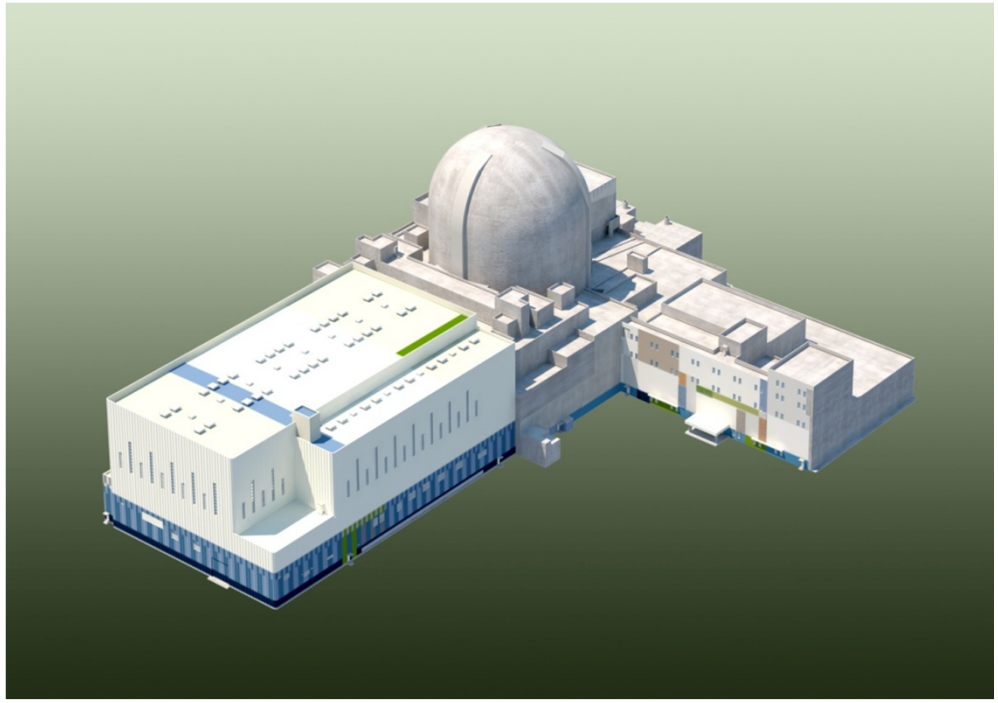
NON-PROPRIETARY

Loop Seal Reformation for APR1400



KEPCO/KHNP

OCTOBER 12, 2016

Public Meeting

Contents

- Introduction
- CEFLASH-4AS Calculation
- PARCH/EM Evaluation
- Differences
- Conclusion

Introduction

Introduction

- **Background and Relevant RAI**
  - ✓ Loop Seal Reformation due to ECCS injection during the long term cooling phase of a LOCA can cause suppression of the two-phase mixture level in the reactor core.
  - ✓ If this level drops below the top of the active fuel, cladding heatup and oxidation can occur.
  - ✓ NRC RAI 8092 requires the PCT caused by Loop Seal Reformation should be below 800℉ in the APR1400 plants.
  - ✓ In the previous NRC Public meeting, NRC asked for the results of Loop Seal Reformation calculation using CENPD SBLOCA methodology.
  - ✓ KHNP performed the sensitivity study and break spectrum calculation using CENPD SBLOCA methodology.

