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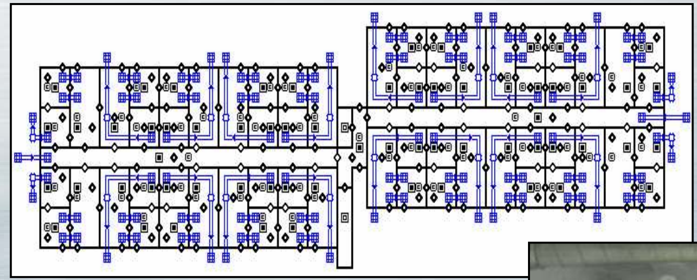

Integration of Transport Modeling with Test and Evaluation in CBR Building Protection Programs

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Introduction

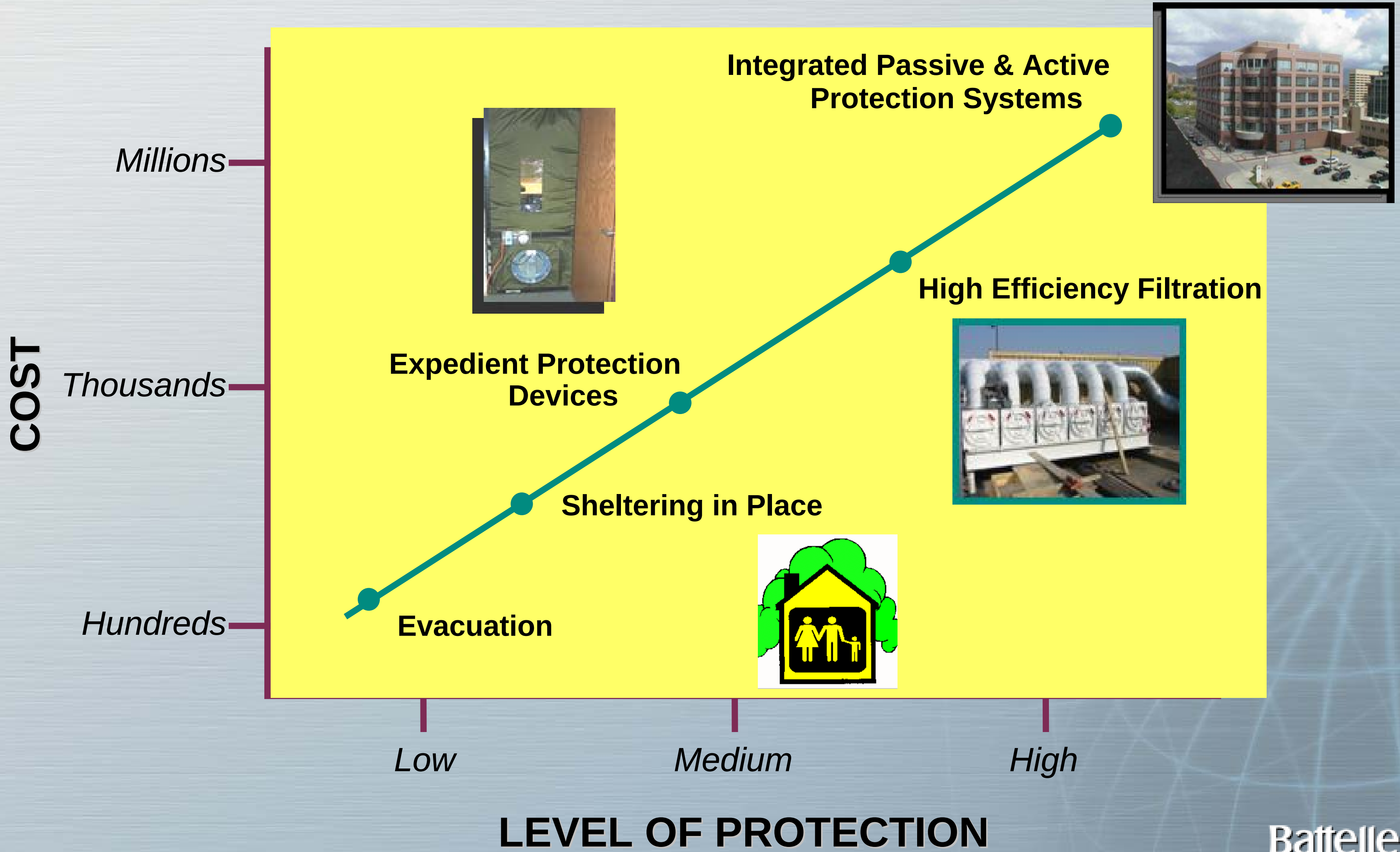
- CBR Building Protection Overview
- Role of M&S and T&E in the building protection process
- Types of models and experimentation
- Interactions between nodal modeling and contaminant transport experiments
- Example of modeling and experimental interactions and conformance analysis process
- Summary

