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Integration of Canadian and South African Reactors into RASCAL

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Outline

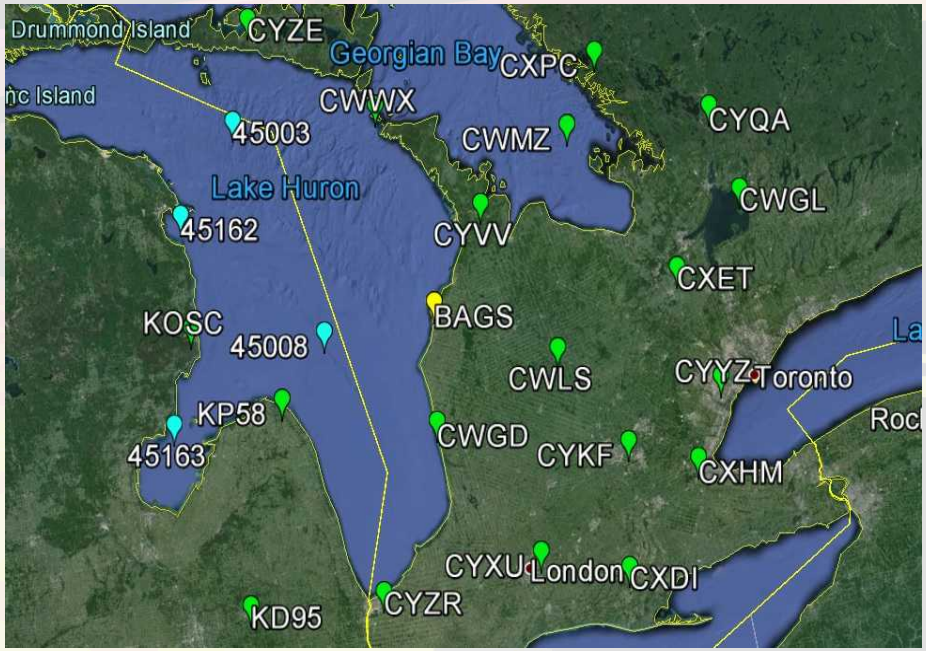
- Status of South African Reactors
- Status of Canadian CANDU Reactors
- RASCAL Model for Contamination Movement
- CANDU Challenges for Contamination Movement
- Dilution Factors in RASCAL
- CANDU Challenges for Dilution Factors
- Steps Forward for CANDUs
- Summary

Status of South African Reactors

- Sites
  - Koeberg (PWRs) and SAFARI-1 (research)
  - Map Background images
- Meteorology
  - Terrain and surface roughness
  - First-order meteorological observation stations
  - Automated Meteorology Download
    - Source identified
    - Modifications to MetFetch in progress
  - Document for manual upload of site meteorology complete
- Proposed
  - Changes to dose calculation methodology
  - Default SI units mode

Status of Canadian CANDU Reactors

- Sites
  - Bruce A & B, Point Lepreau, Pickering A & B, and Darlington (all active units)
  - Map Background images
- Meteorology
  - Terrain and surface roughness
  - First-order meteorological observation stations
  - Automated Meteorology Download
    - Canadian observations are sent to the National Weather Service (NWS)

