

10/02

Accident Progression, Source Term and Consequence Estimates

Objective: Develop realistic accident progression, source term and consequence estimates to identify key vulnerability issues

- Major Tools

- MELCOR
- MACCS

- Major Tasks:

- Review / improve fission product modeling
- Improve consequence modeling treatments
- Perform integrated reactor analysis - BWR & PWR
- Perform integrated SFP analyses
- Mitigation

Testing

Follows Ex 5

Information in this record was deleted in accordance with the Freedom of Information Act, exemptions 5 and 7. FOIA 2004-0226

Ex 5

~~Ex 2 entirely~~

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Spent Fuel Pool Analyses

- **Evaluate Response to Initiating Events in Terms of Heatup and Source Term Generation**
 - Partial Pool Drainage
 - Complete Pool Drainage (Air Natural Circulation)



Ex 5

- **FLUENT and FLOW-3D Used to Evaluate**
 - Details of Single Assembly in Air Circulation and Heat Flows
 - Flow and Mixing Behavior in Pool and Building
 - Provide Boundary Conditions for MELCOR Analyses



Ex 5

- **MELCOR Will Analyze**
 - Global Response of Pool and Assemblies,
 - Fuel Damage, Steam and Air Oxidation
 - Fission Product Source Term
 - Mitigation or Recovery Actions

Overview of CFD Analyses

- Intent is to analyze flow details of individual assemblies to provide input and boundary conditions for MELCOR models of SFP
 - Detailed flow and pressure drops → loss coefficients
- Full pool and building analysis using porous media approximation will provide additional flow boundary conditions for MELCOR
 - Principal flow patterns → MELCOR volume/flow path nodalization
 - Room air mixing → correct return air temperatures
 - Underfloor pressure drops →

Ex 5

MELCOR SFP Modeling Approach

- **2 Model Approach - Separate Effects and Whole Pool/Building Models**

- Subdivided into 2 Types of Scenarios

- **Complete Loss-of-Inventory**

- **Partial Loss-of Inventory**

Ex 5
Ex 5

- **Separate Effects Model**

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- Developed to Guide Full SFP Model Development

- **Identify Sensitivities and Uncertainties**

- **Use Separate Effects Model to Develop Appropriate Modeling Approach and Code Improvements**

- **Full SFP + Building Model**

- **Integral Effects**

- **Whole SFP Source Term**

Ex 5

MELCOR SFP Separate Effects Model Calculations

- **>50 Calculations Completed in Preliminary Matrix**
- **Considerable Effort to Develop Robust Model**

- **Model Includes**



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- **Parametric Calculations Performed on Both Scenarios**
 - **Complete Loss-of-Water Inventory**
 - **Partial Loss-of-Water Inventory**