CBR Building Protection Overview

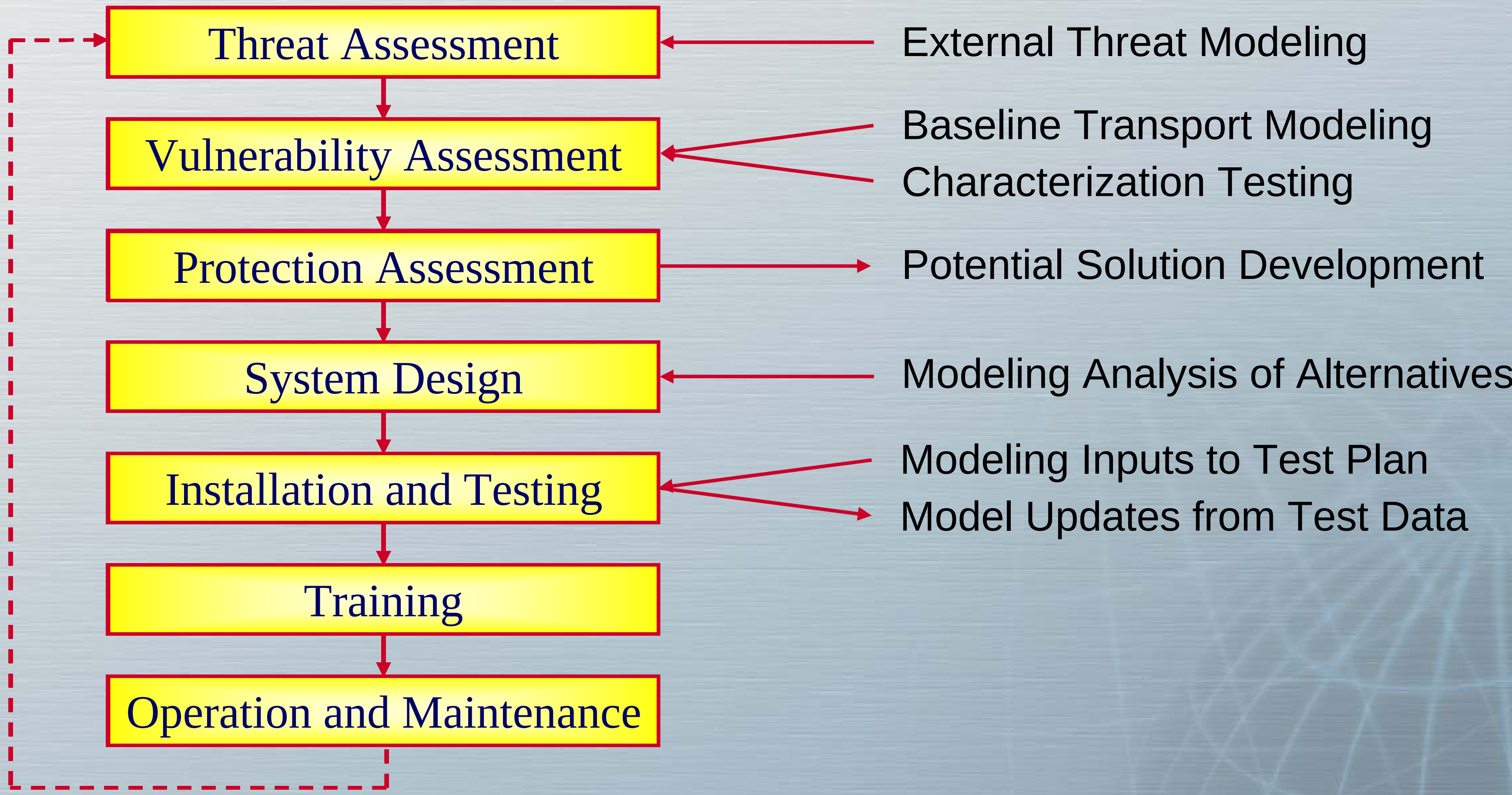
Why are buildings vulnerable to CB attack?

- Containment of CB agents within a confined space allows concentrations to rapidly reach and sustain lethal levels
- CB agents are effectively transported throughout a building by mechanical systems
- Population densities are high in buildings
- Potential to deliver agent covertly
- Numerous adsorbing surfaces that make building restoration difficult

