



TH 37: Unique Aspects of Regulating Research and Test Reactors

Thermal Hydraulic Analyses of Research and Test Reactors

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Research and Test Reactor Thermal Hydraulics

- The NRC Office of Research is investigating the applicability of TRACE and RELAP5 to research and test reactor safety calculations. TRACE will be developed and assessed for use in NRC confirmatory calculations of research and test reactors
- Problems with traditional research and test reactor thermal hydraulics (T/H) codes (PARET) at uprated conditions have led licensees to turn to RELAP5 for licensing calculations

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Research and Test Reactor T/H (continued)

There is a lack of code assessment and validation of TRACE and RELAP5 under the conditions the code is being used for

- Critical Heat Flux (CHF)
- Subcooled boiling
- Gap model

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T/H System Safety Codes

Codes like TRACE and RELAP5 are not “first principles codes”. The codes have semi-empirical and empirical models that need validation and assessment for the conditions they are being used for

- The codes have models that were developed for power reactor LOCA calculations. They have been assessed against data from the ECCS research program and data relevant to other power plant transients.
- The codes have not been assessed for research and test reactor calculations.

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TRIGA Reactor Geometries

- Regular Lattices
 - Hexagonal
 - Square
- Irregular Lattice
 - Circular

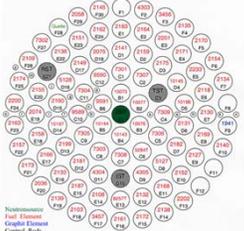


Figure from IAEA.org

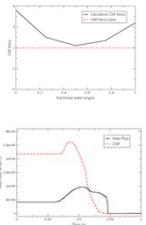
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Research and Test Reactor Thermal Hydraulics

Critical Heat Flux (CHF) Margin

- CHF can lead to cladding failure and release of fission products
- Steady state operating limits
- Pulse mode operating limits

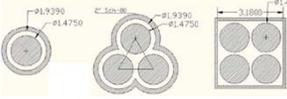


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CHF Data Applicable to TRIGA Reactors

- DOE/Argonne Nat'l Lab funded the Univ. of Wisconsin to measure CHF data relevant to TRIGA reactors
- The University of Wisconsin built 3 test assemblies and operated them under a range of pressure, mass flux and temperatures relevant to TRIGA operating conditions



“Critical Heat Flux at Conditions Representative of TRIGA-Type Reactors—Single, Three Rod and Four Rod Bundle CHF Data,” Oct. 2012, UWFD-1419, Yang et al., Fusion Technology Institute, University of Wisconsin.

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TRACE and RELAP5 CHF

- TRACE uses the 1995 Groeneveld CHF tables. An error was found in the implementation of the Groeneveld hydraulic diameter and rod bundle modifiers in TRACE. To address the error, a correction will be made in future releases of TRACE
- RELAP5 uses the 1986 Groeneveld CHF tables
- The Bernath correlation has been traditionally used for TRIGA reactor CHF calculations
- Comparisons of the TRACE and RELAP5 calculated power at CHF were made to the University of Wisconsin measured data

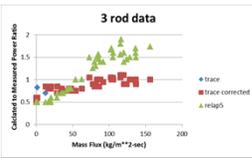
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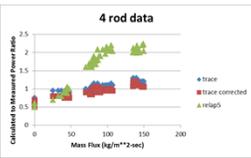
TRACE and RELAP5 CHF

There is a strong mass flux dependence in the CHF. Results show that the 1986 Groeneveld tables in RELAP5 give non-conservative calculations of power for some mass fluxes. The red squares show data from TRACE calculations using a new pre-release version in which the error has been corrected.

3 rod data



4 rod data



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TRACE and RELAP5 CHF

- The Bernath correlation and the 2006 Groeneveld CHF tables will be added to future releases of TRACE, fixing the error in the Groeneveld implementation
- The 2006 Groeneveld CHF tables will be added to RELAP5

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Other Areas of Investigation

- Subcooled boiling
- Fuel rod gap conductance
- Correlations and data relevant to research and test reactors other than TRIGAs

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Current Status and Conclusions

- TRACE is being assessed against data relevant to the T/H analysis of research and test reactors
- TRACE will be modified and validated for use by the NRC in confirmatory calculations of research and test reactors

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