RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**343-8420**
SRP Section:	**12.02 - Radiation Sources**
Application Section:	**12.2**
Date of RAI Issue:	**12/22/2015**

Question No. 12.02-23

This is a follow-up to RAI 8090, Question 12.02-13.

Requirement

10 CFR 52.47(a)(5) requires that the FSAR contain the kinds and quantities of radioactive materials expected to be produced in the operation and the means for controlling and limiting radioactive effluents and radiation exposures within the limits set forth in 10 CFR 20.

Issue

In the response to Question 12.02-13, the applicant indicates that source terms for components are conservative because the RCS source term is based on five cycle operation. However, the applicant provides no justification for why this is conservative. Past staff experience with previous applications indicates that typically RCS activity reaches near equilibrium value after several months of operation and would not be expected to change significantly after that time (with fuel leakage and operating conditions staying the same, the RCS concentrations of most radionuclides are constant). Therefore, it is unclear why assuming five cycle operation is conservative. No justification is provided why it is conservative, versus normal fuel replacement.

In addition, the applicant indicated that the nuclides selected in the source terms in FSAR Chapters 11 and 12 are consistent with the nuclides included in ANSI/ANS 18.1. As indicated in the SRP, it is acceptable to only consider the nuclides listed in ANSI/ANS 18.1 (as well as it is acceptable to consider the additional nuclides in those source associated with the liquid waste management system, because the DIJESTER code considers the additional nuclides).

However, the applicant indicates that only the DIJESTER code considers the buildup of radioactive daughters (besides Ba-137m, which is acceptably considered to have the same

activity as Cs-137 in all sources, except for in the Steam Generator Blowdown, Condensate Polishing System, and Spent Fuel Pool Demineralizer source terms). Therefore, in the other source terms downstream of the RCS, some of the nuclide activity values listed do not provide an accurate estimation of the nuclide concentrations. Staff review indicates that the buildup of some the daughter products in some components may be significant to some of the gamma source terms in the plant (and therefore, the shielding and zoning for those components). For example, for the gaseous waste management system components, the accumulation of Rb-88 from the decay of Kr-88 would likely provide a difference in the gamma dose rates from those components. Staff analysis indicates that the daughters of noble gasses (mostly Rb-88) listed in ANSI/ANS 18.1 may contribute nearly 20% to the source terms of the guard beds and the delay beds. In addition, the decay of Te-132 to I-132, would significantly increase I-132 activity in many components. There are several other radionuclides listed in ANSI/ANS 18.1 which would also impact source terms, to a lesser extent.

SRP 12.2 indicates that the buildup of radionuclides in components and systems should be addressed. Part of the buildup in components is from daughters generated in the decay of parents. Therefore, update the source terms and plant shielding and zoning, as appropriate, to include the contribution of daughter radionuclides for daughters listed in ANSI/ANS 18.1 (including for Ba-137m in the Steam Generator Blowdown, Condensate Polishing System, and Spent Fuel Pool Demineralizer source terms in Tables 12.2-18 and 12.2-17a), or provide additional detailed justification for why due to the RCS activity source terms are already more conservative than they would be if the contribution of daughters was included.

Response

Assumption of Five Cycle Operation

In the calculation of RCS source term, most of the fission products reach their equilibrium activity level within one fuel cycle. However, several of the important nuclides (e.g. Kr-85, Sr-90, I-129, Cs-137) may not reach equilibrium before the fourth or fifth fuel cycle. Therefore to insure maximum reactor coolant activities the code (DAMSAM) is set up to run for four equilibrium fuel cycles with no leakage or load maneuvering waste from the primary coolant. At the beginning of the fifth cycle primary-to-secondary leakage begins. Hence, the duration of reactor operation is provided to 5 in the basis for reactor coolant source term calculations (DCD Table 11.1-1).