Introduction

- **Loop Seal Reformation Calculation Procedure**

1. CEFLASH-4AS Conservative Base Input Preparation
   - Calculation End Time: [ ]TS,(a,c) sec
   - [ ]TS,(a,c)

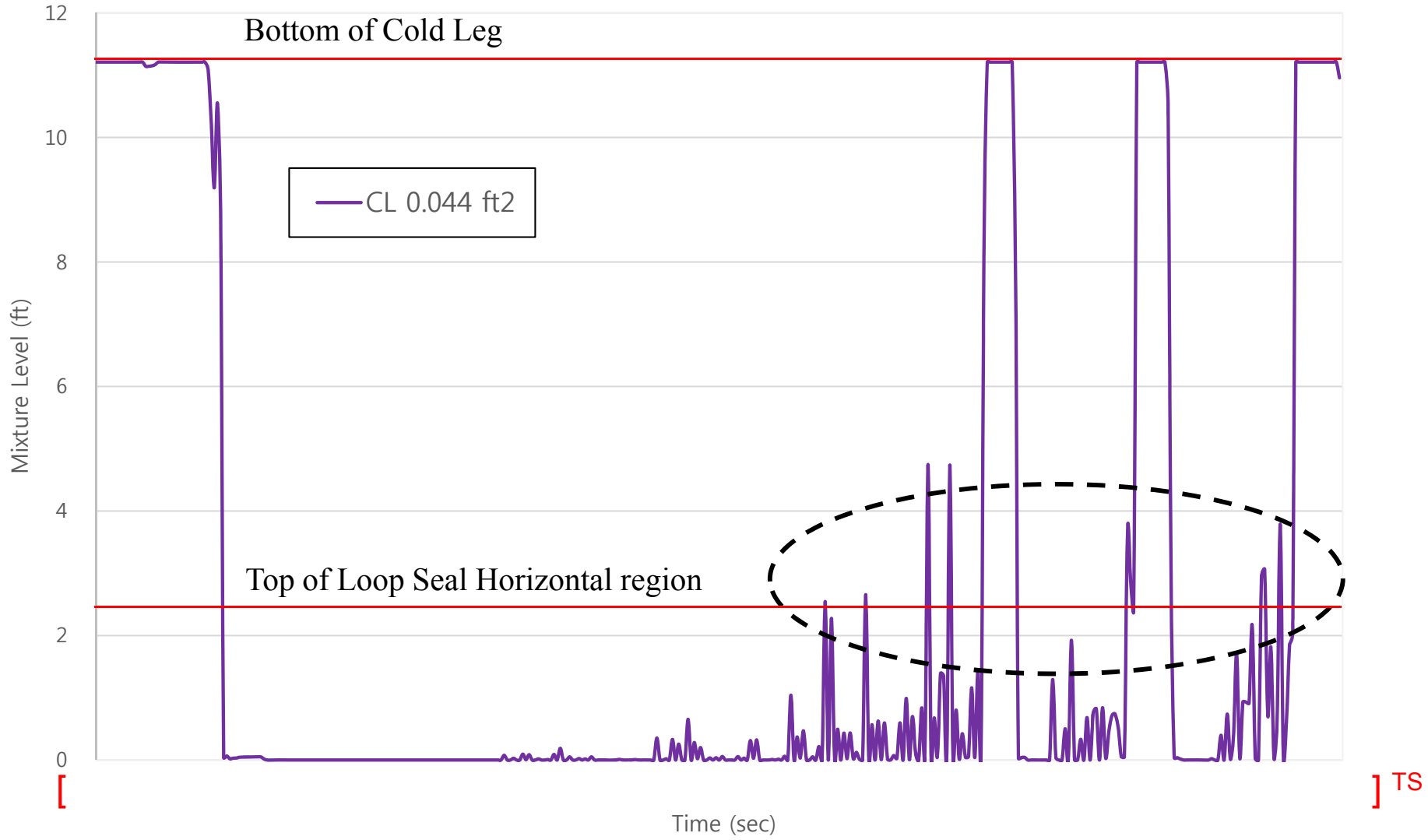
2. Break Spectrum Analyses (CEFLASH-4AS)
   - [ ]TS

3. Input Preparation for the fuel rod heat-up code (PARCH/EM)
   - Data transfer of CEFLASH-4AS result for each limiting case
     - [ ]TS,(a,c)

4. Evaluate the PCT caused by Loop Seal Reformation (PARCH/EM)

CEFLASH-4AS Calculation

- **Loop Seal Mixture Level for Broken Loop**



CEFLASH-4AS Calculation

- **Break Spectrum Summary**
  - ✓ Break location: pump discharge leg
  - ✓ Range of break size occurring Loop Seal Reformation are below

TS

* No sustained uncovery but cycling of reformation and clearing

CEFLASH-4AS Calculation

- **Limiting Case Selection**
  - ✓ [ ]^{TS} loop seal clearing cases for conservative core recovery
  - ✓ [ ]^{TS} for conservative PCT

TS

[

]

CEFLASH-4AS Calculation

- **Core Mixture Level**

TS

PARCH/EM Evaluation

PARCH/EM Evaluation

- **Input Preparation for PARCH/EM Calculation**
  - ✓ Each PARCH/EM input for the selected cases in CEFLASH-4AS is prepared with the following three modifications applied to PARCH/EM base deck;
  - ✓ Prepare the [ ]$^{TS,(a,c)}$ based on CEFLASH-4AS result.

