Requests for additional information regarding NEDC-33083P, "TRACG Application to ESBWR"

318. The qualification report for application of TRACG to the ESBWR design indicates that the code version used for the assessment calculations was TRACG02A. The intended code of record is to be version TRACG04. Please confirm and verify that no changes would occur in the calculations when performed with the later version of TRACG. If any changes would occur in the calculated results, submit the corrections to the qualification cases.

319. The TRAC-BD1 code from which TRACG was derived had an error such that a junction placed other than at the center of a volume would result in an incorrect hydrostatic head. Please confirm that this error does not exist in TRACG.

320. The uncertainty analysis methodology for the application of TRACG to anticipated operational occurrence (AOO) events is described very well. Please provide a detailed description of the methodology by which uncertainties are determined for the application of TRACG to the loss of coolant accident (LOCA).

321. Please augment the discussion presented in Section 3.3.1.1.1 of NEDC-33083P, "TRACG Application to ESBWR," to include the safety relief valves (SRVs). Provide a revised Figure 3.3-1 including the location of the SRV release point into the suppression pool. In the augmented discussion, using the modified figure as a reference; describe what happens in the model as the flow in each main vent stops. For example, when the lower main vent closes, what happens to the interface between the stacked cells (at ring 5 between level 2 and level 3, at ring 6 between level 2 and level 3) as well as what happens to the radial cell interfaces (level 2 between ring 5 and ring 6). Take the discussion through the time when the upper main vent flow stops. What happens to the energy from the SRVs? What cells are considered in the stratification model to account for the SRVs?

322. NEDC-33083P, Section 2.2.1.2 defines the Main Steam Line Break (MSLB) LOCA scenario. It assumes that the feedwater flow is not available during the transient. From the emergency core cooling system (ECCS) LOCA evaluation perspective, this assumption leads to conservative ECCS performance evaluation. For containment analysis, it is the common practice to assume that the feedwater flow is available during the LOCA and the injection continues until all the hot water from the feedwater system is consumed. Please provide justification and explain why the feedwater flow is assumed to be cut off during MSLB and why it is conservative to do so.

323. For the ECCS LOCA case, in Section 2.6.1 of TRACG application, it is stated that "Drywell model set to minimize containment pressurization rate." In Section 3.1.4 (Page 3-3), it is indicated that a conservative application approach for containment analysis has been used to model MSLB LOCA containment behavior. GE also pointed out that the TRACG code is not designed to accurately predict containment phenomenon. Specific application procedures are used to apply TRACG to this specific design and different procedures are used to evaluate ECCS and containment

responses. Please address the following questions for ECCS LOCA and containment LOCA analysis:

ECCS/LOCA

(1) Does the minimized containment pressurization rate provide a conservative gravity driven cooling system (GDCS) line injection timing and minimum water level prediction? Please explain why.

(2) List all other detailed modeling procedures and practices to minimize the containment pressurization rate and provide justifications.

(3) In particular, please explain how the wetwell (WW) and drywell (DW) are partitioned into different radial and axial cells and what criteria are used to establish the cell face boundary?

(4) The TRACG physics package is mainly developed based on small and confined space test data. This package has been used to calculate the WW pool condensation, thermal and interfacial heat transfer between the noncondensible gas and WW pool water. Can this physics package provide a conservative two-phase water level in the shroud with the given nodalization?

(5) Due to the TRACG ECCS/LOCA model containment radial distortion, the staff is not convinced that the distribution of steam and noncondensible gas calculated by the ECCS/LOCA model is inaccurate. Please explain how the long term cooling through passive containment cooling system (PCCS) was affected and why the current application procedure can lead to a conservative minimum water level prediction at about 10 to 11 hours into the transient.

(6) For the same reason, have other parts of the containment (WW, GDCS Pool, PCCS) model been set to minimize the prediction of the two-phase water level above the core? If so, please provide detailed modeling procedures and justifications.

(7) Have the DW to WW vents been modeled in the same way for ECCS /LOCA as for containment/LOCA? If not, please explain why.

CONTAINMENT/LOCA

(8) It is stated that a special modeling approach has been used to model WW and DW to WW vents to conservatively calculate the WW temperature and pressure response. This approach appears to be developed based on the TRACG model nodalization for the pressure suppression test facility (PSTF) test. Please explain why the similar nodalization can produce conservative response even though the PSTF geometry dimensions appear to be different from that of the ESBWR WW.