Effects of Daughter Products Buildup

A response to this RAI to the effects of contribution of daughter radionuclides on the plant and zoning will be provided after the completion of the evaluation of conservatisms in DAMSAM/SHIELD-APR Code methodology by Westinghouse Electric Company LLC. The working plan of Westinghouse Electric Company LLC to resolve this RAI is presented in Attachment 1. The evaluation of conservatism is expected to be finished around December 15. 2016.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environment Report.

Working Plan to Resolve RAI on DAMSAM / SHIELD-APR Code Methodology – Effort to Address Daughter Products

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Outline of Approach

- Task 1:
  - Review DAMSAM and SHIELD-APR code analyses for the APR1400 design.
  - Identify the conservatisms inherent in the computer models, assumptions and input values.
- Task 2:
  - Review DAMSAM code.
  - Generate input enabling the inclusion of daughter products.
- Task 3:
  - Identify alternate computer code for calculating component and system activities, accounting for daughters explicitly.

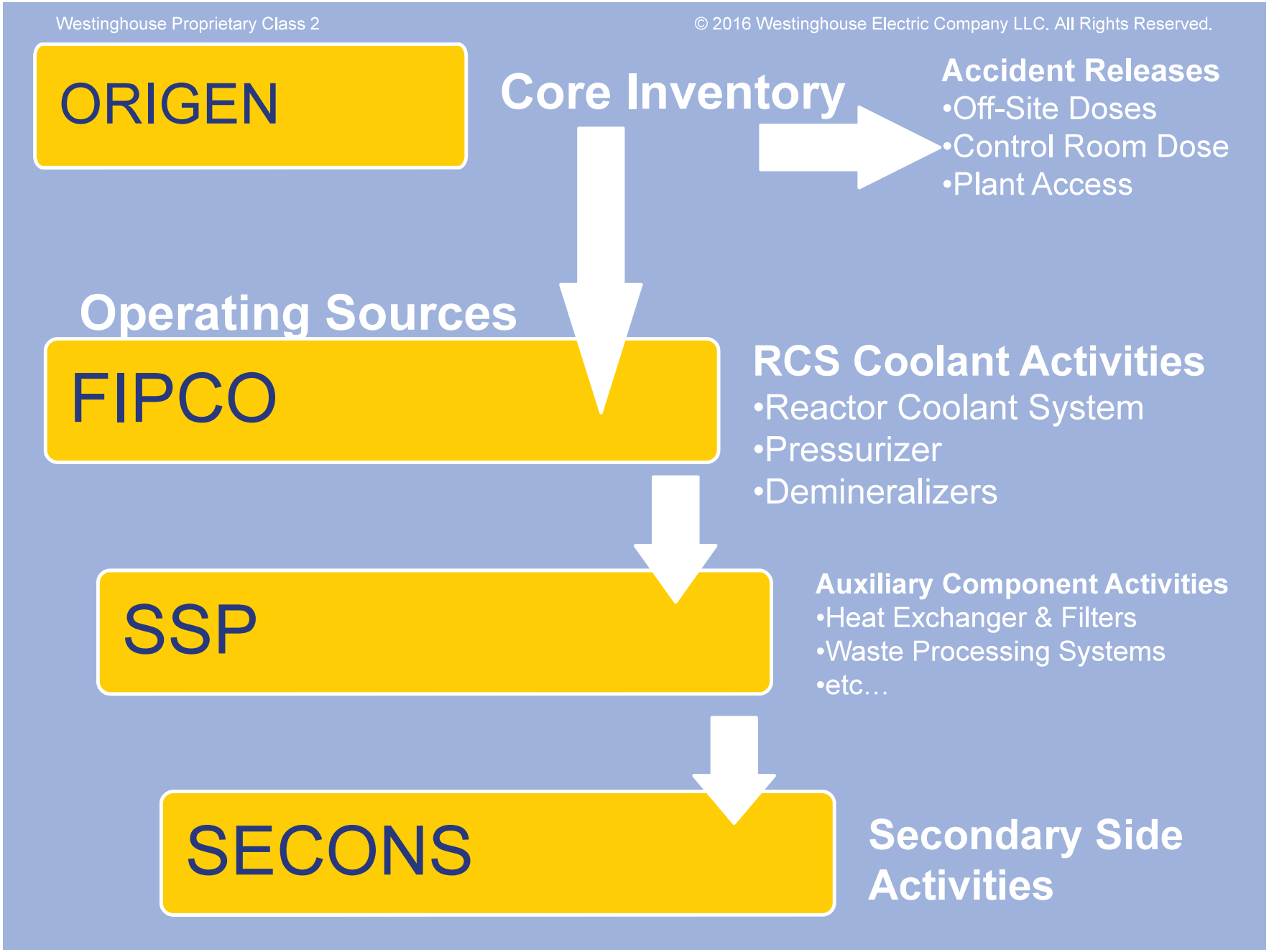
Outline of Approach (continued)