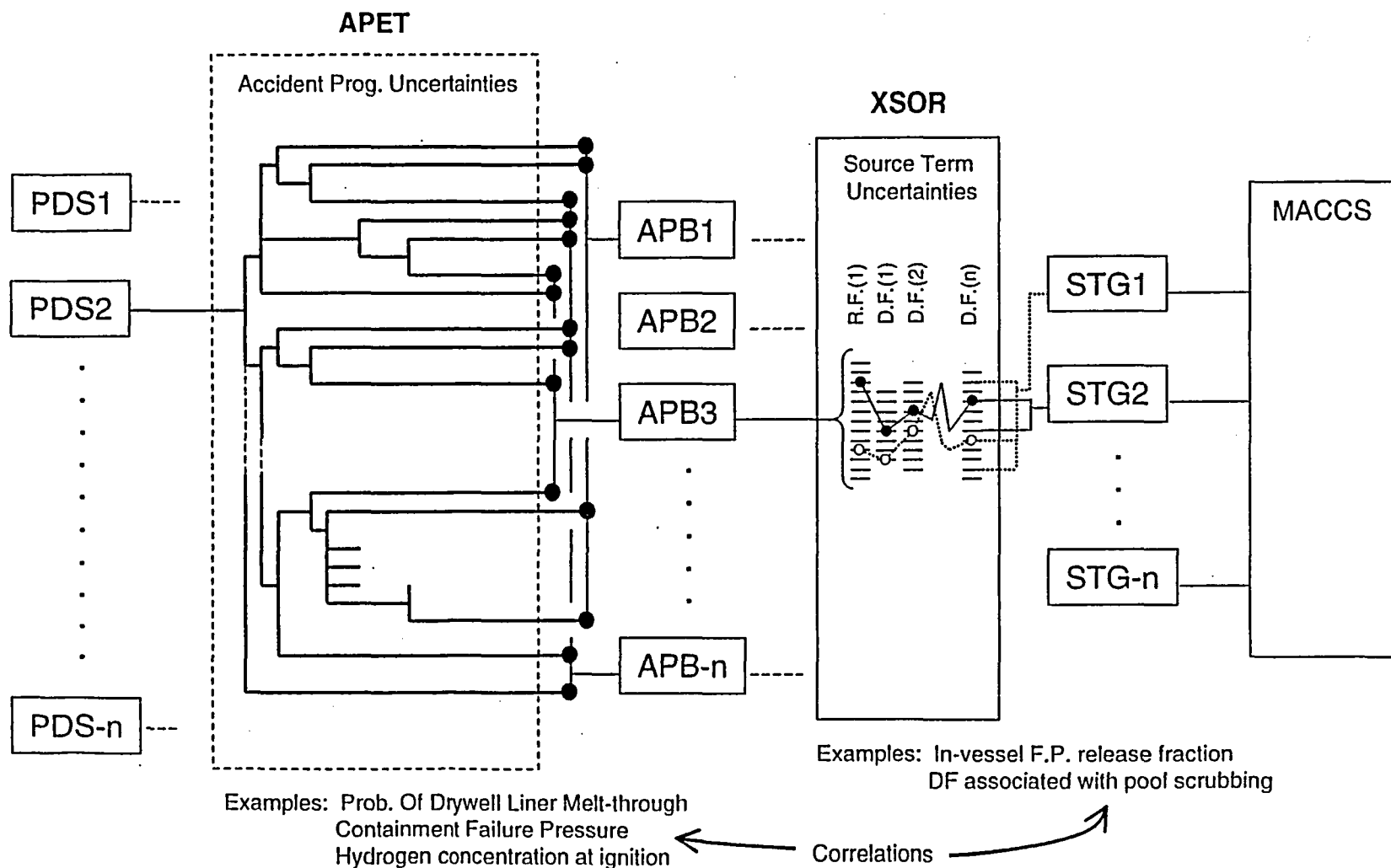
Fission Product Modeling

***Objective: Reflect Best-Estimate Fission Product
Release, Transport and Deposition***

- Review and assess present MELCOR fission product source term modeling
- Update as appropriate for present applications

