Gesellschaft für Anlagen-
und Reaktorsicherheit
(GRS) mbH

ATHLET
Mod 3.0 Cycle A

Program Updates since
Mod 2.2 Cycle A

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This document lists the major program modifications of the current ATHLET version since the last general release version Mod 2.2 Cycle A. It provides information not only for the ATHLET users but also for the developers, i.e. it contains details which are not relevant for normal code users.

Further information on program modifications relevant for ATHLET applications can be found under *Document Updates* of the User's Manual as well as under *Input Data Updates* of the ATHLET Input Data Description.

Bold face indicates that user's action may be required even for existing input decks.

1 Thermo-Fluiddynamics

- New working fluids:
  - Heavy Water: can be combined with all non-condensable gases including interaction of steam and gas
  - Liquid Lead, LBE, Sodium: can be combined with all non-condensable gases; no simulation of metal steam
  - Helium: only pure Helium simulation
- New non-condensable gas: Helium, can be combined with Light or Heavy Water
- **4 balance equations EIMMB method not longer available**
- Fully 2D/3D momentum equations can be selected via new control word `3D-MODULE`. Since the model equations are not yet completely tested, an application is only recommended for research and test purposes.
- Steady state calculation improved:
  - Pump feed pressures considered for preset of pressure distribution.
    Solves problems in TFD systems with very high pump feed pressure (e. g. in the feed water system)
  - Consideration of mass and energy transfer between TFD (autonomous) systems improved.
  - The adaptation of the friction and form loss coefficients can be controlled for selected priority chains (s. `IPRI0` of CW `TOPOLOGY`).
  - New thermo-fluid or autonomous system can be started with a mixture level control volume.
- Evaporation rate caused by superheated vapor increased (as it was in A 2.1A and before)

- The modelling of a mixture level is irrevocably terminated whenever the void jump at the ML has dissipated.
- Two phase friction loss: The Martinelli-Nelson model has been improved:
  - Table replaced by correlation
  - Model improved for (very) low steam quality
  - Improved transition to and modelling of single phase vapor (gas) flow
- Friction loss of laminar flow in bundle geometry: λ = 100. / Re (pipe: 64. / Re)
- Friction loss of supercritical water: correction factor acc. X. Fang et al. for heated / cooled channels implemented
- Friction loss correlation (Ergun equation) for pebble bed
- Near the critical pressure, the 'evaporation rate' can be optimized (in terms of stability) for different types of transients (e.g. speed of depressurization). **See `GG` of CW `MISCELLAN`.**

2 HECU

- New geometry type 'Pebble'
- Simulation of TRISO particles for NC feedback
- Mokry HTC correlation for supercritical fluid available
- Mikityuk HTC correlation for bundles with liquid metal coolant
- Chang & Tak HTC correlation for pipes with liquid metal coolant
- HTC correlation for pebble bed (KTA 3102.2)
- New output data: `DNBRMI` (minimum DNB ratio in core)
  `IDRNBM` (index of HCV where DNBRMI is appearing)
  `ICDNBR` (index of CHF correlation used for DNBR calculation)
  `TSURFM` (max. cladding surface temperature of all rods)
  `TCENTM` (max. fuel center temperature of all rods)
- Burnup data may be provided but ignored (s. `IBURN` of CW `ROD`)
- Model for zircon nitride formation during air ingress added
- Quench front model: If PW `QFCON` was not input, QF was not started. (Local spontaneous quenching was still simulated.) Error fixed.
- `CORESUM` output data: Could be erroneous if the rods have been discretized unequally. Error fixed.
- Preset of HTC correlation selection controllers can be input in addition to HCO-specific controllers.
- **Oxidation model: `MODOXI` restricted to 1…3**

3 Neutron Kinetics

- Doppler feedback considers TRISO fuel temperature of pebble bed reactor

- At the End of a simulation run, the rod power data can be printed to be input by a new simulation (s. CW `SERVICES`). So, the rod power distribution of an ATHLET calculation with 3D kinetics can be easily input to a simulation with point kinetics.

- External reactivity is now balanced during steady state and zero-transient calculation (like the other reactivities).

4 FEBE/FTRIX

- ...

5 Component Models

- P-h-boundary objects (TDV) do not require compensating fills anymore.

- P-h-boundary objects (TDV) allow the simulation of more than three NC gases.

- New spray condensation model available

- New turbine model available

6 GCSM

- **Controller PROP:** **IOPT > 0: X2NAME = temperature**
  IOPT < 0: X2NAME = enthalpy

7 General

- Input decks may be composed by several sub-datasets via `INCLUDE` directives.

- `HTML ON` (2nd input line) creates a HTML version of the print output.

- `TOPOLOGY`: Pipes can be automatically coupled at their ends.

- Print output extended, in particular for input and steady state calculation:
  - Coolant and material masses sorted by object name categories
  - Rod summary after input processing
  - Several prints improved (object names added, etc.)

- New special services provided (s. CW `SERVICES`).
  - Generation of plot data during steady state calculation enabling to plot the course of SSC iterations
  - Generation of four-quadrant curves data from homologous pump data
  - Print of idle TFOs and HCOs (appearing in input deck but not used)
  - Print of idle GCSM signals (appearing in input deck but not used)
  - Print of mass flows at the end of the run (**`GG` of CW `MISCELLAN` has new meaning**)
  - Print of rod power distribution at the end of the run (s. chap. 3)

- **Input checks extended.**