- Task 3 (continued):
  - Investigate overlap between DAMSAM and Westinghouse FIPCO and SSP codes.
  - Perform limiting scoping runs to demonstrate that DAMSAM values can be obtained via FIPCO or SSP codes. Find analogous system or components to best show comparison.
  - Using comparable results, model full set of fission products and daughters with the FIPCO -- SSP sequence. Quantify results FIPCO/SSP vs DAMSAM.
- Task 4:
  - Review source code for DAMSAM and SHIELD-APR.
  - Determine treatment for daughter products and identify conservatisms in this area.

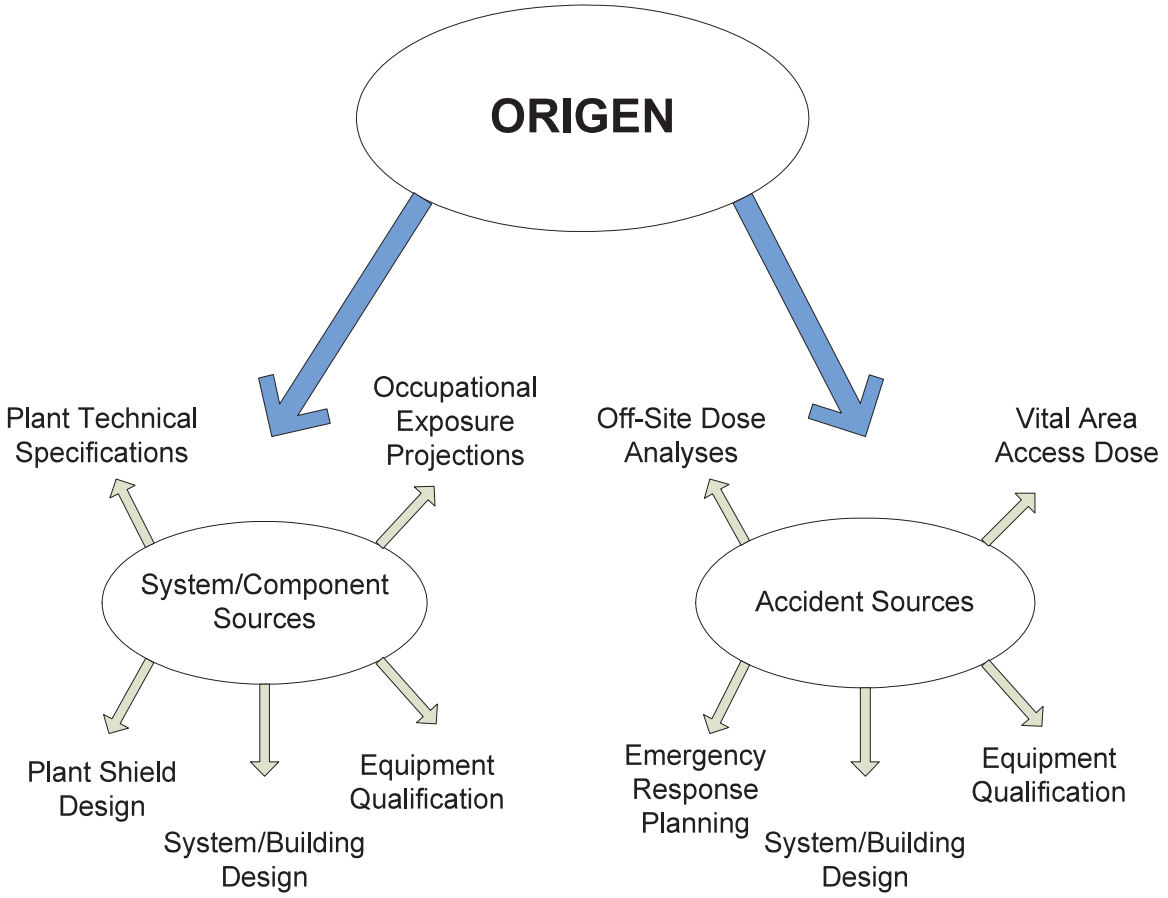
Methods & Codes for Source Term Development