Range of Protection Solutions



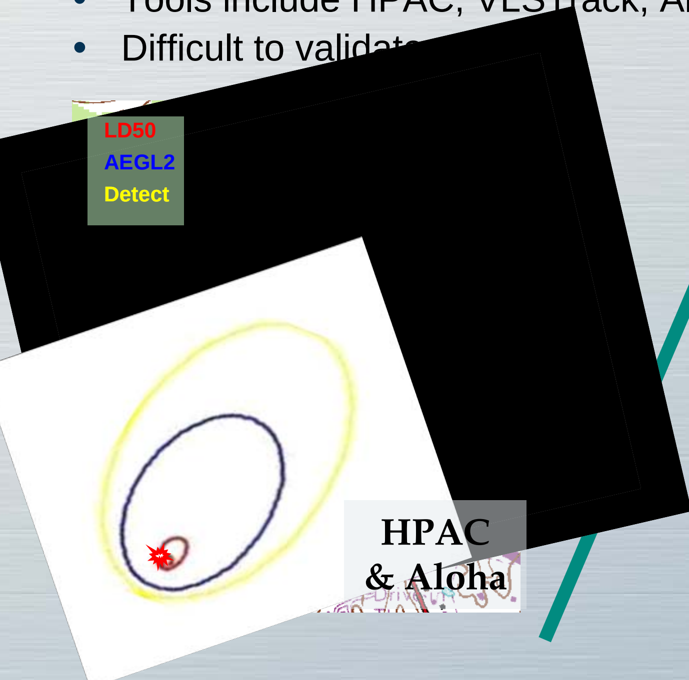
Protection System Development Process



Types of Models

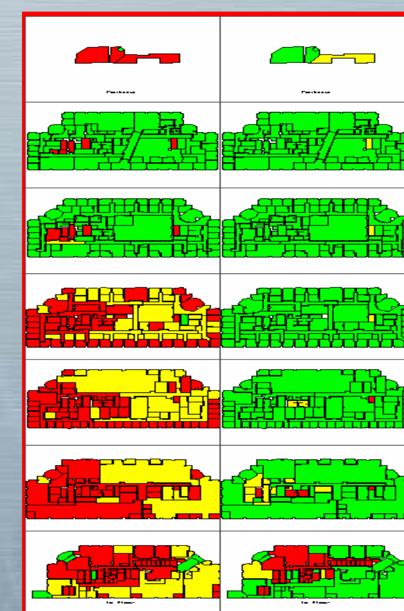
Ambient Dispersion Modeling

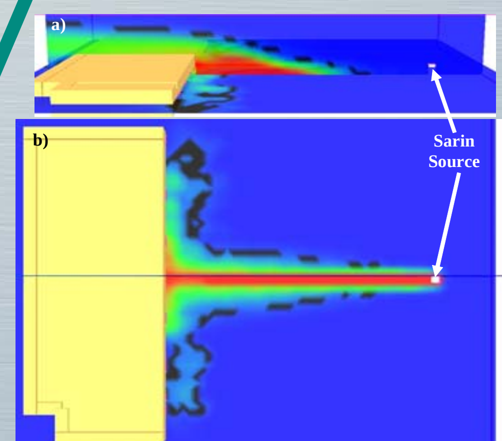
- Used to characterize external threats
- Tools include HPAC, VLSTrack, Aloha …
- Difficult to valida



Nodal Modeling

- Used to characterize internal transport and evaluate protection system performance
- Tools include CONTAMW and COMIS
- Allows conducting numerous model runs quickly
- Validate using dosage measurements throughout building





CFD Modeling

- Used to Integrate outdoor and indoor models and to characterize flow dynamics within rooms
- Time-consuming to configure and run
- Validation requires distributed concentration vs. time measurements

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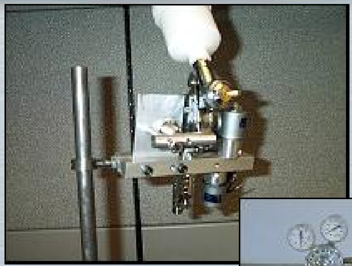
CONTAMW Nodal Modeling

- Designed for characterization of contaminant transport though ventilated buildings
  - Utilities to simulate building HVAC systems and components
  - Libraries with representative building leakage data
  - Model output of zone concentration profiles and flow-path airflows
  - GUI for simple model construction.

Limitations . . .	. . . Solutions
• Well-mixed assumption inaccurate for larger building volumes.	• Break large volumes into subzones and/or correlate test data (parameterizations) with model.
• Inaccurate contaminant transport time scales.	• Correlate test data with model and/or apply CFD modeling to large volumes.
• Cannot model external releases.	• Characterize external cloud using ambient dispersion models. • Utilize CFD or parameterizations to correct for plume/building wake interaction.
• CB agent properties not fully represented.	• Post process model results with corrections derived from test data for deposition rates, release efficiencies, removal mechanisms, etc.

Modeling and Experimentation Requirements

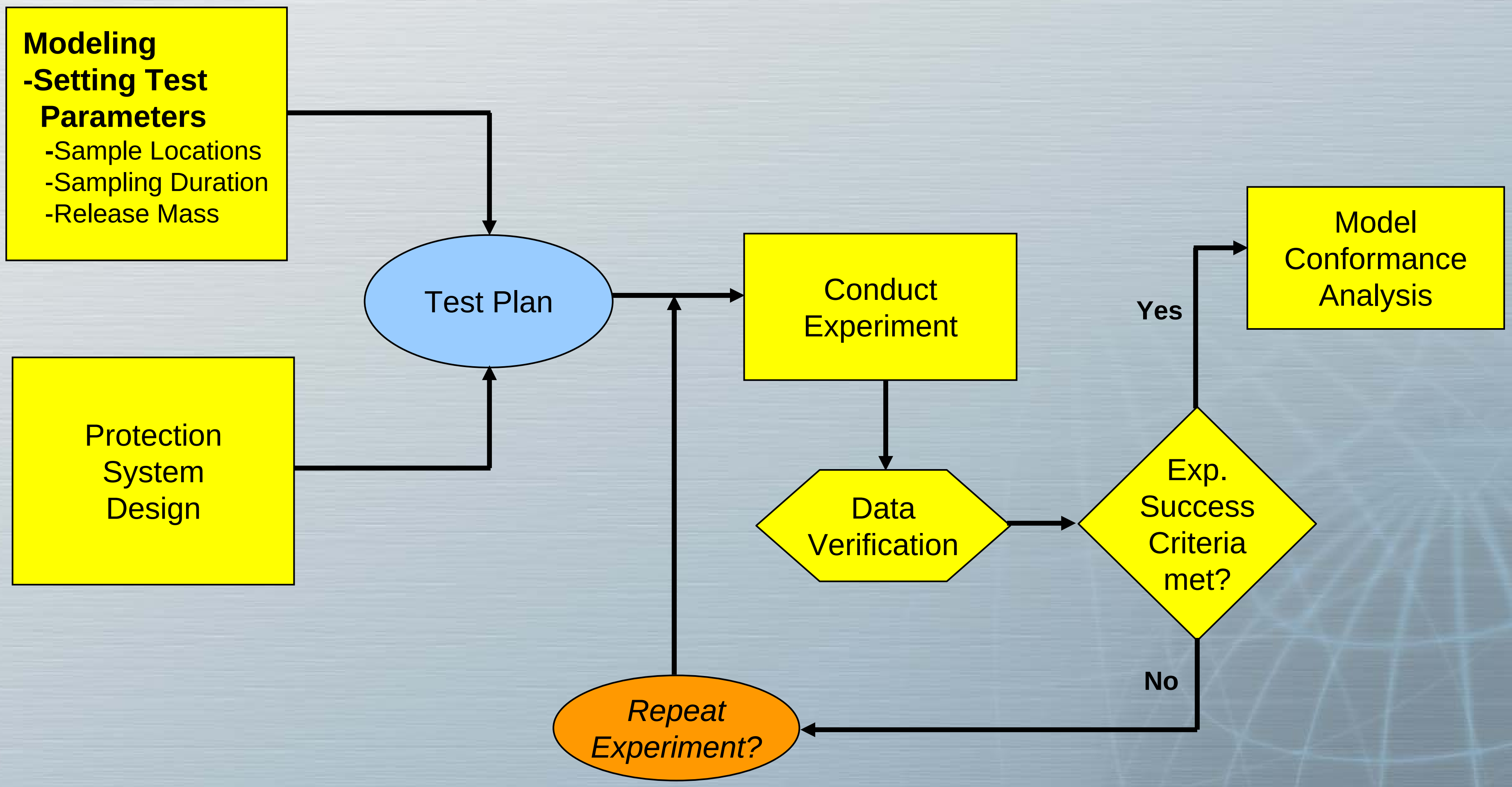
- Nodal Modeling
  - Knowledge of threat agent characteristics
  - Knowledge of building environment
  - Understanding of limitations and solutions to limitations
  - Automated post-processing
  - Experience in interpreting model results
  - Methods for modeling personnel movement
- Experimentation
  - Simulant to agent correlations
  - Controllable release mechanisms for repeatable releases
  - Sampling instrumentation, sample handling and analysis methods
  - Data analysis methods (including uncertainty analysis)







