MELCOR Code Development Status, Code Assessment, and QA

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and

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

MELCOR Code Development

- **MELCOR is developed by:**
  - **US Nuclear Regulatory Commission**
  - **Division of Safety Analysis (DSA)**
  - **Office of Nuclear Regulatory Research**
- **MELCOR Development is also strongly influenced by the participation of many International Partners through the US NRC Cooperative Severe Accident Research Program (CSARP and MCAP)**
  - **Development Contributions – New models**
  - **Development Recommendations**
  - **Validation**

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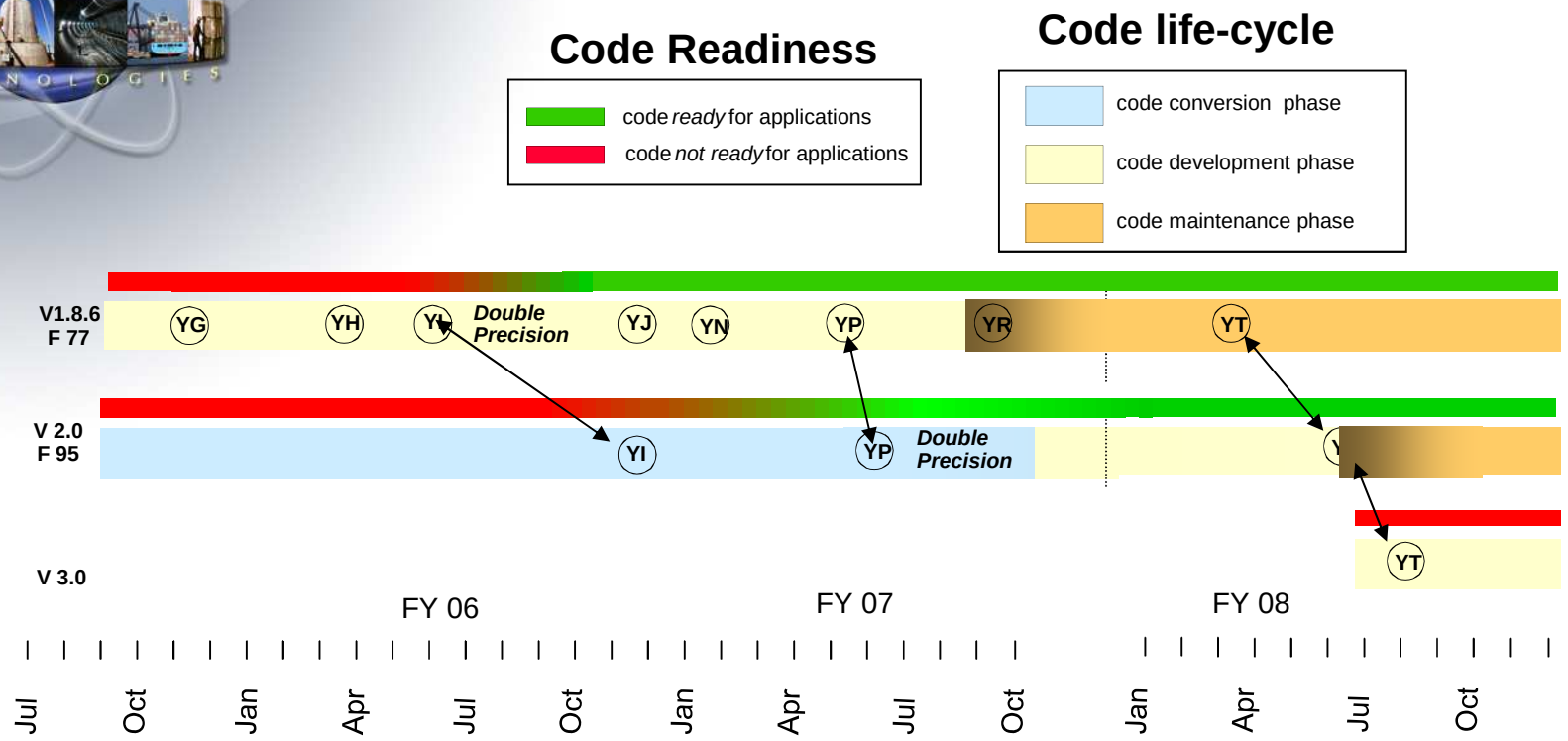
Current MELCOR Development

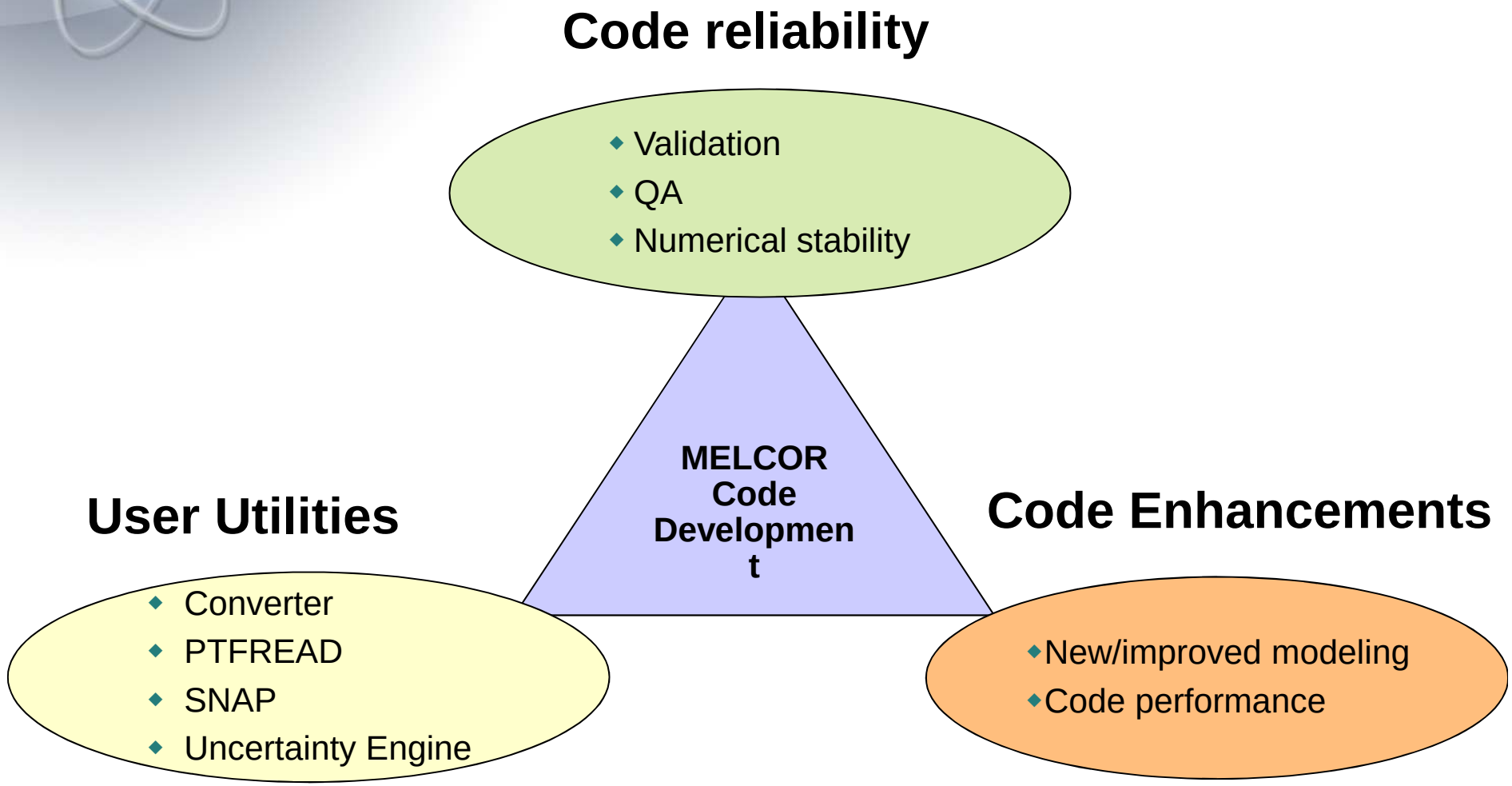


- **MELCOR 1.8.6**
  - Molten pool models
  - Core Package upgrade
  - Released Fall 2005
  - Code Maintenance
  - Current Workhorse

- **MELCOR 2.1**
  - FORTRAN 95
  - New input
  - 2.0 beta version released Sept 2006
  - 2.1 Release Sept 2008

- **MELCOR 3**
  - Current developmental version

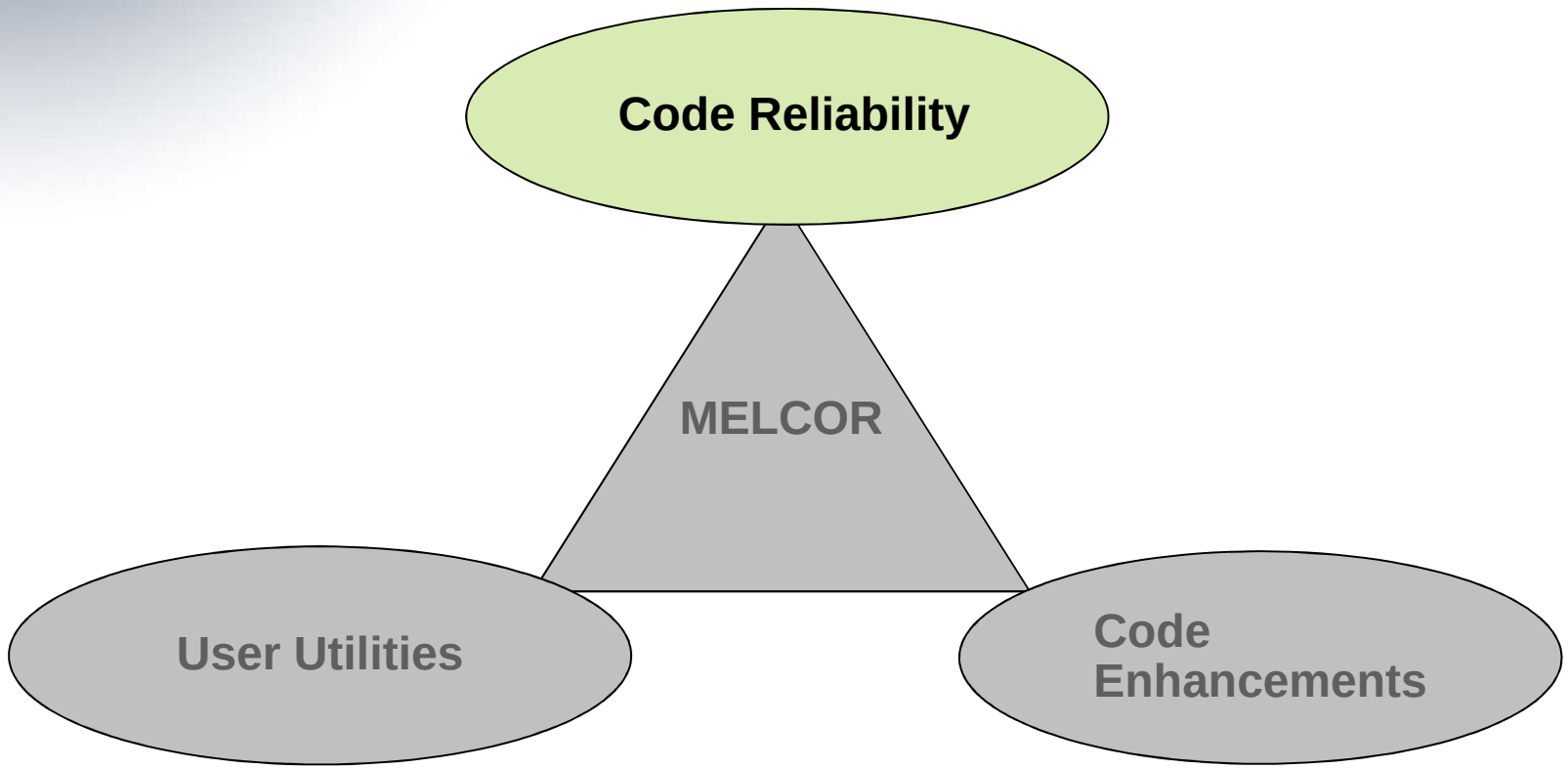
MELCOR 3.0 Code Development Thrust Areas