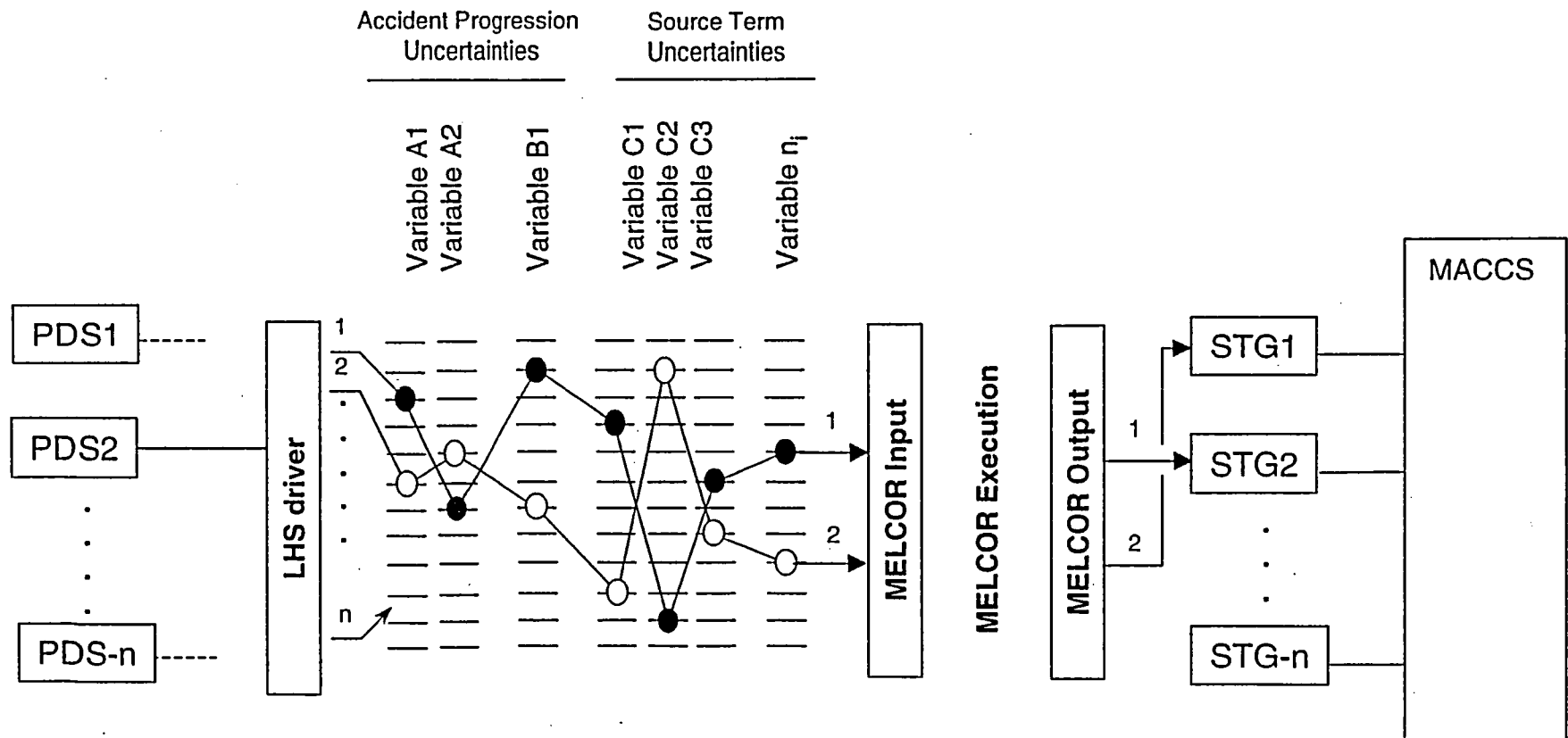
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NUREG-1150 Probabilistic Risk Analysis



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Probabilistic Physical Process Modeling



Testing Activities

ANL Cladding Air Oxidation Experiments

- **Present data base sparse in low temperature regime**
- **Experiments presently underway at ANL**
- **Emphasis on low temperature oxidation in air**
 - **Important in predicting thresholds for initiating zirconium fire**
- **Will incorporate data in MELCOR as is becomes available**

SFP Thermal Hydraulic Experiments

- Characterize effect of SFP geometry on air thermal-hydraulics and onset of oxidation
 - Grid spacers and end pieces
 - SFP rack construction, flux trap, boral
 - Under-floor details affecting flow and pressure drop
 - Flow paths and Bernoulli effects
- Characterize air oxidation and Zirc Fire Onset
 - Heat generation from oxidation and nitriding combined with decay heat profile
 - Air reactions affecting flow and pressure drop
 - Burn localization, role of radiation heat transfer
 - Rack wall heating, failure (melting and materials interaction)
 - Adjacent assembly heating and zirc-fire propagation
- Model Integral effects
 - Modeling extensions to capture integral behavior of SFP damage progression
- Testing also applicable to Dry Cask Storage analysis

Fission Product Release Experiments

- Data on fission product release from fuel in air-oxidation environment deficient
- Ru release of more volatile oxide expected - data lacking
- UO_2 oxidation to volatile higher oxides also expected
 - Fuel decrepitation observed in Canadian testing
 - Large fuel volatilization can release otherwise low volatile fission products owing to physical stripping of fuel matrix