324. It was stated on page 2-38 of NEDC-33083P that the minimum chimney water level occurs at about 10 to 12 hours after the break. However all the ECCS LOCA cases documented in the report stop at 2000 seconds. Please provide a conservative GDCS LOCA calculation to demonstrate that the two-phase water level remains above the core beyond 12 hours after the break. When performing the calculation, consider using 102% power, the correct scram time and other conservative assumptions.

325. What computer code was used to calculate decay heat and core void effects? Has that code been previously reviewed by staff? If so, please provide any relevant references.

326. According to the ESBWR design description, the GDCS pool air space is connected to the suppression pool air space through three large diameter vent pipes. Therefore, the pressure should be equalized during normal operation. However, TRACG calculated a higher GDCS pool air space pressure than the suppression pool pressure due to the simplified GDCS pool nodalization. This unrealistic pressure results in a higher initial inventory of air in the GDCS space. Please explain the effect of this nodalization on the calculated ECCS performance and, ultimately, the minimum chimney two-phase water level.

327. It is assumed that the MSLB never occurs outside containment inside the out-board main steam isolation valve. Please explain why.

328. TRACG models the two-phase flow in the chimney using three large 3-D vessel radial rings instead of 1-D pipe components. Does the 3-D vessel component result in the same flow regime as 1-D pipe components if 1-D components have been used to model the chimney?

For the open space above chimney and below the separator inlets, what would be the flow regime there during normal operation? Is it possible that, during the normal full power operation, steam and saturated liquid would tend to separate in this open space and the volume averaging approach may not be valid?

TRACG 1-D Pipe component has been validated against Ontario Hydro test data. Does this validation apply to 3-D Vessel component too? How? Does Ontario Hydro test data cover both ESBWR full power operation condition and start-up operation? During the start-up, when the channel outlet void fraction is small (in the bubbly flow regime), is it possible that the void tend to flow preferably in a small region in the chimney or the open space above to form a high void concentration region so that the averaging by TRACG would over-estimate the two-phase natural circulation driving head?

329. It has been repeatedly stated that the ESBWR has significant margins for LOCA since the calculated two-phase water level by TRACG is always above the top of active fuel. The TRACG 3-D vessel two-phase water level tracking algorithm has been used to calculate the two-phase water level location in the chimney region during GDCS LOCA transient. The underlying assumption of this level tracking algorithm is that within each cell, there are no flow restrictions. However the entire core is not under a single chimney partition. The two-phase water level in the chimney is expected to vary. The TRACG 3-D vessel model numerically averages the two-phase mixture level in three radial rings. Please provide justification or demonstrate through sensitivity runs that the

TRACG code is capable of calculating the minimum two-phase water level considering the chimney partition and bundle power distributions for GDCS LOCA.

330. Please provide the following TRACG input decks:

(1) ECCS/LOCA Bottom drain line LOCA case

(2) MSLB/LOCA case power/time table (TRACG Power Cards) considering delayed scram

(3) Ontario Hydro Void Fraction Tests TRACG deck

(4) PSTF level swell test TRACG input decks

(5) PANTHER PCC TRACG qualification input decks

Please provide both the pre-test and post-test
calculation input decks for Tests 15_1 and 23_4.
(Page 4.1-1 of TRACG SBWR qualification for SBWR.)
Need 1-Tube model and eight tube models.
Test T12, T13, T11 and T02 input decks.

331. Please provide the material properties and dimensions of the vessel wall, vessel thermal insulation layer, air gap and vessel shield. Justify why these components are lumped into one heat structure.

332. On Page 2-36 of NEDC-33083P, it is stated that "There are three GDCS pools in the ESBWR containment, supplying four divisions of GDCS to the vessel." Based on the ESBWR design description, there is only one division of GDCS for each GDCS pool. Please clarify the total number of divisions from GDCS pools.

333. In order to verify the TRACG critical flow model, we have developed and run a simple test problem. It consists of two break components and a pipe component. Two break components define the pressure boundary conditions (73 bar upstream and atmospheric pressure downstream). A pipe with an orifice at the center was initially set to 73 bar through out its entire length. Then, the downstream break is depressurized to atmospheric pressure. The TRACG code predicts choke condition at the orifice. However, the calculated fluid velocity at the choke point is only about 60 meters per second. Usually, the sound speed is expected to have be on the order of 100 - 300 meters per second. Therefore, the calculated choke flow velocity appears to be lower than the sound speed. Please provide a separate effect test benchmark TRACG deck to assist the staff's further review.