MELCOR 2.1

- **Source code ported to Fortran-95 by IBRAE**
- **Essentially equivalent to MELCOR 1.8.6 modeling**
  - **Many MELCOR1.8.6 execution issues resolved**
  - **Bit-for-bit parity between v1.8.6 & v2.0**
  - **New models added to M2.1**
- **Dynamically allocated memory**
  - **Arbitrary number of objects (CVs, FPs, Cells, etc.) limited by the available system memory**
- **Input deck converter**
  - **Can be used to 'replace' MELGEN to jumpstart use of code**
  - **Improvements to GUI**
  - **Double precision version**
  - **Debugged against assessments**

Code Development: Code Reliability



Software Quality Assurance

- **Review of current SQA practices**
  - **Internal audit & review**
- **Code Configuration Management (CM)**
  - **Recently moved to 'Subversion' CM**
- **Assessment calculations of MELCOR 2.1**
  - **Currently underway**
  - **Regression testing and reporting**
  - **Automation of testing and reporting procedures**
  - **Nightly builds & testing**
- **Bug tracking and reporting**
  - **Bugzilla online**

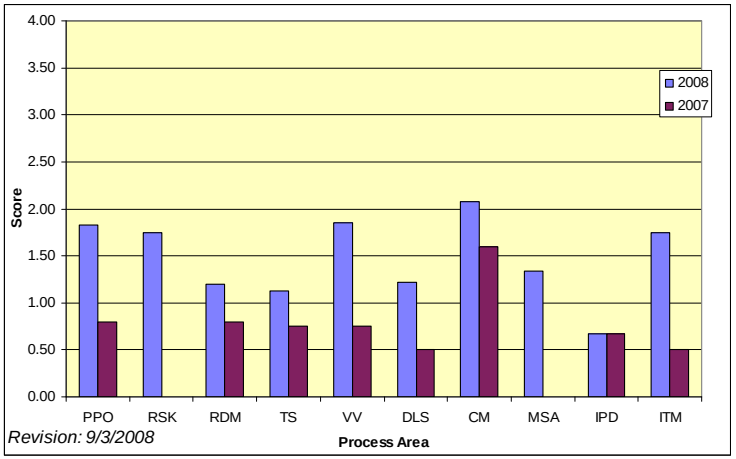
Software Quality Assurance

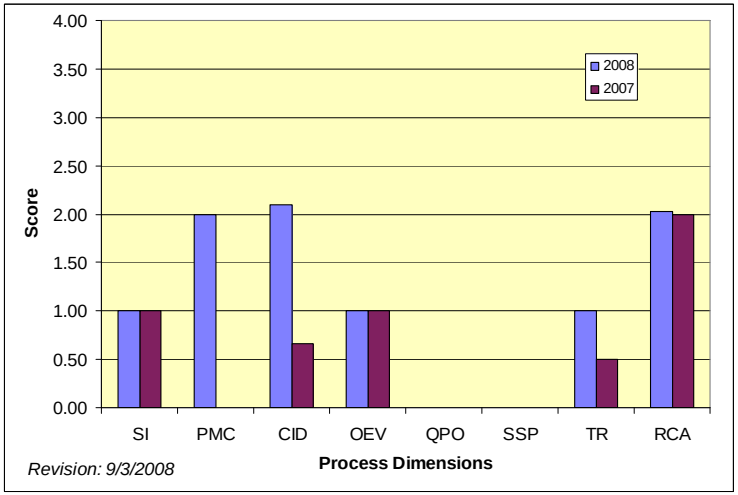
- Sandia Corporate Process Requirement 001.3.6 (CPR 001.3.6)
- The software management framework adapted from two internationally recognized standards
  - the Capability Maturity Model Integration (CMMI) ®
  - and ISO 9001
  - These standards provide elements of traceability, repeatability, visibility, accountability, roles and responsibilities, and objective evaluation

- Process areas
  - Project planning and oversight
  - Requirements Development and Management
  - Risk Management
  - Configuration Management
  - Technical Solution
  - Integrated Teaming
  - Integrated Product
  - Verification and Validation
  - Measurement and Analysis
  - Development and Lifecycle Support

Software Quality Assurance Annual Re-evaluation

- **Annually review of MELCOR SQA Practices.**
  - **Weighted average of team members**
  - **0-None, 1-Little, 2-More, 3-Most**
- **Highlights areas of improvements.**
  - **Verification & Validation**
  - **Collected Improvement Data**
  - **Risk Management**
  - **Integrated Teaming**
- **Focuses attention on areas needing improvement**
  - **Requirements Development and Management**
  - **Integrated Product Development**
- **Sandia's commitment to SQA**





MELCOR Assessments

- MELCOR 2.1 Assessment Matrix
- Example Experiments
  - Phebus
  - Quench
  - OLHF/LHF
  - RASPLAV
  - LOFT
  - PANDA
  - FLECHT/SEASET
  - CORA13
  - LACE
  - NUPEC
  - Three-Mile Island

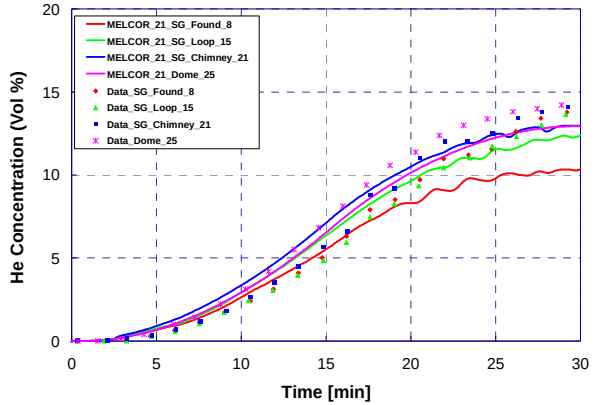
- **MELCOR 2.1 Assessment Matrix**
  - **Over 70 calculations currently in the assessment matrix**
  - **Performed by Sandia National Labs and Russian Academy of Science**
  - **Results to be published with MELCOR 2.1 release**
- **Test calculations cover a broad range of phenomenon**
  - **Core uncovering (i.e., TMI-2 and LOFT-FP2),**
  - **Core damage/melt relocation (TMI-2, PHEBUS, LOFT-FP2)**
  - **Core to upper plenum natural circulatin (TMI-2)**
  - **Natural circulation within SG tubes (i.e. IIST)**
  - **Core to lower plenum natural circulation (i.e., BACCHUS tests)**
  - **Lower head failure (i.e., LHF & OLHF)**
  - **FP release (i.e., ORNL HI & VI, VERCORS, PHEBUS)**
  - **Containment Thermal Hydraulics (i.e., CVTR, HDR, NUPEC, Marviken blowdown, CSTF ice condenser, PANDA etc.)**
  - **Aerosol Deposition (i.e., ABCOVE, SUPRA pool scrubbing, DEMONA, etc.)**

Alternative TMI-2 Accident Benchmark Study

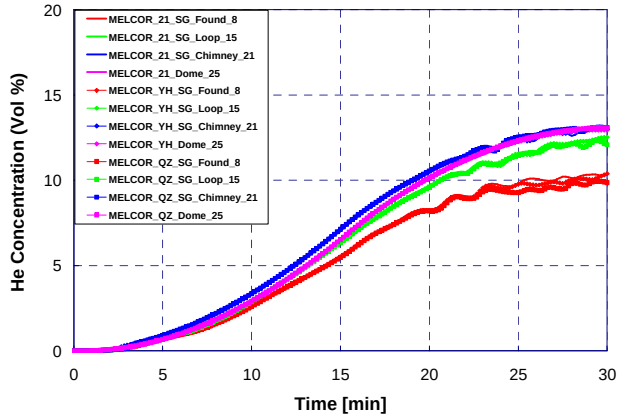
- **OECD/CSNI Alternative TMI-2 Scenario Benchmark**
  - **Participating codes: ASTEC v1.3, ATHLET-CD, ICARE /CATHARE V2, MAAP4 , MELCOR 1.8.5, MELCOR 1.8.6**
  - **Objective to perform a benchmark on a well-defined plant (similar to TMI-2) and with prescribed boundary conditions**
- **Conclusions**
  - **Codes performed well in all phases with little or no tuning of parameters**
  - **Importance of adequate user training**
  - **Prediction of oxidation of molten mixtures**
  - **Prediction of UO_2 melting & interactions**
  - **Prediction of debris coolability**

MELCOR 2.1 Assessment NUPEC M-8-2

- **The key quantities of interest obtained from Test M-8-2 include:**
  - **Helium (e.g., simulated hydrogen) mixing;**
  - **Containment spray performance**
  - **Pressure and temperature response and stratification.**



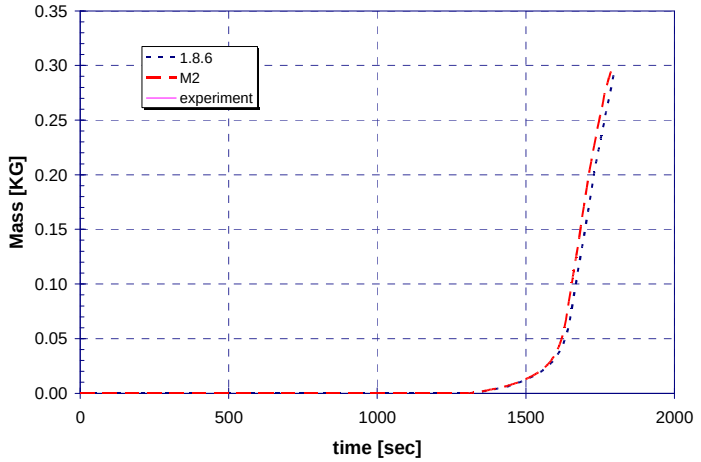
Helium Concentrations in CVs 8, 15, 21, and 25: MELCOR 2.1 Versus Experiment