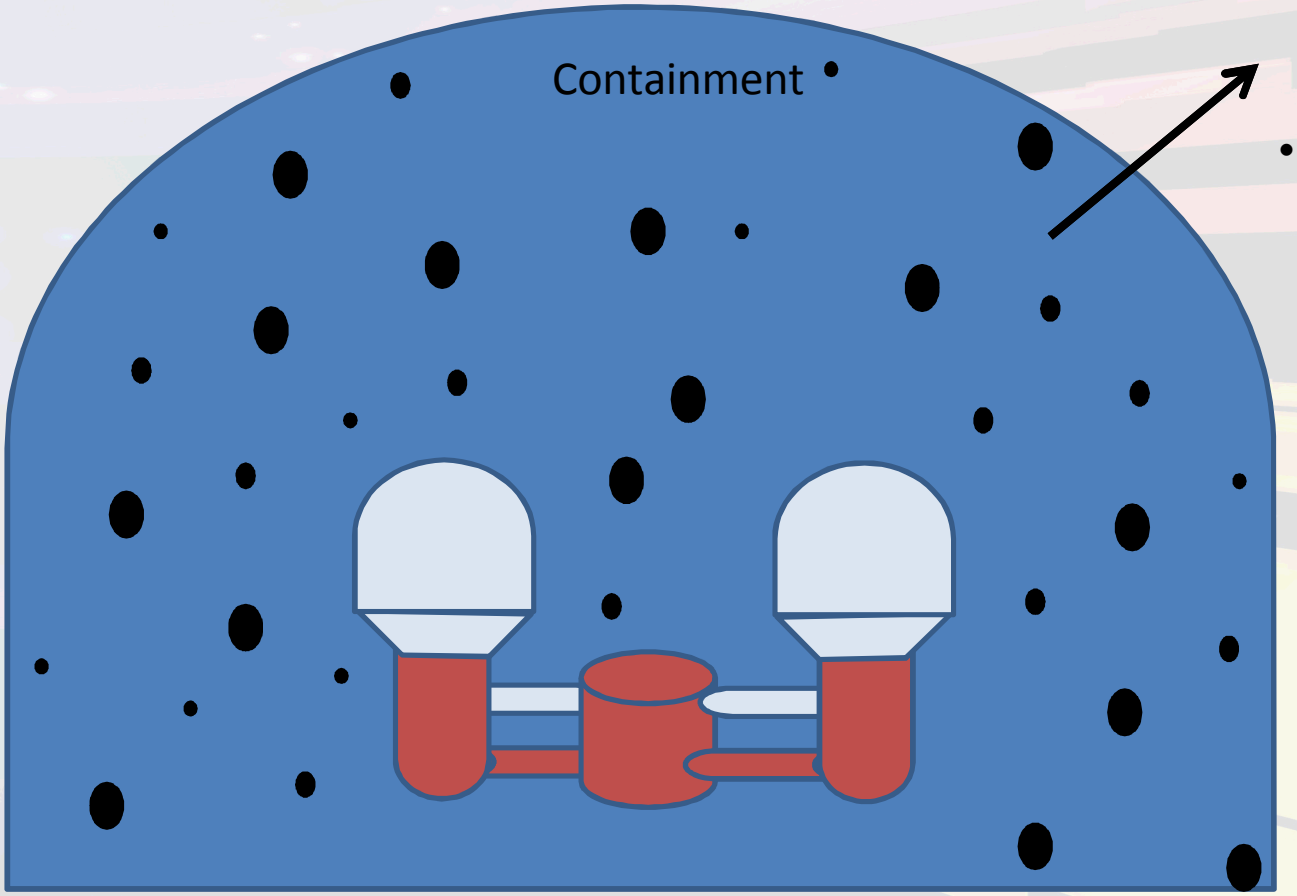


Status of Canadian CANDU Reactors

- Source Term Modeling
  - Literature Review and Scoping Study Completed in December 2015 on CANDU designs
  - Meeting held with CNSC and CANDU industry representatives to request data and verify understanding in January, 2016
  - Multiunit sites present challenges to the RASCAL modeling framework

RASCAL Model for Contamination Movement

Core inventories released to containment vs. time



- Particulates are uniformly and instantaneously mixed in containment
- Dilution Factors are applied for
  - Hold Up (natural depletion)
  - Sprays
  - Filters
  - Wetwell (BWR)

Containment leaks to the environment as a function of:

- % vol / time
- Pressure - hole size

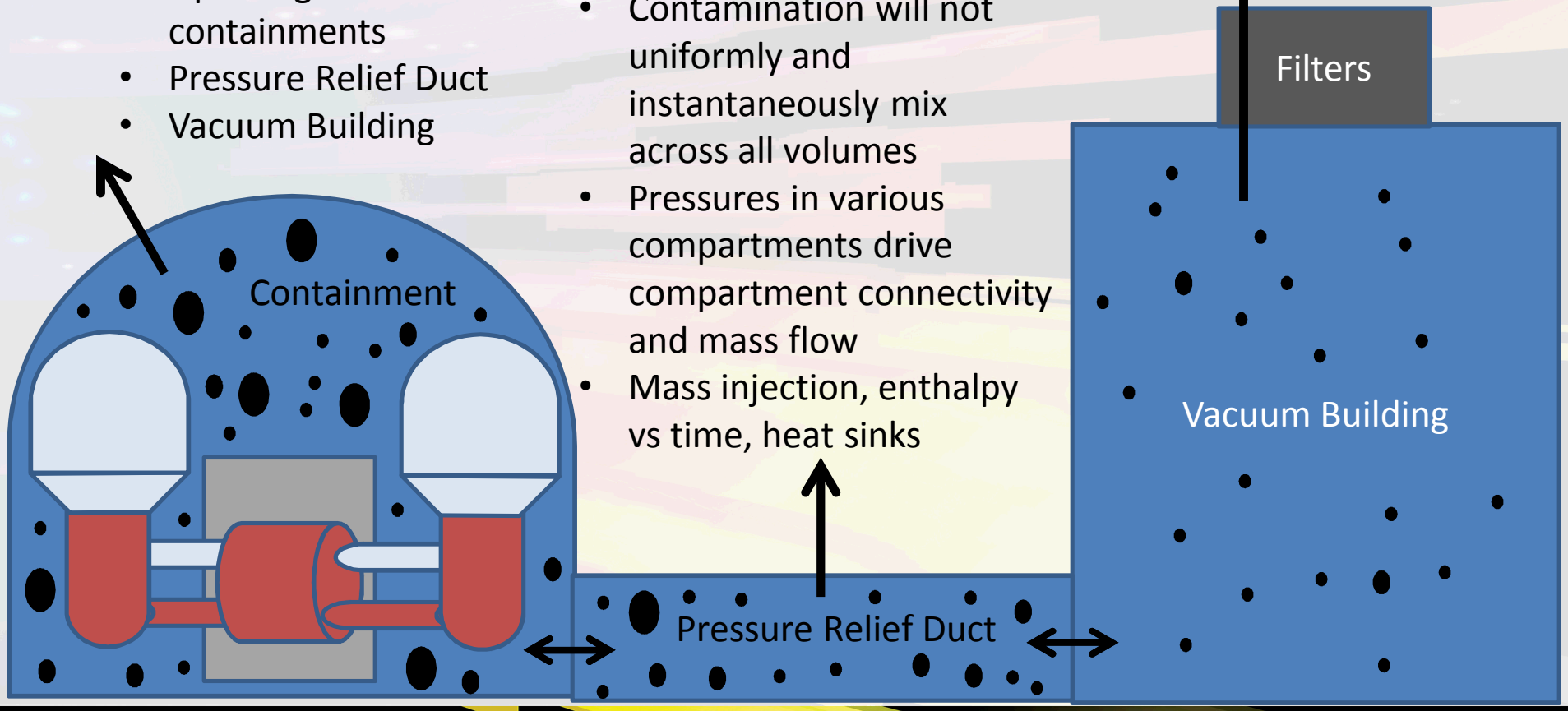
CANDU Challenges for Contamination

- Multiple significant volumes
  - Up to eight connected containments
  - Pressure Relief Duct
  - Vacuum Building

