NUSCALE POWER™

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Docket No. PROJ0769

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Submittal of Changes to Subchannel Analysis Methodology Topical Report, TR-0915-17564

REFERENCES: 1. NuScale Power, LLC, "Response to NRC Request for Additional Information No. 12 (eRAI No. 8773) on the NuScale Design Certification Application," dated May 26, 2017 (ML17146B356)

2. NuScale Topical Report, "Subchannel Analysis Methodology," TR-0915-17564, Revision 1, dated February 15, 2017 (ML17046A333)

On May 26, 2017 NuScale submitted a response to RAI 04.04-1 from eRAI No. 8773 (Reference 1) which included changes to the Final Safety Analysis Report Section 4.4. This letter submits conforming changes to the Subchannel Analysis Methodology topical report (Reference 2).The Enclosure to this letter provides the changes to the topical report in redline/strikeout format. Because the changes affect only a nonproprietary portion of the topical report, the Enclosure includes a markup of the nonproprietary version only. NuScale will provide these changes to both the proprietary and nonproprietary versions of the report as part of a future revision to the Subchannel Analysis Methodology topical report.

This letter and the enclosed revisions make no new regulatory commitments and no revisions to any existing regulatory commitments.

Please feel free to contact Darrell Gardner at (980)-349-4829 or at dgardner@nuscalepower.com if you have any questions.

Sincerely,

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Enclosure: "Changes to Subchannel Analysis Methodology Topical Report, TR-0915-17564"

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flow for the NuScale design accounts for the total amount of flow that circulates through the nuclear steam supply system (NSSS). With the natural circulation design of the NuScale reactor, the flow rate is dependent upon the pressure drop from the steam generator and reactor core.

VIPRE-01 is used with the RECIRC numerical solution option even though positive flow (upward flow) is maintained within the core when applying this methodology. Although the core pressure drop and the exit enthalpy can be input in place of the inlet mass flow rate boundary condition, this is not a requirement or necessarily the optimum technique for VIPRE-01 simulation of the NuScale core. Using the inlet flow rate boundary condition provides a more direct way of accounting for bypass flow and the treatment of flow imbalance-related uncertainties.

3.8.2 Inlet Enthalpy

The inlet enthalpy may be uniform or prescribed for each channel separately. If the inlet flow is subcooled or superheated, the inlet temperature may be specified in lieu of enthalpy, and may be either uniform or specified for each channel. As a PWR, the NuScale design has subcooled inlet flow; therefore, inlet temperature (uniform) is utilized. The exit enthalpy is not needed unless the exit (top of the bundle) flow reverses.

3.8.3 System Pressure

The system pressure is used to define saturation conditions uniformly throughout the core. VIPRE-01 assumes the flow is incompressible and that the momentum pressure drop is small compared to the system pressure. The pressure drop for the NuScale fuel assembly is on the order of {{ }}$^{2(a),(c),ECI}$ psid, with a nominal system pressure of 1850 psia. As defined in Table 3-1, an example CHF correlation minimum valid pressure is 300 psia.

Therefore, even at the minimum values of the applicable pressure ranges, a change in pressure as a result of the fuel pressure drop would have negligible impact on the fluid properties. As a result, the treatment of system pressure as uniform is valid for NuScale conditions. In the event future CHF correlations use significantly different pressure ranges, a restriction of this methodology defined in Section 7.2.1 is that the fuel pressure drop must be significantly less (by a factor of 10) than the minimum system pressure evaluated with the uniform pressure option <u>or</u> the local pressure drop option must be used in VIPRE-01.

3.8.4 Bypass Flow

For subchannel calculations, the maximum bypass is conservative because this results in less coolant flow in the reactor core available for heat transfer. The following bypass flow paths for bypass are considered:

- reflector block cooling channels (for the purpose of cooling the heavy reflector)

- gap between the heavy reflector block and the core barrel
- fuel assembly guide and instrument tubes

3.8.4.1 Reflector Cooling Channel Bypass

The heavy reflector surrounding the core has several cooling channels that allow flow to pass through the reflector. A conservative calculation results in a recommended example value of 4.5 percent for the reflector cooling channel bypass fraction for steady-state and transients.

3.8.4.2 Flow Leakage between the Heavy Reflector and Core Barrel

It is not ~~permissible~~ possible for bypass flow to occur between the heavy reflector and the core barrel ~~to bypass the core~~because there is no direct flow inlet path to this region~~.~~; therefore, ~~This region is expected to decrease in area due to thermal expansion from the reflector cooling block. Because the flow in this region is relatively stagnant and there are conservative assumptions in the other bypass fractions,~~ this ~~bypass~~ potential flow path is ~~treated as negligible~~not a contributor to core bypass.

3.8.4.3 Guide Tube and Instrument Tube Bypass

The maximum amount of bypass flow fraction for the guide tubes and instrument tube for the fuel assemblies is an input into subchannel analysis. An example value for this report is a maximum bypass flow of 4 percent, which includes a 1 percent uncertainty. NRELAP5 uses core bypass flow as an initial condition for Non-LOCA analyses as discussed in Reference 8.2.10.

3.8.4.4 Total Bypass

The total bypass flow assumed in the subchannel analysis is 8.5 percent of total system flow at full power conditions. This is considered to be a maximum value and conservative with respect to MCHFR.

3.8.5 Inlet Flow Distribution

In general, the core inlet flow distribution is dependent on the geometry of the RCS loop, including the lower core plate and bypass flow paths. The bypass flow paths for the NuScale design are discussed in Section 3.8.4. There are flow inlets for each of the 37 assemblies in the core, similar in nature to the current fleet of PWRs. However, the natural circulation design of the NuScale reactor is unique in that the flow distribution is dependent on the buoyancy-driven flow rate and unique vessel design in which flow in the lower plenum changes direction. The core inlet flow distribution is not constant and changes based on power level, axial and radial power distribution, and core average temperature. An example value for this report is a 5 percent inlet flow maldistribution applied to the fuel assembly that contains the hot rod.