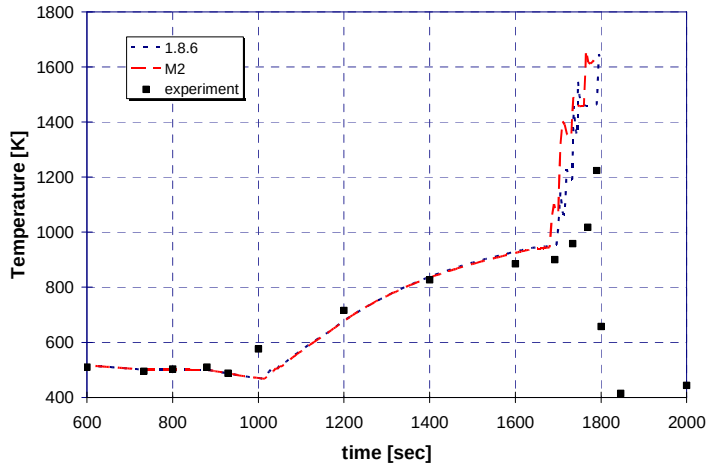
Helium Concentrations in CVs 8, 15, 21, and 25: MELCOR 2.1 Versus MELCOR 1.8.6 (YH) and MELCOR 1.8.5 (QZ)

MELCOR 2.1 Assessment
LOFT LP-FP-2

- **Key phenomena in the LOFT LP-FP-2 tests were oxidation/ hydrogen generation, relocation of core materials, forced convection, conduction, radiation, and fluid-structure heat transfer, pressure response**



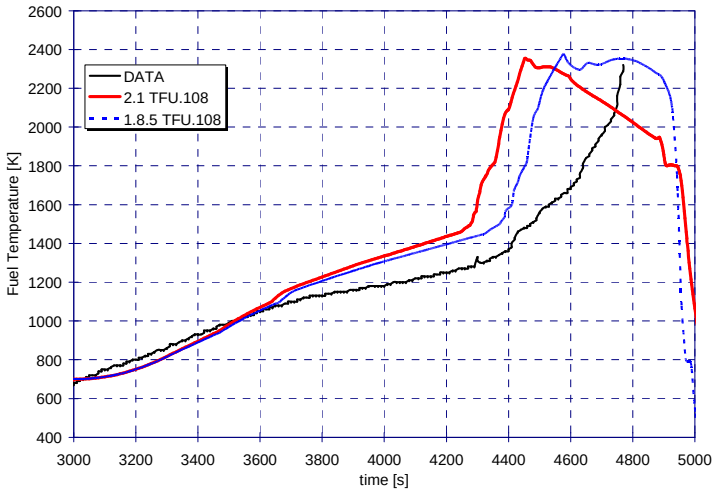
Hydrogen Production from Oxidation of Zircaloy Cladding

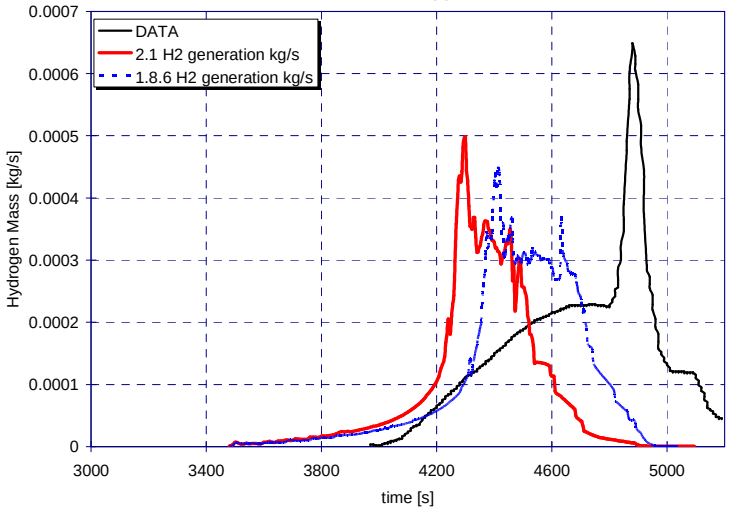


CFM Cladding Temperature 0.25 m from Bottom of Module

MELCOR 2.1 Assessment CORA-13

- **Key phenomena in the CORA-13 tests were oxidation/hydrogen generation, relocation of core materials, forced convection, conduction, radiation, and fluid-structure heat transfer.**





MELCOR 2.1 Assessment
LACE-LA-4

- Aerosol Modeling
- Hygroscopic effects
  - Temperatures
  - Pressures

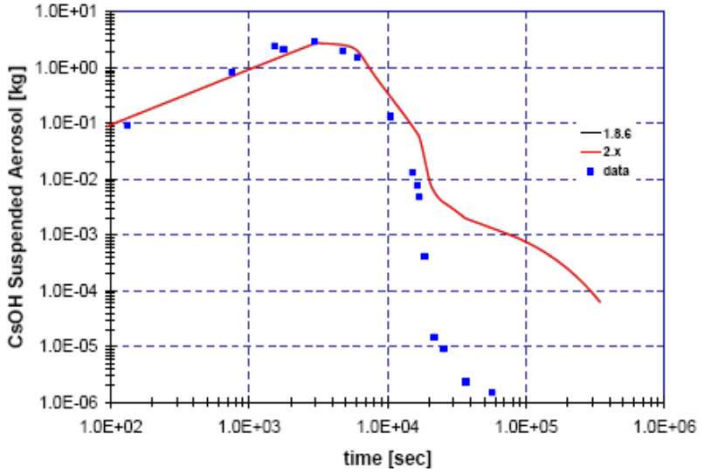


Figure 3-9. Suspended CsOH Aerosol

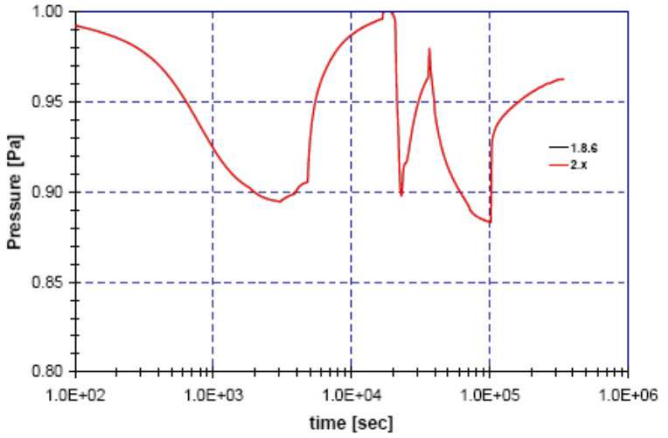
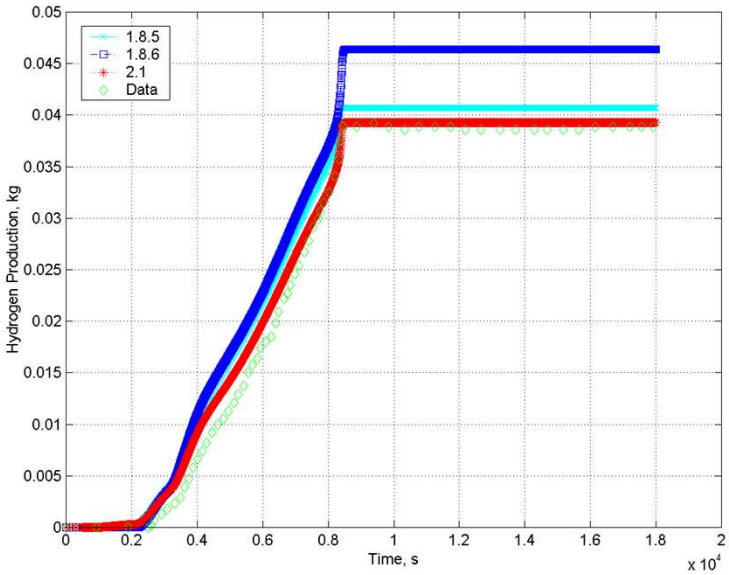


Figure 3-7. Test Vessel Relative Humidity

MELCOR 2.1 Assessment PHEBUS B9

- **Key Phenomenon**
  - **Core material relocation,**
  - **temperature histories,**
    - **Heat conduction/ convection**
    - **fuel relocation**
  - **hydrogen production.**
    - **hydrogen production occurrs during the initial steam phase before any relocation,**
    - **relatively insensitive to simulation parameters.**



MELCOR 1.8.5, 1.8.6, and 2.1 Hydrogen Production and Data

MELCOR Code Regression Testing

- **Test Suite run on a distributed computer cluster**
  - **10 Dell PowerEdge 2950s (40 runs)**
    - **2 Dual Core, Hyperthreading 64-bit Xeon Processors, with 2MB cache, running at 3 GHz**
    - **667MHz Front-side bus**
    - **8GB RAM**
  - **DEF - tool for automatically launching jobs to distributed machines**
  - **Results archived in subversion**
- **Test Cases**
  - **Standard test cases chosen for physics coverage ~14 test cases**
    - **New cases will be added as validation calculations are run**
    - **Debug & optimized versions tested**
    - **Unix versions not tested as frequently (will test more frequently in future)**
  - **Special purpose cases to address particular bug issues**

Case	BUR	CAV	CF	COR	CVH	DCH	FCL	FDI	FL	HS	NCG	PAR	RN	SPR
M-8-1 NoMix			X		X				X	X	X			
M-8-1 SYM			X		X				X	X	X			
Lace7			X		X	X			X	X	X		X	
Lace8			X		X	X			X	X	X		X	
Vanam-M3			X		X				X	X	X		X	
Molten Salt			X	X	X				X	X	X			
PHEBUS-B9			X	X	X				X	X	X			
FPT1			X	X	X	X			X	X	X		X	
LOFT			X	X	X	X			X	X	X			
Test Inew	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SURRY (LBLOCA)	X	X	X	X	X	X	X	X	X	X	X		X	X
Zion (SBO)		X	X	X	X	X	X	X	X	X	X	X	X	X
PeachBottom (SBO)	X	X	X	X	X	X			X	X	X		X	X
Grand Gulf (SBO)	X	X	X	X	X	X		X	X	X	X		X	

Table 1-1: Physics Package Coverage

Regression Tests

- **Regression testing performed with each interim code release**
- **Standard Test Suite**
  - **Qualifies the code for particular application**
    - **Analytical results**
    - **Using ISP or other recognized assessments**
    - **Baby problems**
  - **Formal regression testing report (made available to users)**
  - **Review test cases**
    - **Every major code release**
    - **Coverage testing**
- **Special Purpose Testing**
  - **Regression test for each resolved bug**
  - **Regression test for new feature or enhancement**
  - **Responsibilities of submitter (owner)**
    - **supply success criterion**
    - **review test results for success**
  - **Test case made inactive after three successes (still available for future testing)**

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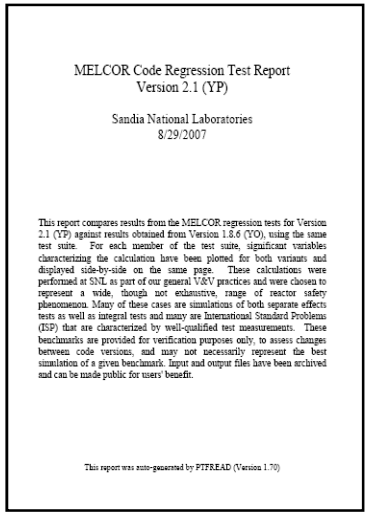
MELCOR Code Regression Test Report

- **Auto-generated regression test report**
  - **Readable and highly formatted report (PDF)**
  - **Auto-generation allows report for each interim code release**
  - **Reports to be made available to users**
- **Side-by-side comparison of regression test results**
  - **Comparison plots for two code versions**
  - **Event time tables**
- **Test suite coverage tables**
- **Test case dimension table**
- **Pedigree information**
- **Automated Nightly builds and regression testing (New!)**



MELCOR Code Regression Test Report
Version 2.1 (YP)

Sandia National Laboratories
8/29/2007

This report compares results from the MELCOR regression tests for Version 2.1 (YP) against results obtained from Version 1.8.6 (YO), using the same test suite. For each member of the test suite, significant variables characterizing the calculation have been plotted for both variants and displayed side-by-side on the same page. These calculations were performed at SNL as part of our general V&V practices and were chosen to represent a wide, though not exhaustive, range of reactor safety phenomenon. Many of these cases are simulations of both separate effects tests as well as integral tests and many are International Standard Problems (ISP) that are characterized by well-qualified test measurements. These benchmarks are provided for verification purposes only, to assess changes between code versions, and may not necessarily represent the best simulation of a given benchmark. Input and output files have been archived and can be made public for users' benefit.