Movement

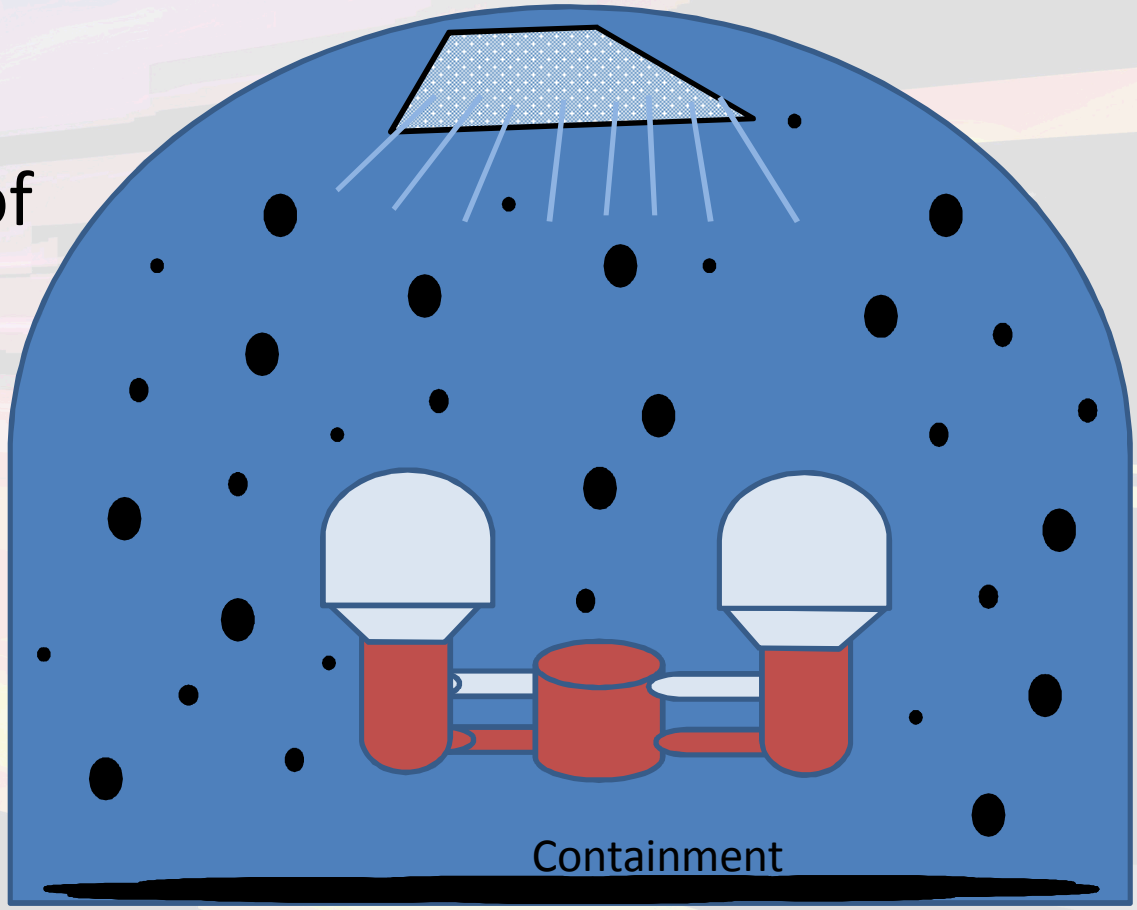
- Contamination will not uniformly and instantaneously mix across all volumes
- Pressures in various compartments drive compartment connectivity and mass flow
- Mass injection, enthalpy vs time, heat sinks