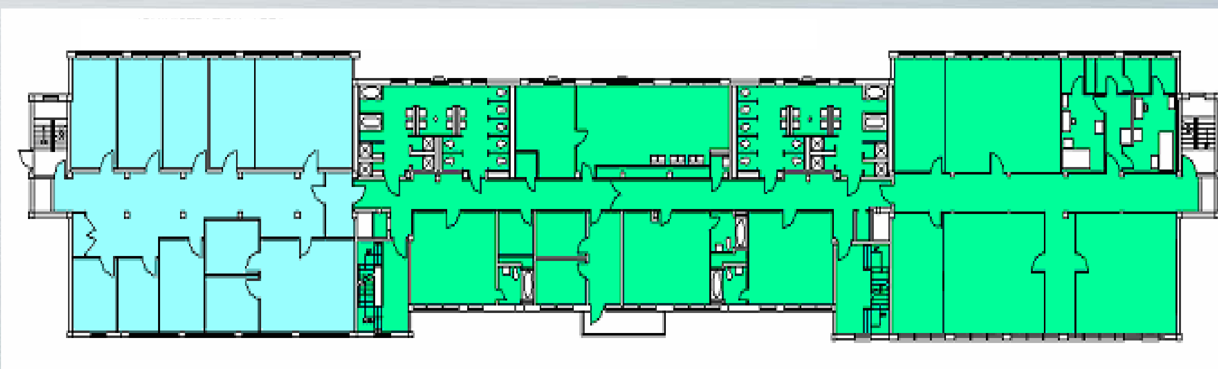
Modeling / Experimentation Process

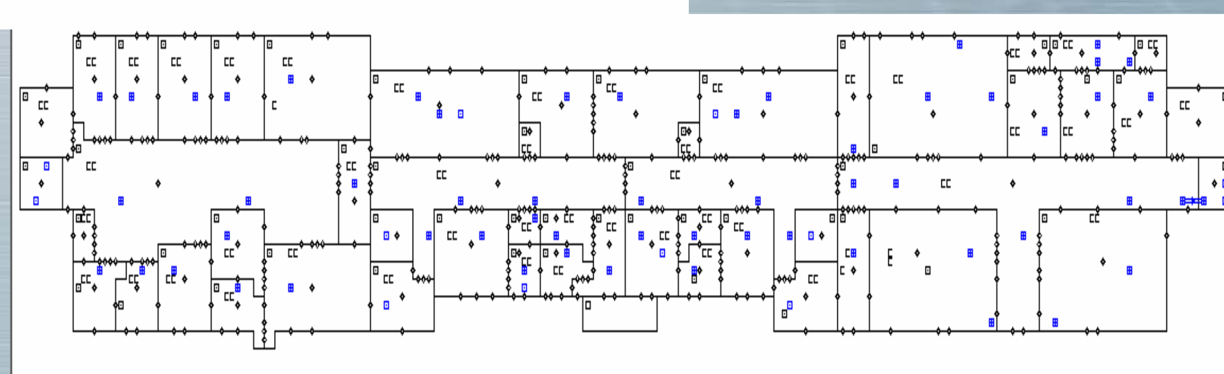


Modeling / Experimentation Process Example

Example Building

- Former military barracks, 30,000 ft^2
- Three stories with a quarter basement
- Four HVAC zones