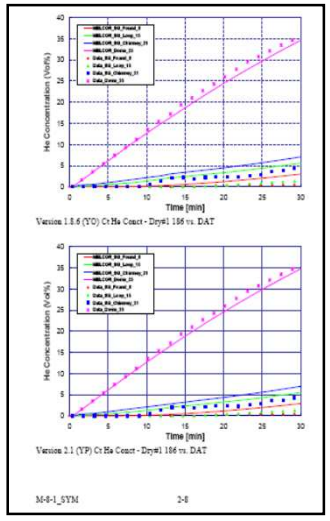
This report was auto-generated by PTFREAD (Version 1.70)

Case	#CVs	#FLs	#HSs	#CAVs	#NCGs	#Classes	NRAD	NAXL	Tend (sec)	CPU (sec)
M-8-1_NoMix	35	60	124		6		0	0	1800	262
M-8-1_SYM	36	63	124		6		0	0	1800	263
Lace7	3	2	6		5	16	0	0	342011	446
Lace8	3	2	6		5	16	0	0	342011	487
Vanam-M3	15	15	56		5	16	0	0	108000	13788
Molten Salt	15	3	5		10	16	3	6	3500	2054
PHEBUS-B9	5	4	13		9	16	3	12	18000	1141
FPT1	31	29	68		9	16	2	31	30000	206255
LOFT	20	30	56		9	0	3	16	1800	904
Test_lnew	8	11	12	1	9	16	3	10	24950	1120
SURRY (LBLOCA)	142	263	324	1	9	19	6	17	43170	484158
Zion (SBO)	123	209	220	1	9	16	6	19	36000	138786
PeachBottom (SBO)	123	254	143	3	9	18	6	17	86400	185090
Grand Gulf (SBO)	112	224	145	1	9	16	6	17	5800	72395

Table 1-2: Calculation Size (Dimensions)

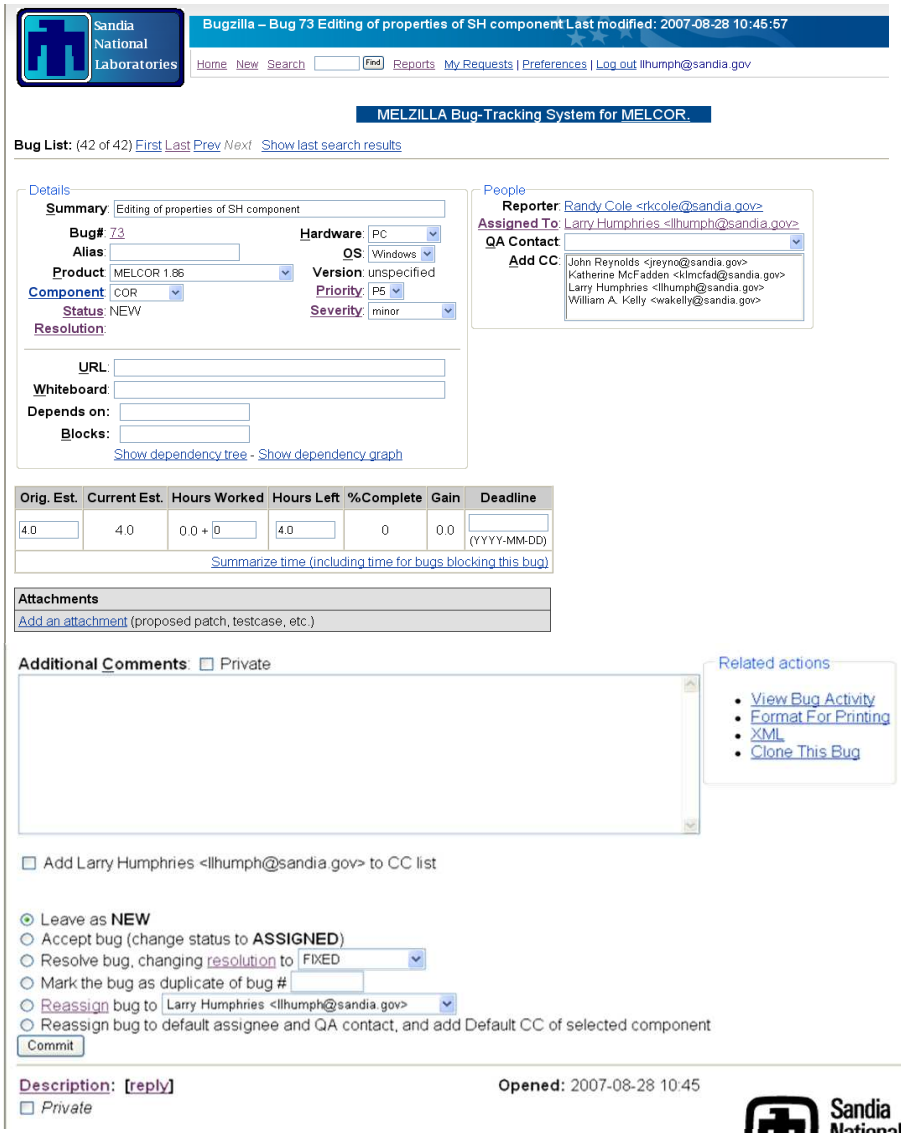
Event	Version 1.8.6 (YO) Time (sec)	Version 1.86 (YP) Time (sec)
Gap Release - Ring 1	12260.28	12255.43
Gap Release - Ring 2	12380.07	12372.34
Gap Release - Ring 3	12500.45	12490.38
Gap Release - Ring 4	12800.27	12785.37
Gap Release - Ring 5	13280.07	13278.2
Support Failure - Ring 1	13957.66	13950.94
Support Failure - Ring 2	14005.5	14000.32
Support Failure - Ring 3	15285.52	15270.52
Support Failure - Ring 4	15357.34	15330.22
Support Failure - Ring 5	21716.79	21712.30
Penetration_Failure_-by_LH_Temperature - 1	25890.57	25870.42
Penetration_Failure_-by_LH_Temperature - 2	25717.45	25710.50
Penetration_Failure_-by_LH_Temperature - 3	25405.02	25403.14

Table 12-1: Event Time Comparison



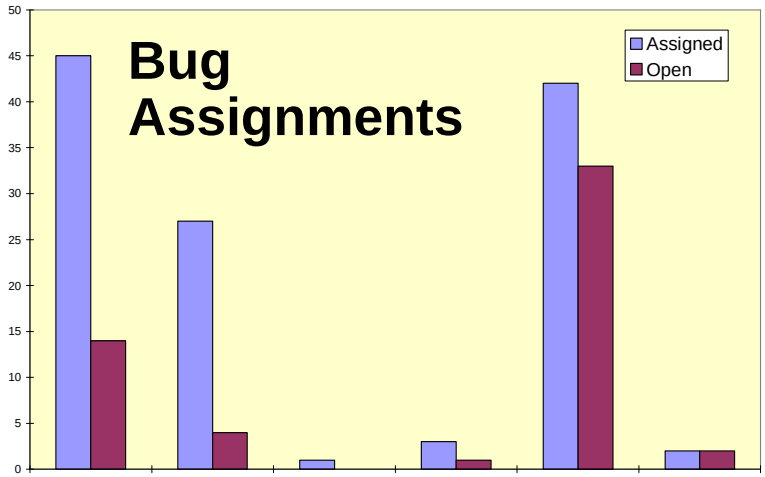
MELZILLA Bug Reporting

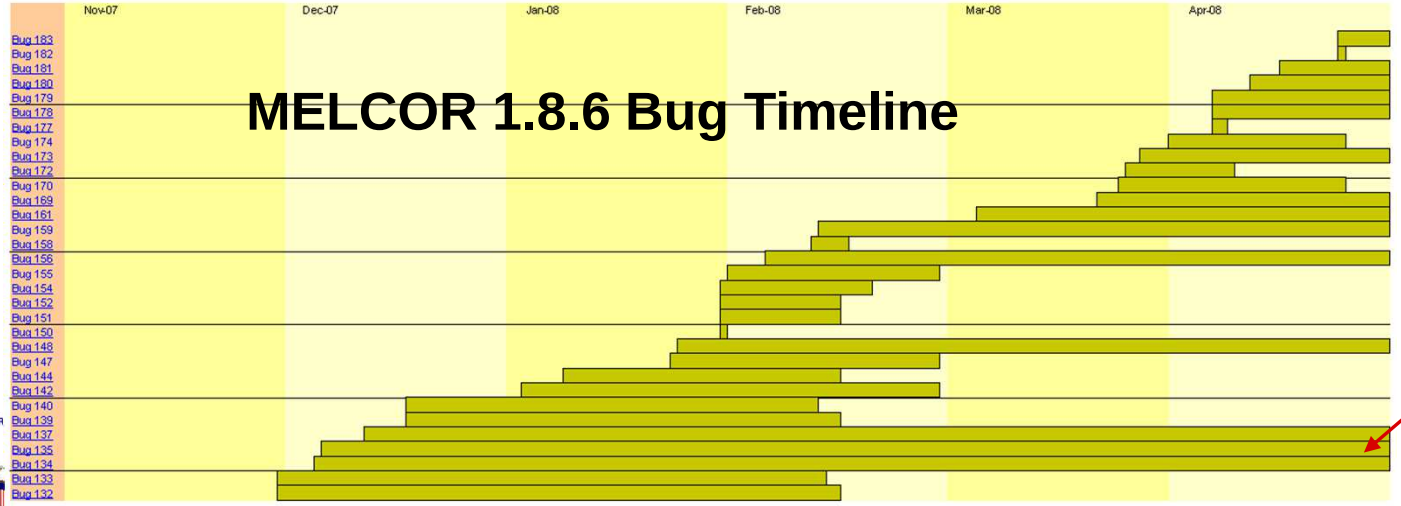
- **Bugzilla site for bug reporting, tracking, and information**
  - **Available from SNL web page**
- **Users submit bugs and details**
  - **OS, Hardware, affected packages, severity**
  - **Bug description**
  - **Attachments**
- **Comments and attachments can be marked private and not visible to other users**
- **Utilized more by MELCOR community**
  - **90 bugs (M1.8.6) reported last 12 mos.**
  - **68 bugs (M1.8.6) resolved**
  - **22 bugs (M1.8.6) unresolved**



Bugs Tracked in MELZILLA

- **Automated applications for reporting issue management**
  - **Integrated with MSOffice, Bugzilla, and internal Wiki**
  - **Charts of open/assigned issues**
    - **Leveling bugs with developers availability**
  - **Timeline showing issues entered into bugzilla**
    - **Trying to reduce the length of time a bug is left open**
    - **Some issues are harder to resolve than others**