Contamination releases to the environment from multiple locations



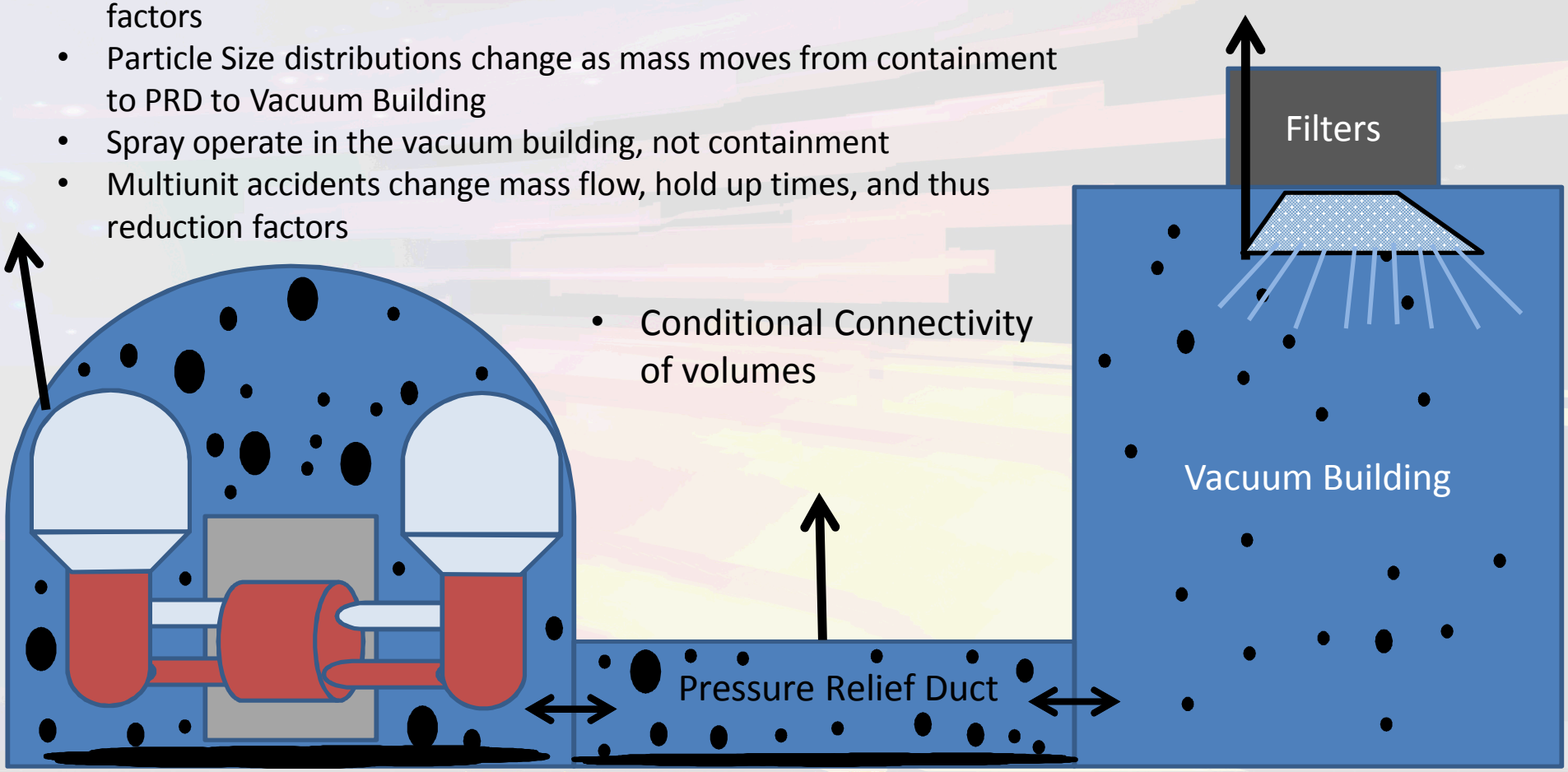
Dilution Factors in RASCAL

- Uniform particle size distribution leads to one set of Dilution factor multipliers ("lambdas") for:
  - Natural process removal
  - Sprays
  - Wetwell (BWR)



CANDU Challenges for Dilution Factors

- Different thermodynamics in each volume lead to different Dilution factors
- Particle Size distributions change as mass moves from containment to PRD to Vacuum Building
- Spray operate in the vacuum building, not containment
- Multiunit accidents change mass flow, hold up times, and thus reduction factors



- Conditional Connectivity of volumes

Step Forward for CANDUs

- NRC is working through information exchange legalities with the CNSC to:
  - Acquire MAAP4-CANDU Severe Accident Simulations
  - Acquire CANDU Probabilistic Risk Analyses
- Pursuing other information pathways
- Evaluating
  - Treating Pressure Relief Duct and Vacuum Building as simple Dilution Factors
  - CONTAIN2
  - Development of Simplified Thermodynamic Mass Transfer model and reduction factors
- All options require MAAP4 simulations or equivalent data to validate and provide necessary input

Summary

- South African and CANDU
  - Sites added
  - Meteorology sites added
    - SA automated download to be implemented
    - CANDU sites part of NWS dataset
- CANDUs
  - Literature Review and Scoping Study complete
  - Meeting held with CNSC and CANDU industry to validate understanding
  - NRC and CNSC working through information exchange legal issues
  - Multi-Unit CANDU's present challenges for existing RASCAL framework
  - Multiple paths forward for solving the CANDU source term problem being evaluated