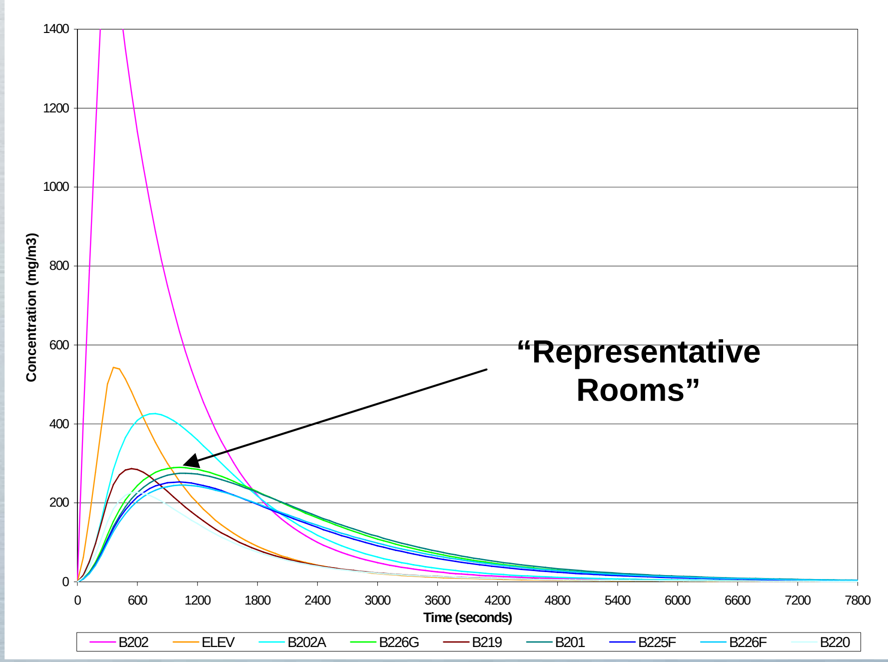


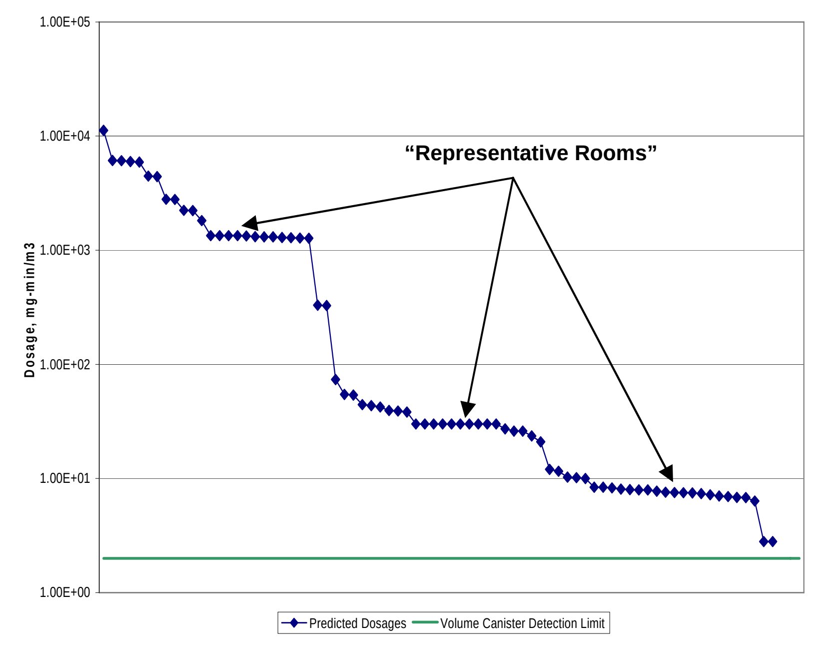


CONTAM Model Schematic

Test Parameter Selection – Sampling Locations

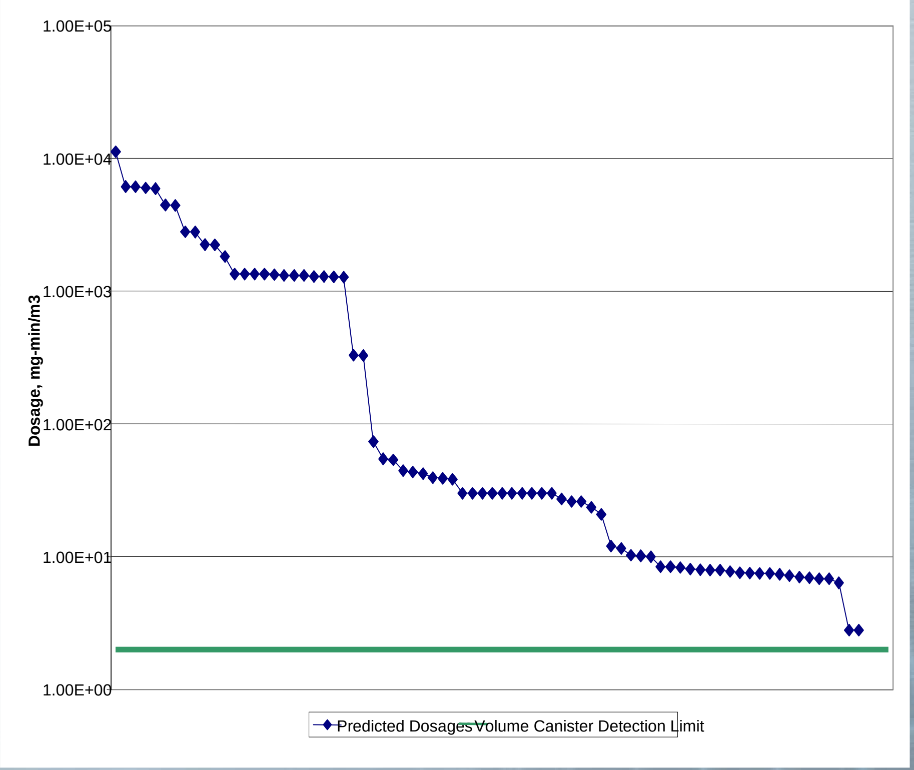
- Selection of sampling locations
  - Release room and adjacent rooms
  - HVAC system returns, supplies and fresh air intakes
  - At primary transport pathways
  - In sets of representative rooms