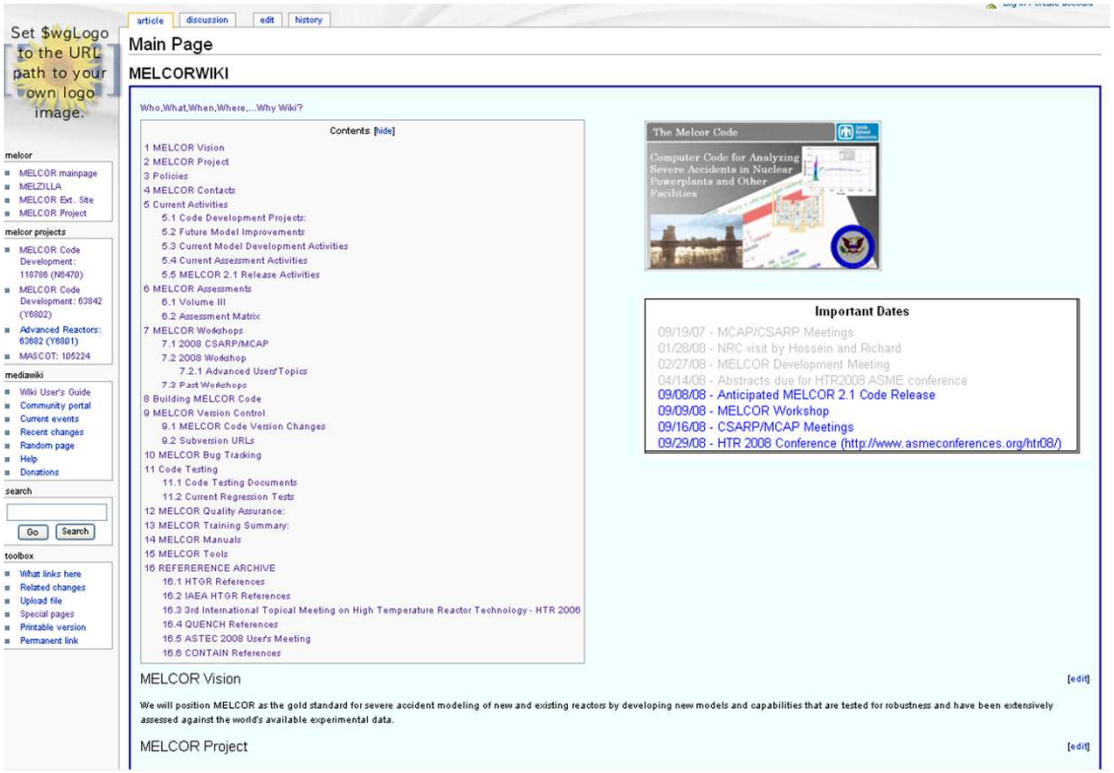
Need to eliminate bugs that are unresolved for more than a month

Post-Workshop Bugs (M2.1)

- 218: Steady-State option leads to temperature on HS_ND record and warningin MELGEN
- 228: Logic error 4 in CVHMOM
- 229: Failure with converted input for VVER440
- 230: Error with unformatted EDF files
- 231: No error checks for time-dependent volume properties
- 234: File open warning in M_EXEC
- 236: PWR Shroud collapse temperature
- 238: Advanced B4C modeling
- 239: VVER calculation volume freezing – Film Tracking
- 240: CORA-13 COREU3 run-time error
- 241: Integer valued CF arguments
- 242: MELCOR 2.1 freezes
- 251: In CVH_INPUT CV_SOU the H2O_VAP for IDMAT isn't functioning properly
- 252: COROXY call to COROXD can result in invalid memory writes
- 254: MACCS interface variables calculation bug
- 257: Component collapse parameters
- 259: Wrong listing of film tracking in MEGOUT_v2-0
- 260: Abnormal termination on EDF with Belikov error
- 261: LOGIC ERROR 4 in CVHMOM
- 262: Content of ERROR and WARNING Messages
- 265: NMPAIR on DCH_EL is supposed to be optional
- 266: Array bounds exceeded in elheat_NSI
- 267: Error flag not set in cvhbv1_NSI
- 271: IHX model incorrectly implemented
- 272: Input echo missing comments and global variables

MELCOR Developers Wiki Site – Internal Use

- **MELCOR Developers Wiki**
  - **Archive records**
    - **Requirements**
    - **Testing reports**
    - **Quality Records**
    - **Assessment work**
  - **Information Sharing**
    - **Debugging Policies**
    - **Testing Policies**
    - **Code Development practices**
    - **Coding Conventions**
    - **Lessons Learned**
    - **Software Risk Management**
    - **Version Changes**



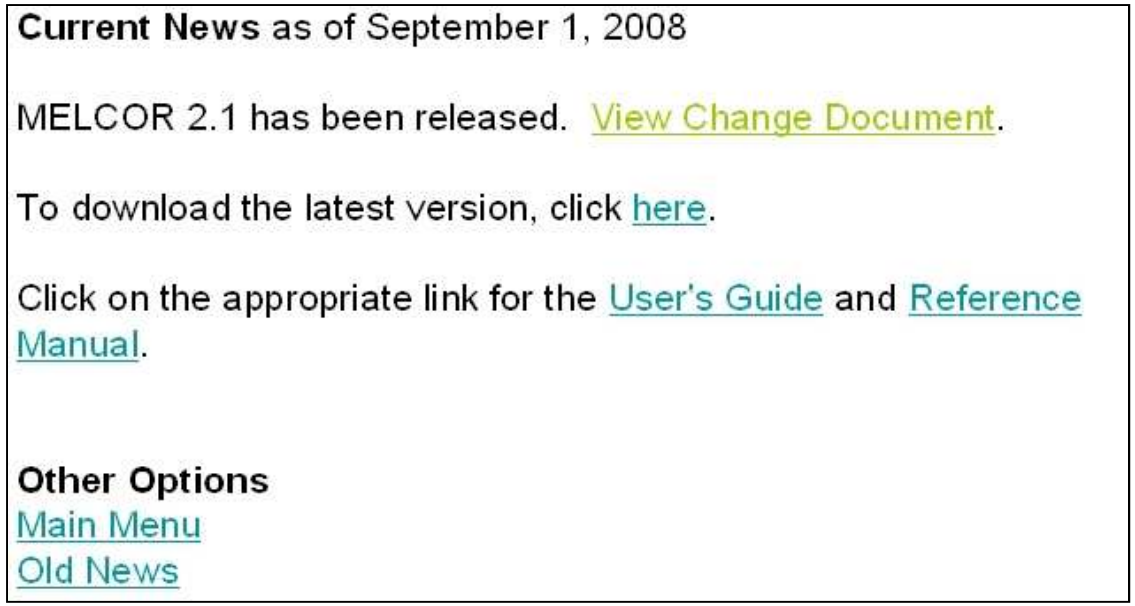
MELCOR Web Page

- New Look
- Downloads
  - MELCOR executables
  - Converter executables
  - 2.1 GUI
  - Documentation
  - PTFREAD
  - Change Documents
- Workshop / CSARP information
- Bug reporting
- FAQs
- More? Regression reports,…

MELCOR Online: Downloading MELCOR

- **Account login is your email address**
- **All authorized MELCOR users are given an account**
  - **First time users must receive authorization from USNRC**
- **Access from MELCOR website or go directly to https://melcor.sandia.gov/MelcorDownloads/MelcorDownloadStart.aspx**
- **You can follow its hierarchical links to access every file on the system**

To quickly download the latest version of MELCOR, just click the “Latest News” link to see a page like this:



Change Document Available Online

1.86YT: Changes since 1.86YS are listed below.

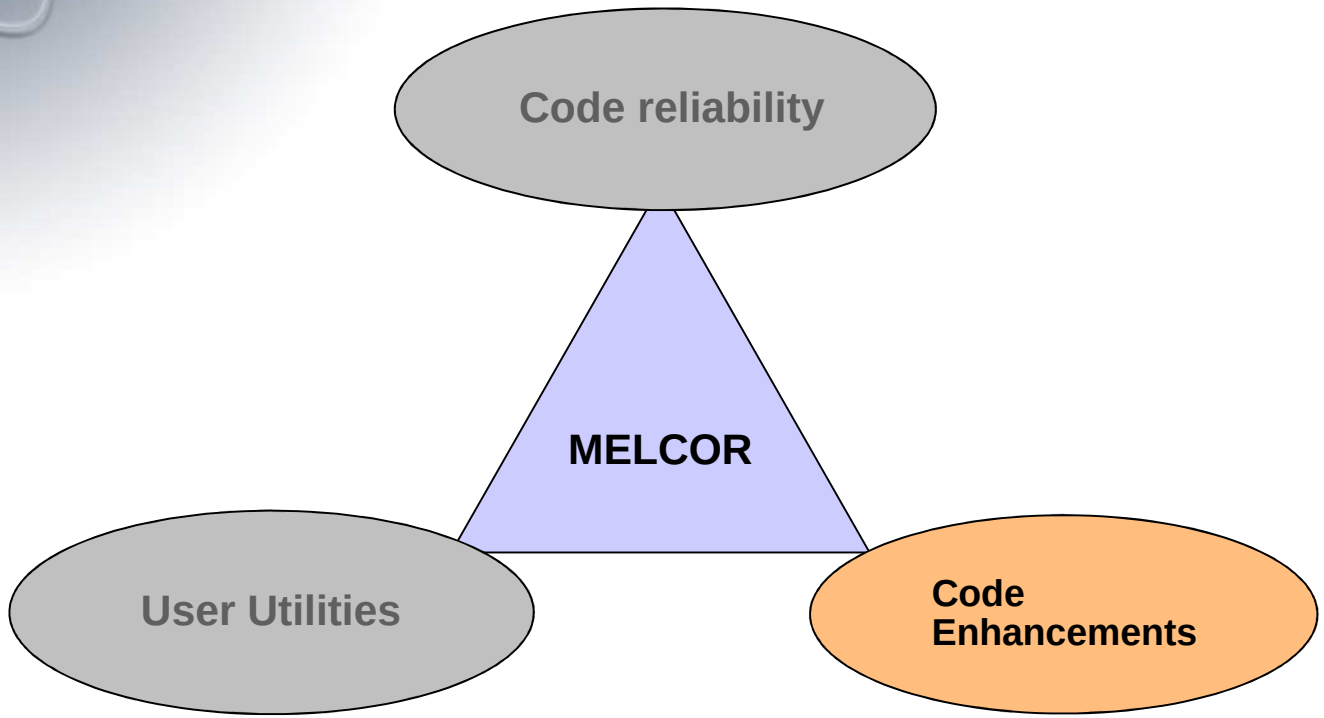
Subversion Branch Location	Revision	Changed Files	Notes
Branches/1.86YS/YT_Development_Trunk	1004	Coredt.f	Correct problem with zero total volume in edit for outer ring without HS. (Bug #: 154)
Branches/1.86YS/YT_Development_Trunk	1001	Melcor.f, melgen.f	Add CVF project workspace and Brisc input
Branches/1.86YS/YT_Development_Trunk	985	aaaPointKinetics.f90 aaarnpool.f	Fix pool deallocate routine 2-15-2008

1.86YS: Changes since 1.86YR are listed below. With this release, a Word document file format is being adopted. Old format will be retained with old release notes at the end of the document.