Take-Aways:

- Basic codes used by Westinghouse for source term calculations
- High-level source term derivation for individual plant systems and components
- Sequence of Westinghouse-developed codes



Radiation Sources - ORIGEN

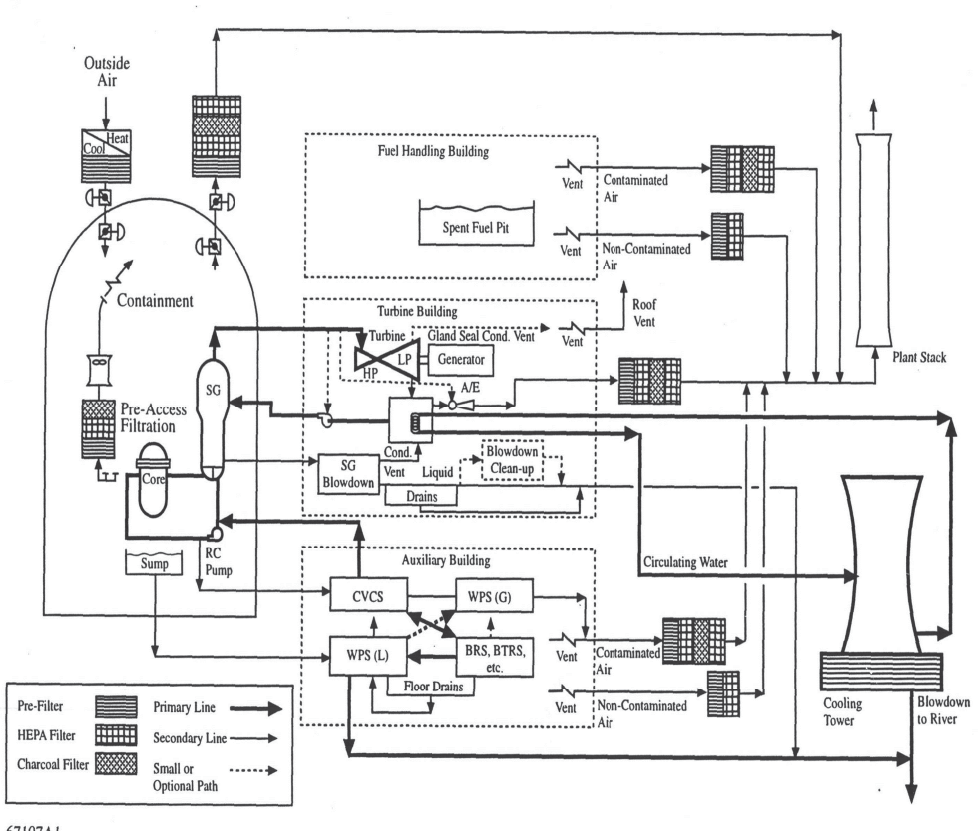


Westinghouse

Radiation Sources - FIPCO

a,c TS

Plant Systems & Effluents Flow Diagram



Radiation Sources - FIPCO

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Radiation Sources - FIPCO

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