Test Parameter Selection – Release Mass

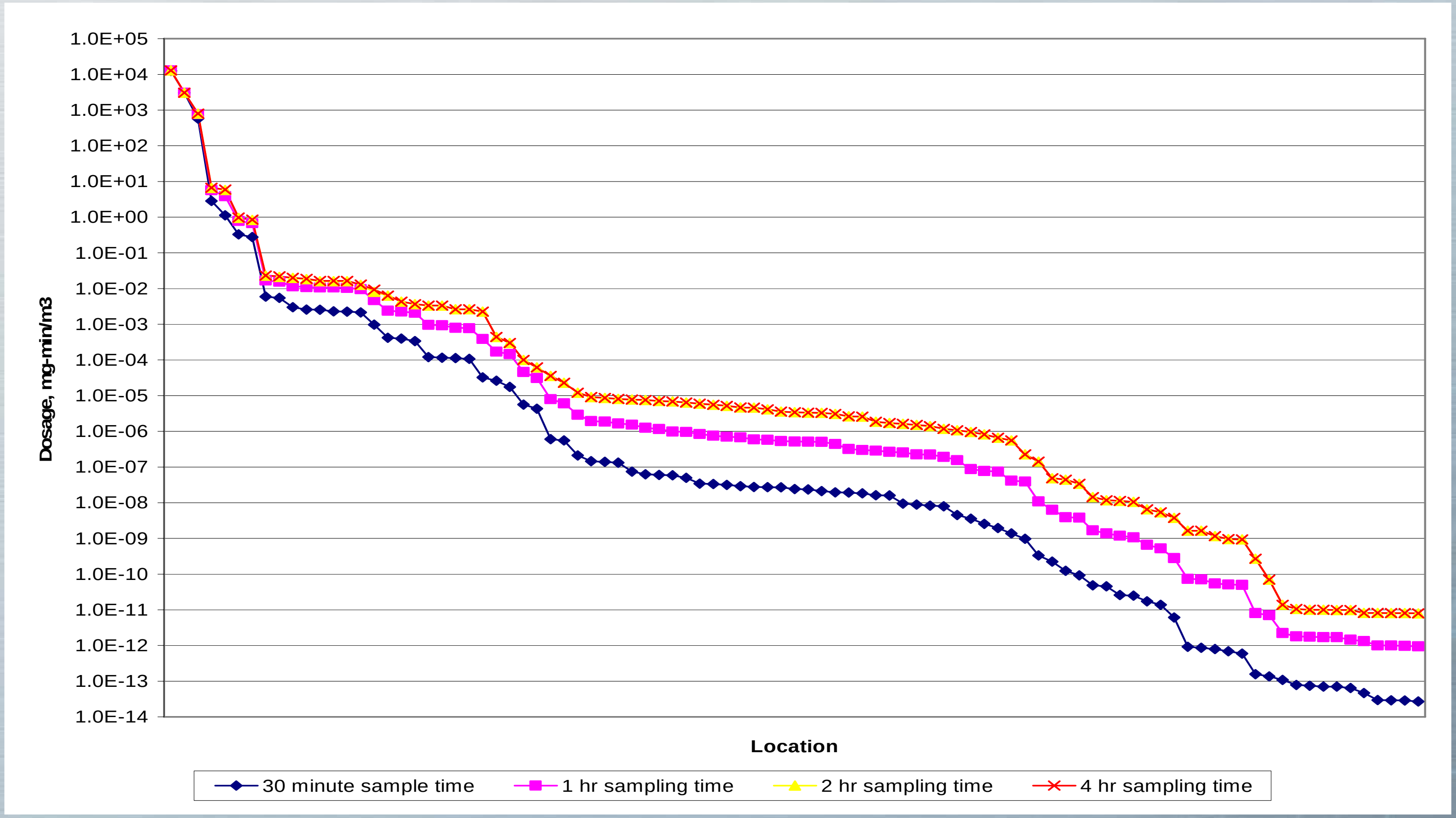
- Determination of mass of simulant to be released
  - Release mass chosen to achieve detection but not saturate real-time detectors (release room may be an exception)
  - Release mass chosen to maximize measurable dosages throughout building.



Real-time Detector Location	Max Release Mass to Saturate Detector, g	Min Release Mass to Achieve Detection, g
Release Room	3	0.01
Room 2	85	0.21
Room 3	66	0.17
Room 4	64	0.16

Test Parameter Selection – Sampling Time

- Determination of sampling time
  - Duration of experiment set so that additional sampling time will not significantly affect measured dosages