MELCOR 1.86.YS Changes

Subversion Branch Location	Start Revision # from SubVersion Repository	Finished Revision # from SubVersion Repository	Changed Files	Notes
Trunk	952	NA	Cordhc, coredt	Fixes for Bug 155 (involving steel canister), including COREDT changes for IOCN(:) and IOCB(:)
Trunk	942	NA	Coredt	Fixes problem with zero Clad masses for the COR text edit for all the test problems. (Bug#: 114)
Trunk	938	NA	Coredt, coruin	Fixes problems with steam starvation plot variable. Allows 7 parameters for COREDV01 (coruin) and removes extra "." in COR-STARV-OXY plot variable.
Trunk	928	NA	Cvthrm	Disable the new "not quite equilibrium" modeling (Bug #68). This feature will be completed in the next code revision.
Trunk	920	NA	Corrn5	Corrects CORE SUPPORT STRUCTURE (*ERR*) HAS FAILED IN CELL (Bug #: 56)
Trunk	915	NA	Coredt	Fixed Missing MP components in volume text edits
Trunk	914	NA	Rnlrnh.f	Fixed problem with surface area calculated for HS with multiplicity 0.0.
Trunk	864	NA	Cvtnqe	Restored from rollback: Significant changes to cvtnqe by rkc to resolve some problems observed with the "original YS", and also to resolve bug 147.
branches/1.86YS RCl/Developers/jjoonyu/trunk	730	841	cavuin	Allow IBUBX=2 for pool scrubbing of all aerosol and vapor species
branches/1.86YR/jjoonyu	558	564	Cordb5, corps2, corrbl, corrn4, cordbz.	Fixed Rod-dam-flag control function argument.

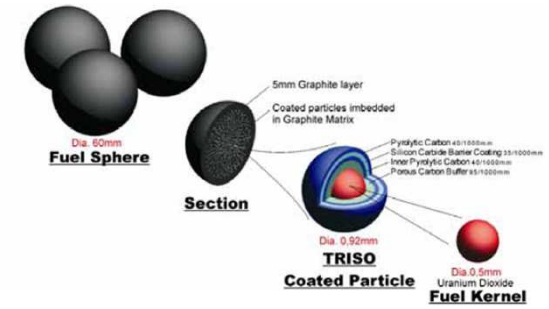
Code Development: Code Enhancements



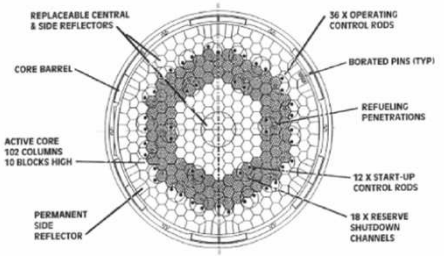
- **All new code development will be performed in MELCOR 2.1**
- **MELCOR 1.8.6 – Code Maintenance only**

Code Development
HTGR - COR Package Updates

- New reactor models (like present PWR, BWR)
- PBR (pebble bed)
  - New components
    - Pebble fuel
  - New heat transfer coefficients
  - Effective thermal conductivity
    - radiation/convection/conduction
  - Coolant friction loss



- PBR (prismatic)
  - New components
    - Reflectors
    - Hexagonal graphite blocks
  - cell-cell conductive/radiative heat transfer



- Graphite oxidation models
- On-going work
  - Fission product release and transport from HTGR fuel
  - Plant demonstration calculations

PBR COR Model

- **Fueled part of pebble is fuel component**
  - **UO_2 with extra COR material as graphite**
- **Unfueled shell is clad component**
  - **Clad material becomes graphite**
- **Center reflector component**
- **Outer reflector component**
- **Fuel radial temperature profile for sphere**
  - **Provides peak and surface pebble temperature**
    - **Better reactor simulation**

PBR COR Model contd

- **Radial cell-cell conductive/radiative heat transfer added**
  - **Uses effective bed conductivity (Zehner-Schlunder with modifications for thermal radiation)**
- **Axial cell-cell conduction modified to use effective bed conductivity**
- **Coolant friction factor is for pebble bed (Ergun equation) when PBR model is invoked**
  - **Achenbach correlation being investigated**
- **Coolant heat transfer uses pebble bed heat transfer coefficients**

PMR COR Model

- More “rod-like”, requires fewer changes to COR
- Fuel compacts represented as fuel component
- Part of hex block associated with a fuel channel is “thick” clad component
  - Temperature gradient in clad as well as fuel
- Reflector components
- Radial cell-cell conductive/radiative heat transfer added
  - Single effective thermal conductivity

Graphite Oxidation Models

- **Oxidation of graphite by steam and air**
  - **The air oxidation rate is implemented as (Richards, 1987)**

$$R_{OX} = 122.19 \exp\left(-\frac{20129}{T}\right) P^{0.5}$$

  - **The steam oxidation model is implemented as (Richards, 1988)**

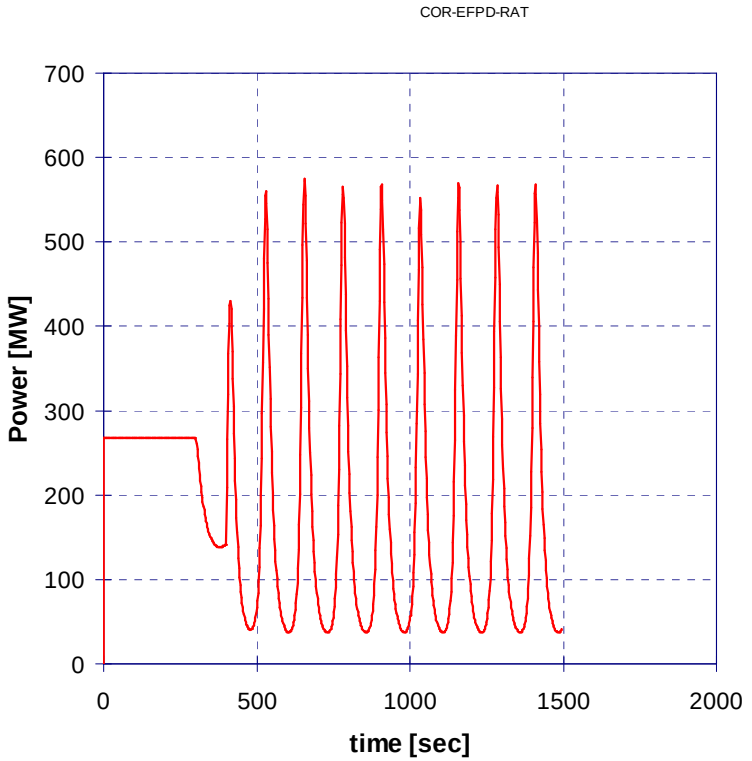
$$R_{OX,steam} = \frac{k_4 P_{H_2O}}{1 + k_5 P_{H_2}^{0.5} + k_6 P_{H_2O}} \qquad k_i = K_i \exp\left(-\frac{E_i}{RT}\right)$$

- **Maximum rates limited by gaseous diffusion to surface**
- **Reaction Products**
  - **Currently, the air reaction produces CO**
  - **Steam reaction produces CO and H_2**
  - **The CO/CO_2 mole ratio is given by (Kim and NO, 2006)**

$$f_{CO/CO_2} = 7396 e^{-69604/RT}$$

Point Kinetics Model

- **Point kinetics for operating reactor applications**
  - **Model developed by UNM**
    - **Stable over wide range of timesteps**
  - **Temperature-dependent reactivity feedback from COR components**
    - **Fuel/Moderator/Reflector generalized weighting for spatially averaged feedback**
  - **External reactivity insertion via control functions**
    - **Generalized and flexible**



Sample Test

- **Initial power level is 268 MW**
- **$0.50 reactivity oscillation (CF)**
  - **Period is 2π/0.05 = 125 s**
- **Doppler feedback from fuel and moderator**
- **PK Model turned on at 300 s**
- **Oscillation started at 400 s**

HTGR COR Model Testing

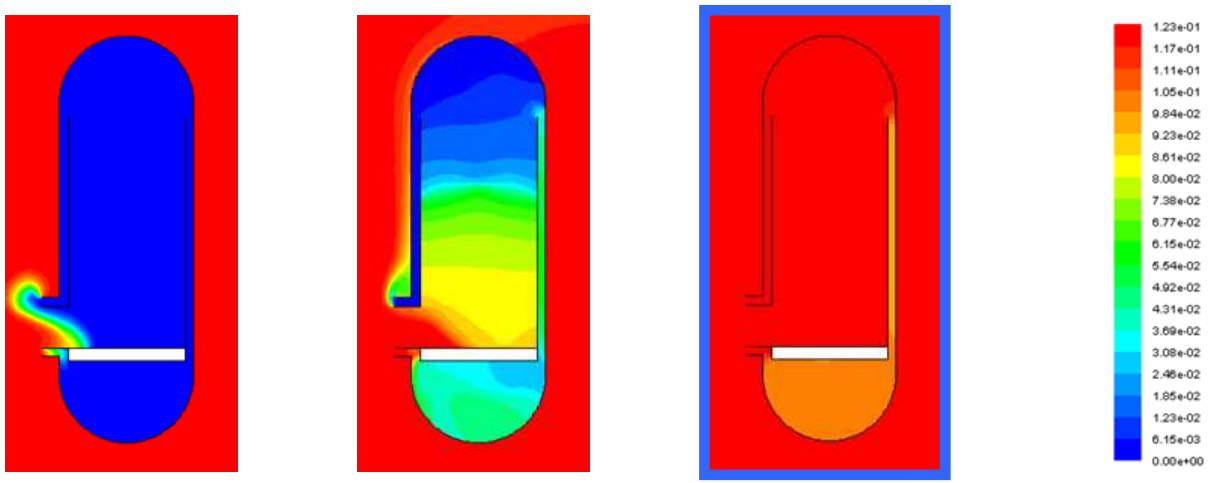
- **PBR Testing of new COR model**
- **Deck adapted from Texas A&M PBR deck**
  - **Pebbles represented as fuel/clad components instead of debris**
  - **Steady state problem**
    - **268 MW reactor power**
    - **Run to 1500 s**
  - **Reactor is older Pty Ltd design as in Reitsma (2006)**

HTGR Ongoing Work

- **Fission product release and transport from HTGR fuel**
  - **Release**
    - **Review PARFUME models**
    - **Devise simplified MELCOR model (Booth?)**
  - **Transport**
    - **Plate out**
    - **Surface sorption**
    - **Dust liftoff**
- **Plant demonstration calculations**
  - **Use of point kinetics for accidents w/o SCRAM**
  - **Consider coupling of 2D neutronics (ie PARCS) with COR**
- **HTGR RCCS model**
  - **Removal of heat from vessel**
- **Plant components**
  - **Gas turbine**
  - **Heat exchangers**
  - **Helium circulator**

HTGR Ongoing Work contd

- **Stratified flow for air ingress**
  - **Original scenario was that air entered by diffusion**
    - **10hr timescale**
  - **CFD simulation shows that air enters via stratified flow and circulation (Kim, 2008)**
    - **260s timescale**