PARCH/EM Evaluation

TS,(a,c)

PARCH/EM Evaluation

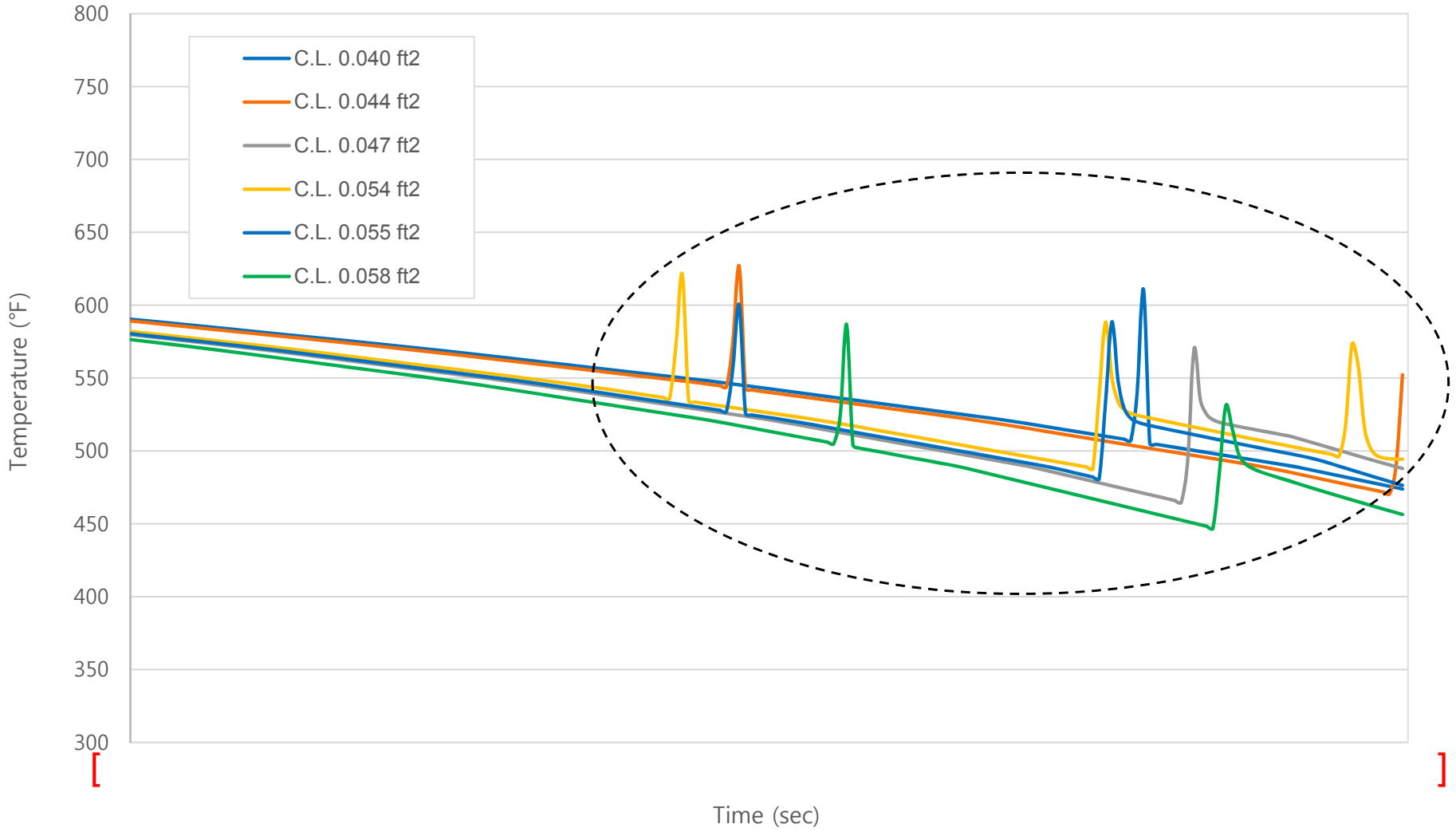
TS,(a,c)

PARCH/EM Evaluation

TS,(a,c)

PARCH/EM Evaluation

- **Cladding Surface Temperature**



[ ] TS

Differences

TS,(a,c)

- **Deep Core Location**

Conclusion

Conclusion

- **Findings and Results**

  ✓ Loop seal reformation cause core reheat while core is uncovered.

  ✓ However, the PCTs of limiting cases for loop seal reformation are below 650℉ for the APR1400 and meet the NRC requirement.