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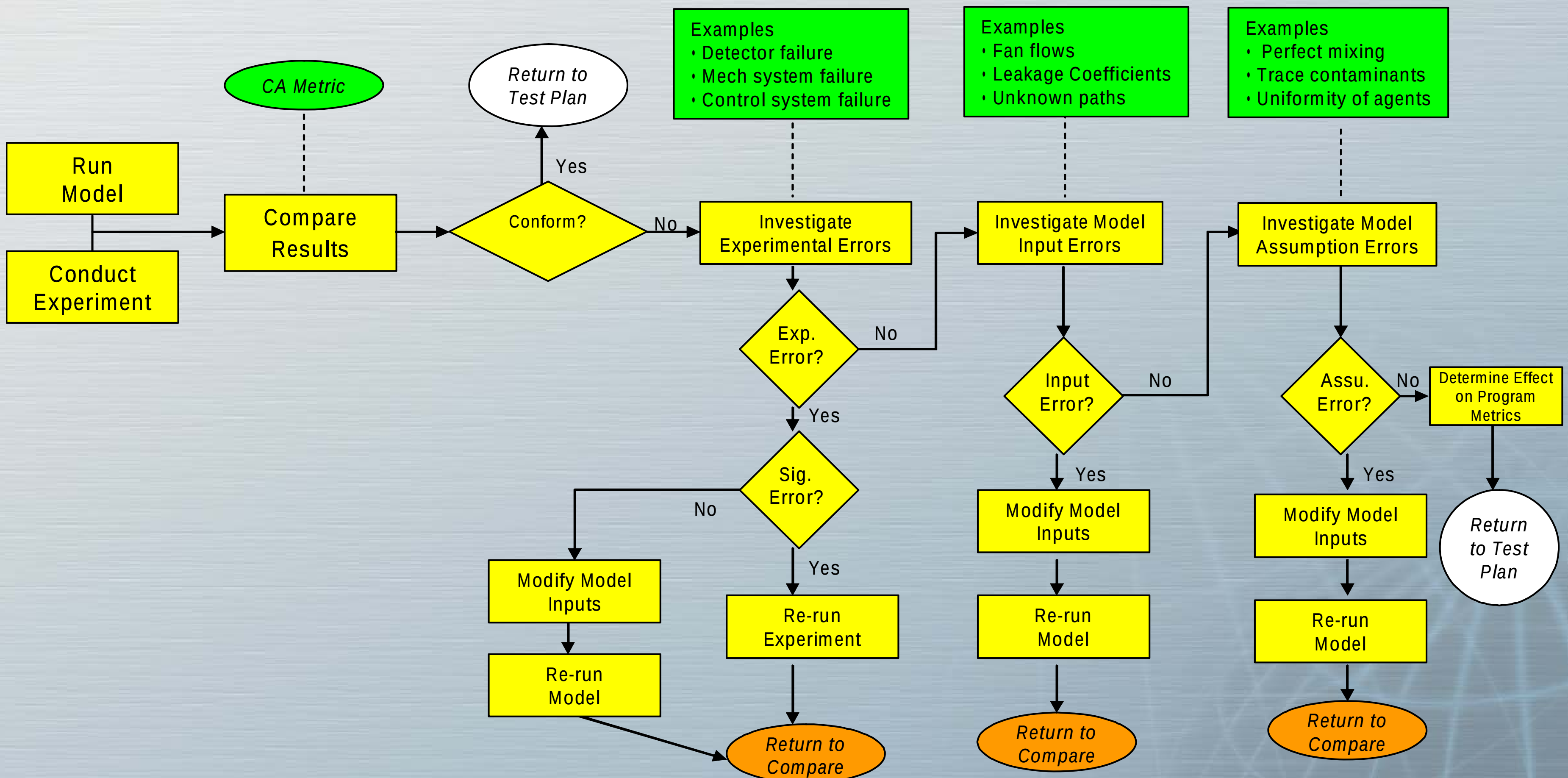
Modeling & Experimentation Conformance Analysis Process