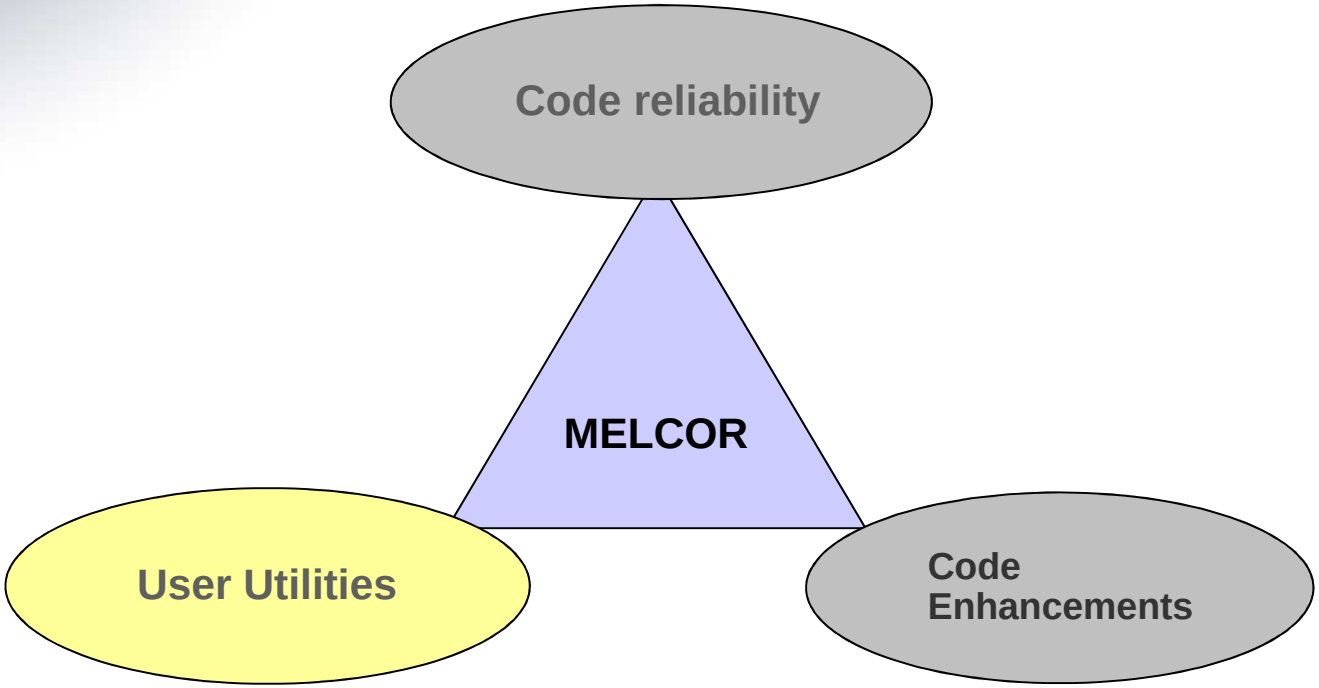
1.0 sec **16.0 sec** **256.0 sec**

- **Snap Shots of Simulation (Air Mole Fraction) from "NRC/INL Meeting on Methods for VHTRs", E. Kim, C. Oh, R. Schultz, INL (2008)**

Code Development
New Modeling for MELCOR 3.0

- **Heat and Mass Transfer Correlations**
  - MELCOR code should be able to model the CONTAIN correlations by default
  - Modify the MELCOR film tracking model and default model parameters based on the CONTAIN parity
- **Engineered Safety Features (ESF) Enhancements**
  - heat exchanger models
  - fan cooler models
- **Improvement of SPARC Models**
  - Review the SPARC98 model for possible improvements over the earlier SPARC90 model
- **Improvement of VANESA Models**
  - improvements for ex-vessel fission product release. Specifically, the modeling of Ru and Mo)releases
- Others…

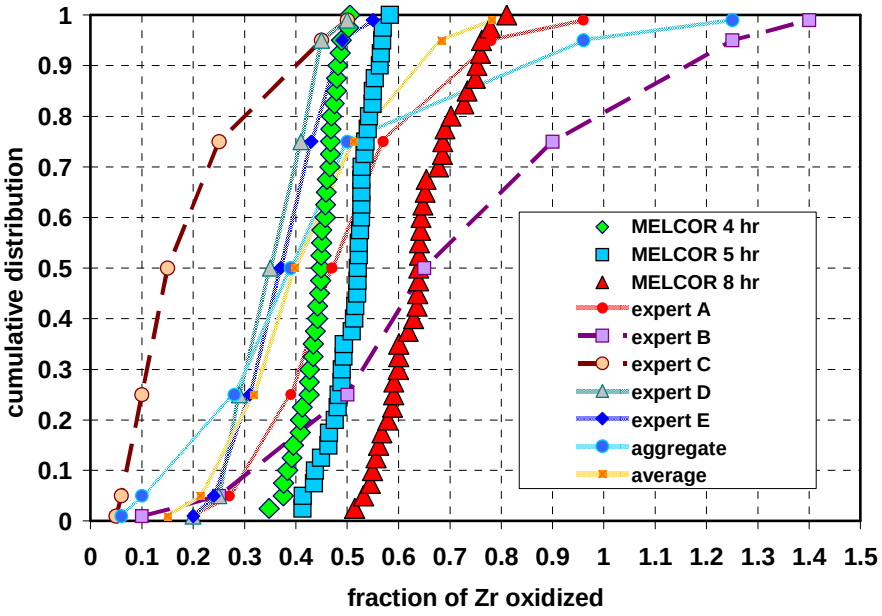
Code Development: User Utilities



Supporting Applications

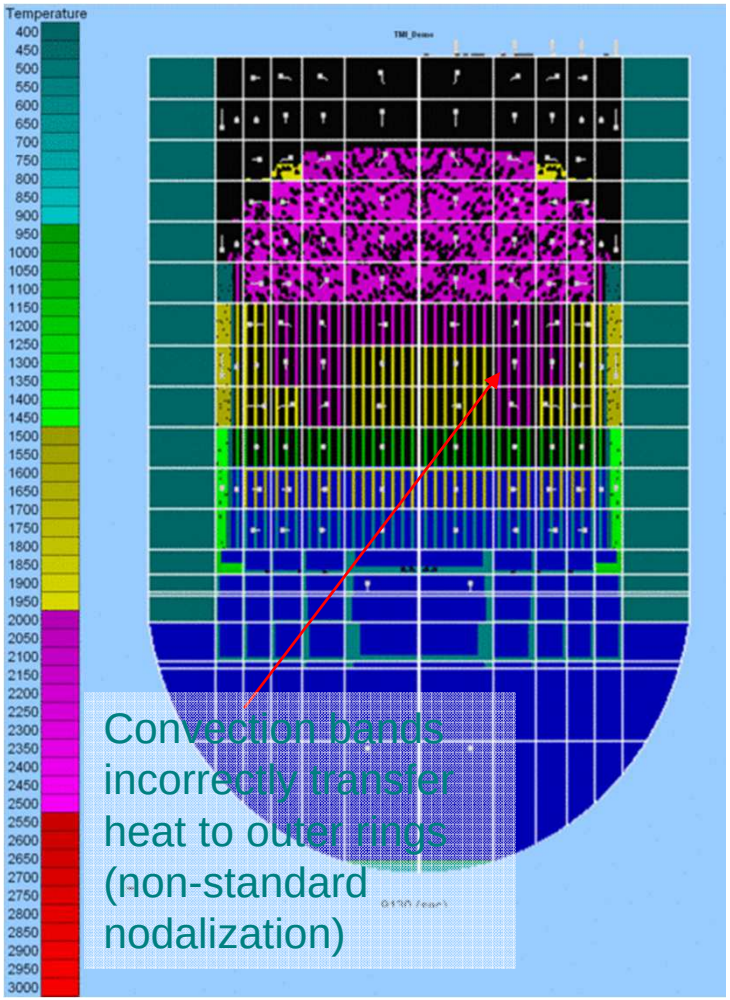
- **SNAP**
  - Symbolic Nuclear Analysis Package develped by API – MELCOR Plug-in
- **PTFREAD**
  - EXCEL add-in for generating plots, analyzing data, creating AVI's, generation of regression reports
- **MELCOR 2.1 GUI & Converter**
  - Utility for generating MELCOR 2.1 input decks and converting existing MELCOR 1.8.6 decks to new format
- **Uncertainty Software**
  - Suite of tools for running MELCOR in batch, Monte Carlo sampling of variables and analyzing statistics

- *Best Estimate with Uncertainty Quantification*
- *Powerful tool for risk-informing regulations*



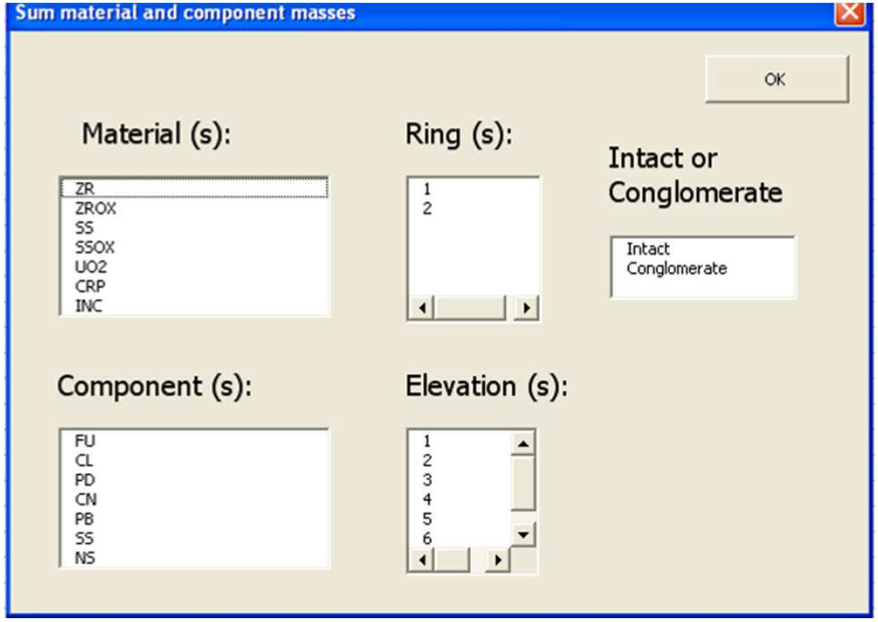
PTFREAD
New AVI Capabilities

- New AVI format indicates temperature of component by color
- Flow velocities
  - If horizontal flow paths exist
    - Vertical component
      - linear interpolation of the vertical flow velocity at the flow path junction height horizontal velocity
    - Horizontal component
      - taken from the horizontal flow path.
    - Vector is positioned at the radial center of the CV & the horizontal flow path junction height.
  - If a horizontal flow path does not exist
    - The vertical velocity component in a control volume is calculated as the average of all inlet and outlet vertical flow velocities and a vector is drawn at the center of the control volume.



