Computational Aid of Hydrogen Impact When Depressurizing Reactor Building for Wolsong 2

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1. Introduction

Hydrogen generation and flammability is a concern throughout most of the guidelines in the Wolsong 2 SAMG [1]. This computational aid (CA) is one of the tools that can be used to assess the hydrogen generation and challenges that may occur. The purpose of this CA is to determine whether depressurizing the reactor building will create either a hydrogen challenge or a hydrogen burn.

2. Basis

When the reactor building depressurizes, either through long term heat losses or due to intentional efforts, steam condenses out of the atmosphere. If the reactor building has been in a steam inert, or non-flammable, state due to the presence of steam, the decreasing steam content in the reactor building atmosphere may lead to a flammable condition. This CA helps to determine whether there will be a future hydrogen severe challenge, or a future hydrogen bum when the reactor building depressurizes. For more information, refer to the background information for CA-5, HYDROGEN FLAMMABILITY IN REACTOR BUILDING [1], concerning the basis for the general concerns of hydrogen production during a severe accident.

3. Usage

To explain the general usage of this CA, it is helpful to consider it in relationship to the other tools that are available to address hydrogen concerns [2].

The purpose of this CA is focused on determining the impact of depressurizing the reactor building in regards to hydrogen flammability.

One of the limitations of this CA is that it is on]y composed for a base case scenario, with no previous venting of the reactor building, and no core/concrete interaction. If the user of this CA knew that either of these conditions was applicable, then information in CA-5 would have to be augmented with this CA to correctly interpret the correct response.

The specific references to this CA throughout the Wolsong SAMG are identified in Table1.

Table 1 Reference to this CA within Guidelines [1]

Guideline	Usage of CA
SAG-03, INJECT INTO REACTOR VAULT	- Determine if there is a future hydrogen severe challenge when using reactor building spray. - Stop the reactor building spray when the reactor building reaches the flammability limit.
SAG-04, REDUCE FISSION PRODUCT RELEASE	- Determine if there is a future hydrogen severe challenge when using any depressurization method. - Establish a limit for reactor building depressurization.
SAG-05, CONTROL REACTOR BUILDING CONDITIONS	- Determine if there is future hydrogen severe challenge or a future hydrogen burn if using any reactor building depressurization method. - Establish a limit for reactor building depressurization. - After depressurization has begun, determine the margin to HYDROGEN SEVERE CHALLENGE and HYDROGEN BURN regions.
SAG-06, REDUCE REACTOR BUILDING HYDROGEN	-Determine possible hydrogen control strategies based on this CA region.

4. Assumptions [2]

- The reactor building environment is assumed to be a homogeneous mixture of air, steam and hydrogen for which the ideal gas law applies.
- Hydrogen igniters have not been used, and there have been no previously hydrogen burns.
- The reactor building environment is assumed to be at 100% humidity.

5. Plant-Specific Information

The following plant-specific input for Wolsong2 [3,4] is required.

Variable	Value	Unit	Description
M	94,923	lbm	Mass of zirconium
nCCI	13.04	lbm-mole	Non-combustible, non-condensable gases released during 24 hours of CCI
SH	114	˚F	Level of superheat to be illustrated for CCI scenario
Volume	1,715,000	ft³	Volume of Reactor Building
T1	105	˚F	Initial Reactor Building Temperature (Tech Spec Minimum)
P1	14.6	psia	Initial Reactor Building Pressure (Tech Spec Maximum)
Pfail	58.9	psia	5% probability of reactor building failure -3.6 psi

6. Equation Definition

To generate the curves for Figures 1 and 2, Figures 5-1 and 5-2 from CA-5 [1] can be used with the following modification. The standard 25%, 50% and 75% zirc reaction lines will be removed and replaced with two zirc reaction lines that will split the NOT FLAMMABLE region into three regions: FUTURE HYDROGEN SEVERE CHALLENGE, FUTURE HYDROGEN BURN, and NO HYDROGEN CONCERN. Steps 23 through 29 in the CA-5 background document can be used to calculate the reactor building hydrogen for any percentage of zirc reaction. These equations should be used, iterating on the zirc reaction assumption until 2 lines are defined as follows:

I) The bottom zirc line should result in 4% reactor building hydrogen (on a wet basis) at the initial reactor building pressure.
2) The top zirc line should pass directly below the lowest point of the HYDROGEN SEVERE CHALLENGE region.

7. Results

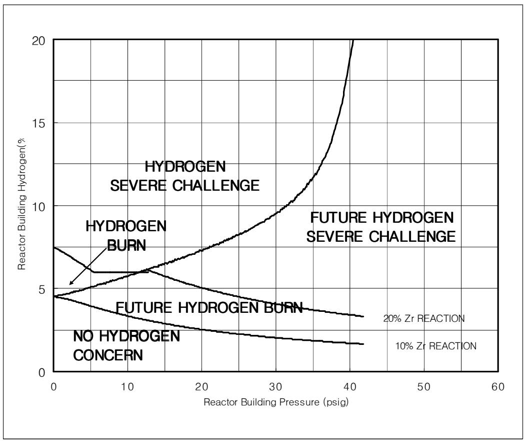

Figure 1 Hydrogen Impact When Depressurizing Reactor Building on Wet Hydrogen Measurement

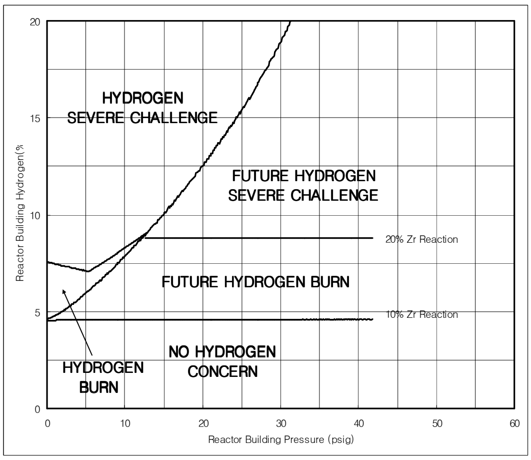

Figure 2 Hydrogen Impact When Depressurizing Reactor Building on Dry Hydrogen Measurement

Acknowledgement

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REFERENCES

[1] KAERI/TR-xxxx/2006. "Severe Accident Management Guidance for Pressurizer Heavy Water Reactors", April, 2006.
[2] WOG PROGRAM MUHP-2310 "WOG Severe Accident Management Guidance", June, 1994.
[3] KAERI/RR-2533/2004. "Development of Optimal Severe Accident Management Strategy and Engineered Safety Features", April, 2005.
[4] "Wolsong Nuclear Power Plant Units No. 2/3/4 FSAR" KEPCO, 1995.