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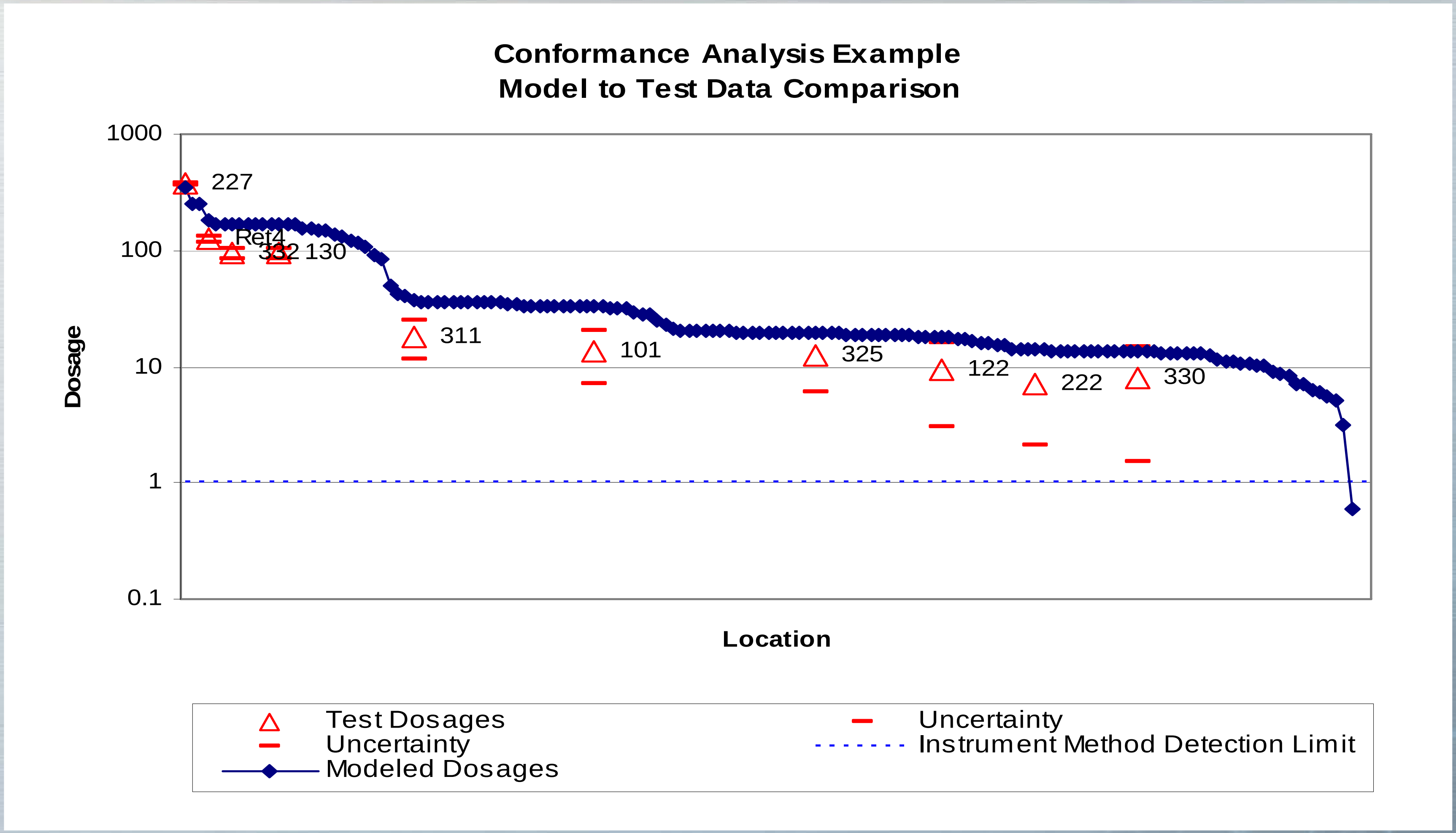
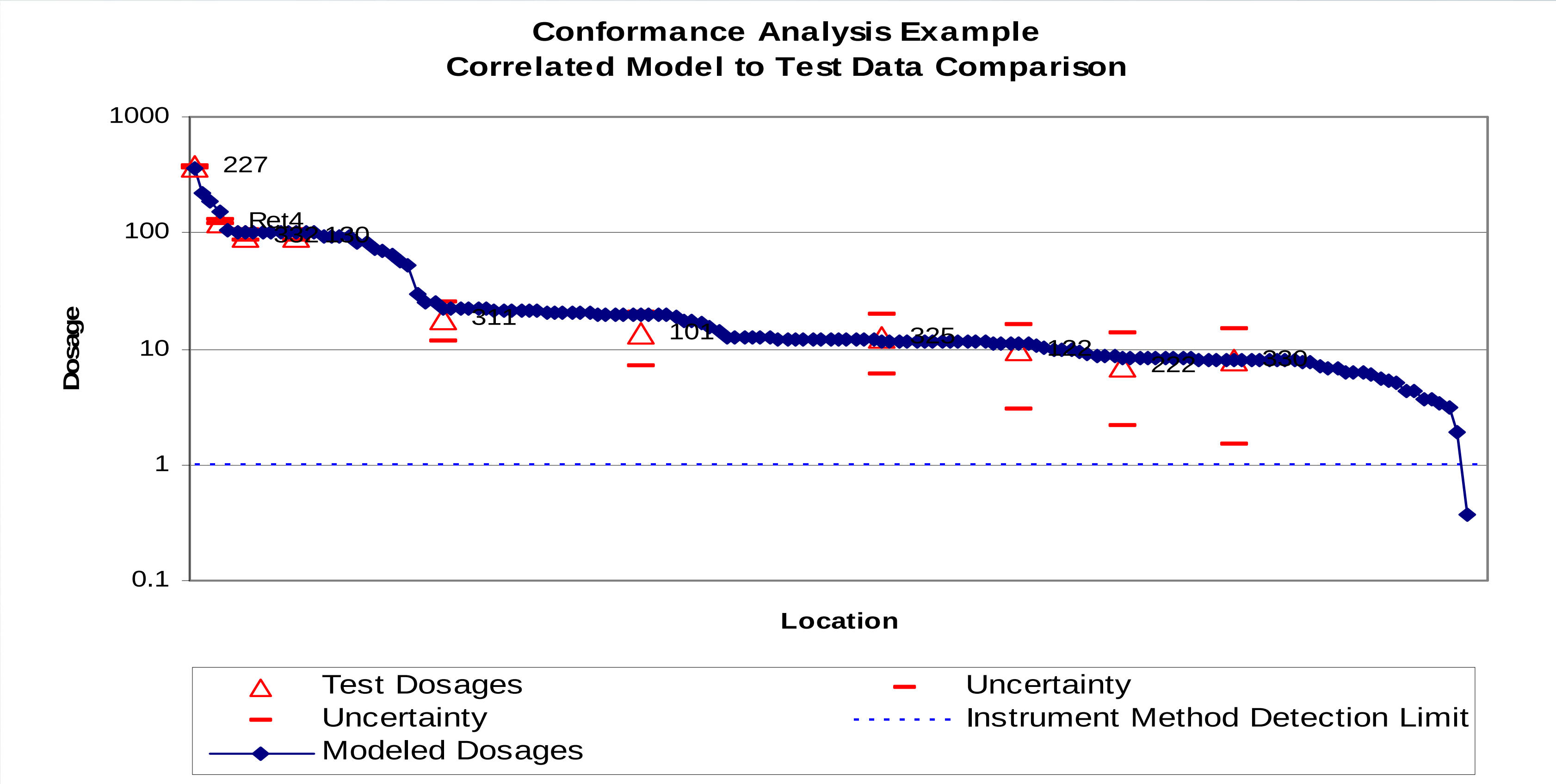
Modeling & Experimentation Conformance



•Comparison of data shows deviations between model and test data

Modeling & Experimentation Conformance



- Fresh air flow-rate model adjustment brings model into better agreement with experimental data.
- Subsequent analysis of all experiments in set indicate adjustment improves or maintains conformance.

Conclusions and Lessons Learned

- Integration of modeling and experimentation efforts is necessary to deal with the shortcomings of each.
  - Instantaneous, well-mixed assumption of nodal models
  - High cost of experimentation
- Using modeling to support planning of experiments improves efficiency in conduct of experiments.
- Conformance analysis provides an effective means of comparing modeled data to experimental data and identifying model improvements to enhance fidelity of model predictions.
  - Conformance analysis must be applied to all components and all test cases.

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