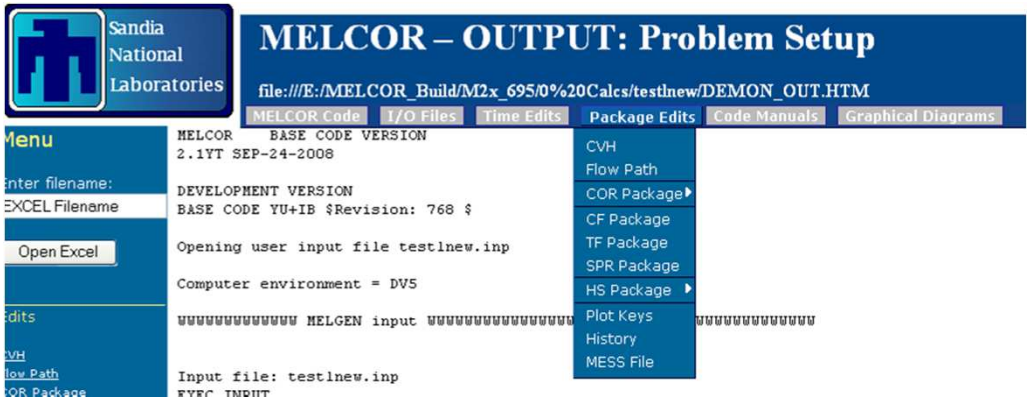
PTFREAD
New Mass Balance plot variables

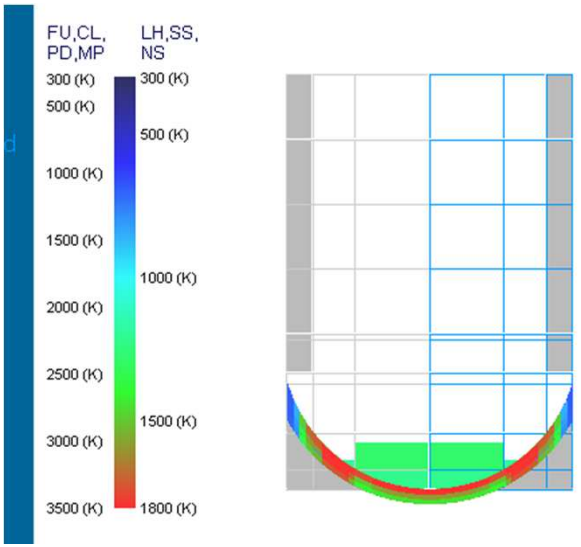
- This is a new PTFread *calculated* variable and is accessed by selecting *CALCULATED* when asked to specify the MELCOR package for the variable:
  - Mass is summed over a user-specified range of materials
  - Mass is summed over a user-specified range of components
  - Mass is summed over a user-specified range of rings
  - Intact and/or conglomerate masses can be indicated
  - Wildcards can be used to sum over an entire range
- PTFREAD variable Format (as appears in the header row on the data sheet):
  - SumMass(intact or conglomerate, material, component, elevations, rings)
  - Example: SumMass(*,SS:SSOX,*,1:2:3:4:5,*)
- Option for elemental mass in oxide (SSel)
  - Only the elemental mass of Fe is included in the sum (does not include Oxygen mass)



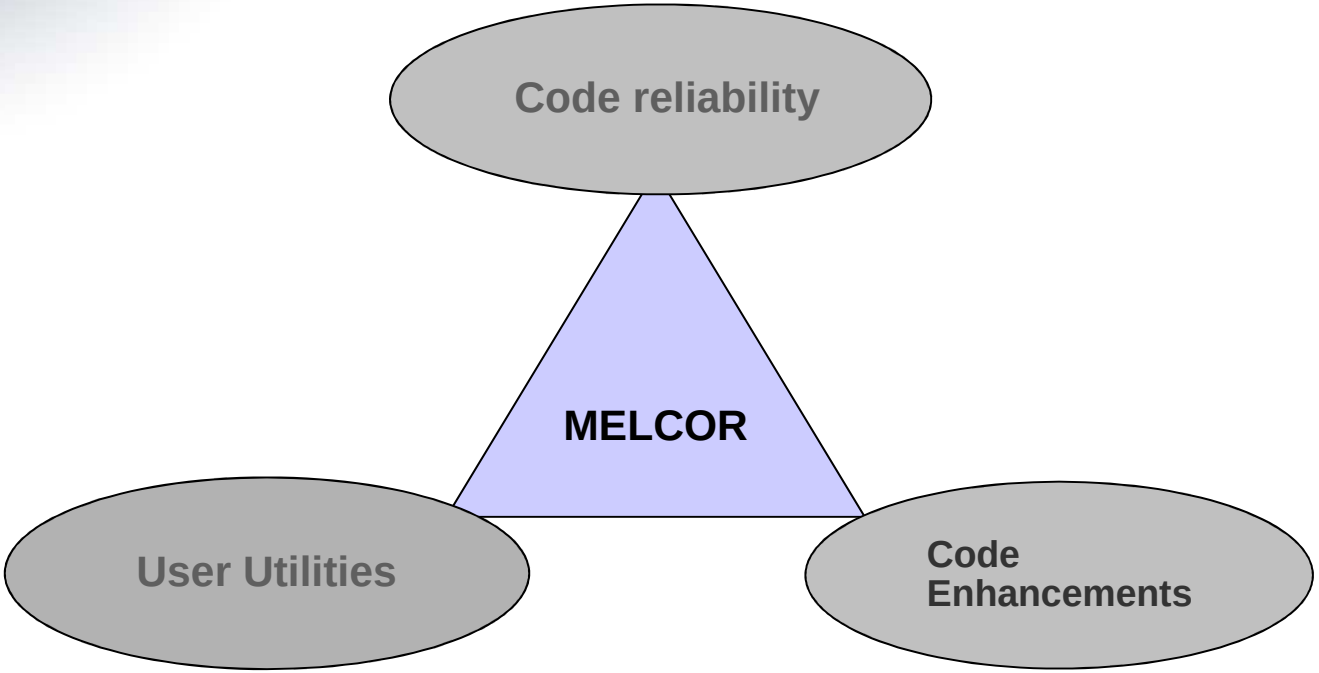
New MELCOR Output Format HTML

- **HTML Time Edits**
  - **Specified with global input**
    - **MEL_HTMLFILE 'DEMON_Out.htm'**
  - **File for each time edit**
  - **Links to other time edits**
  - **Links to package edits/tables**
- **Other Links**
  - **SNL/Bugzilla**
  - **I/O files**
  - **Code Manuals**
  - **Graphical Diagrams**
    - **Node Diagram**
    - **Temperature contours**





Other MELCOR Changes



Intel Visual FORTRAN Compiler

- **Compaq Visual FORTRAN v 6.6C is current developmental compiler**
  - **Did not want to make any changes until after 2.1 was released**
- **Intel Visual FORTRAN will become the new development platform**
  - **No technical support for CVF**
  - **Problems with CVF rebuilding entire project**
  - **Problems with error checking**
- **Advantages to Intel Compiler**
  - **Able to build true 64-bit code for 64-bit operating systems**
    - **Performance improvements**
  - **Better support for F95 code**
    - **Error checking**
  - **Currently the only compiler we are supporting on Linux**
  - **Improvements to the programmer interface (Visual Studio.NET)**
    - **Automatic keyword completion**
    - **Integration with subversion**
  - **Capability to automatically convert CVF projects**

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MELCOR Licensing - Overview

- **This and future MELCOR releases will be node-locked**
  - **Each installation will require a separate license to run**
  - **A license will only work on the computer for which it was issued**
- **All licenses will expire**
  - **Normally within one year**
  - **Period may be shorter for special releases**
  - **The version of MELCOR released at this workshop will expire on 1 February 2009**
    - **Check the MELCOR website for upcoming release dates**

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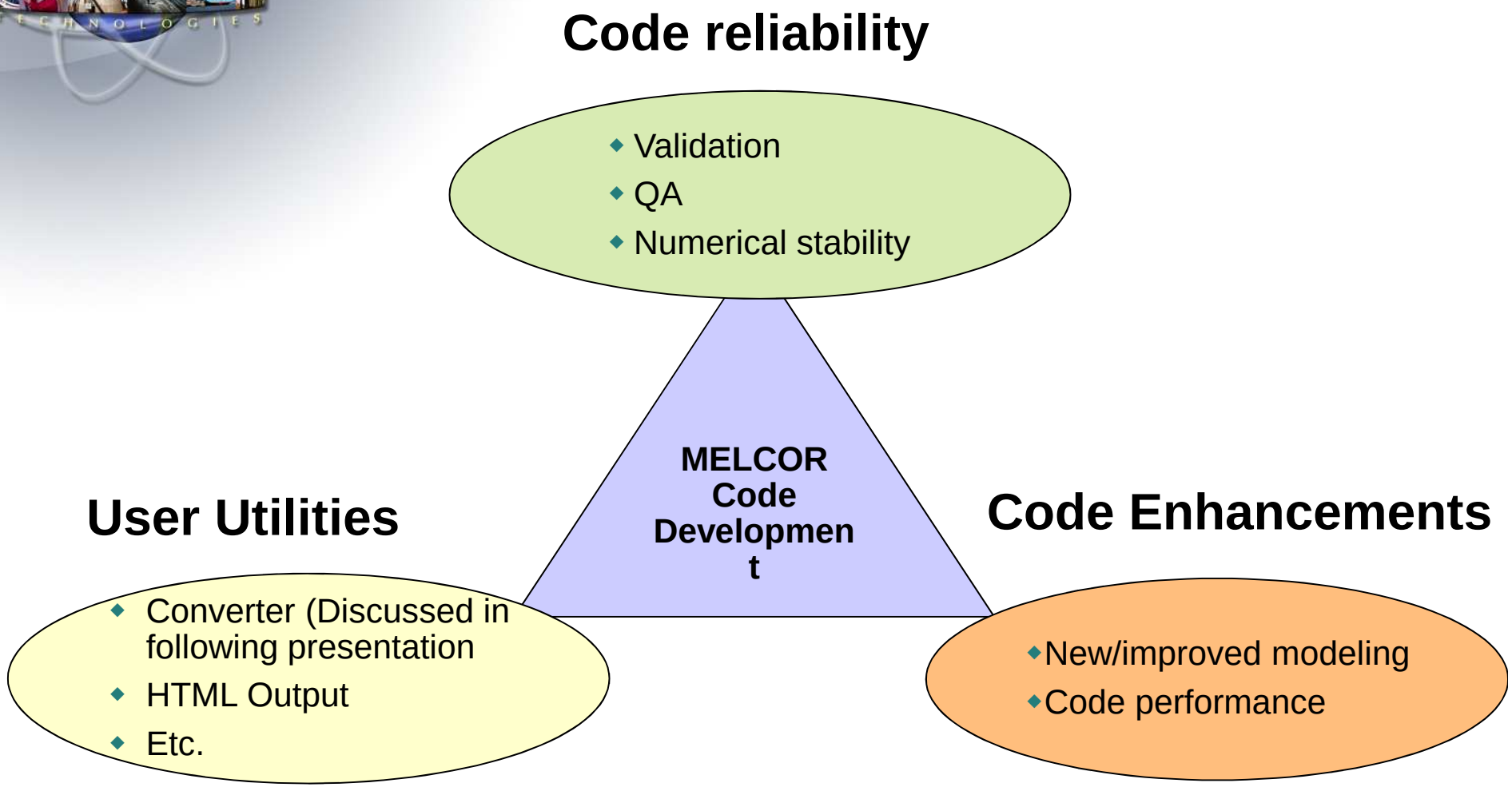
MELCOR Licensing - Requirements

- **Two files now required besides the MELCOR and MELGEN executables:**
  - **calu_nl.dll**
    - **Contains the CALU (Cross-plAtform Licensing Utility) software that is called by both MELCOR and MELGEN**
    - **Any media we provide MELCOR on will also include this DLL**
  - **Product.key**
    - **Contains your license**
    - **This file is requested via email**
- **Both files must be in the same folder as your MELCOR executable or it will not run**

Summary


Code reliability
Validation
QA
Numerical stability
MELCOR Code Development
User Utilities
Converter (Discussed in following presentation
HTML Output
Etc.
Code Enhancements
New/improved modeling
Code performance