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Offsite Radioactive Release Mitigation

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Background

- **Prior security assessment (JCN Y6623) external containment**
  - **"Mitigation of Radioactive Releases from a Damaged Nuclear Power Plant"**
  - **Identified potential mitigative measures**
- **Primary focus on conventional water sprays for external containment**
  - **Analysis and experimental confirmation of system performance**

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Objectives

- **Examine the efficacy of offsite radioactive release mitigation strategies**
  - **External to containment**
  - **Range of hypothetical (but credible) severe accident scenarios**
- ***"If a large scale release were to occur, what steps could be taken?"***
  - **Cool uncovered assemblies in spent fuel pool in the event of a large hole in the pool wall below the top of the fuel**
  - **Scrub airborne release from plant buildings in the event containment spray is lost**

Program Overview

- **Objective**
  - **Estimate decontamination from readily available external sprays**
- **Approach**
  - **Analysis: Use MELCOR, with supplemental detailed CFD analysis, to estimate decontamination**
    - **Use state-of-the-art source terms from SOARCA**
  - **Testing: Use prototypic spray nozzles and smoke plume to confirm analysis**
- **Status**
  - **Preliminary analysis and tests revealed importance of water spray dragging smoke plume to the ground**

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Surry Building Layout

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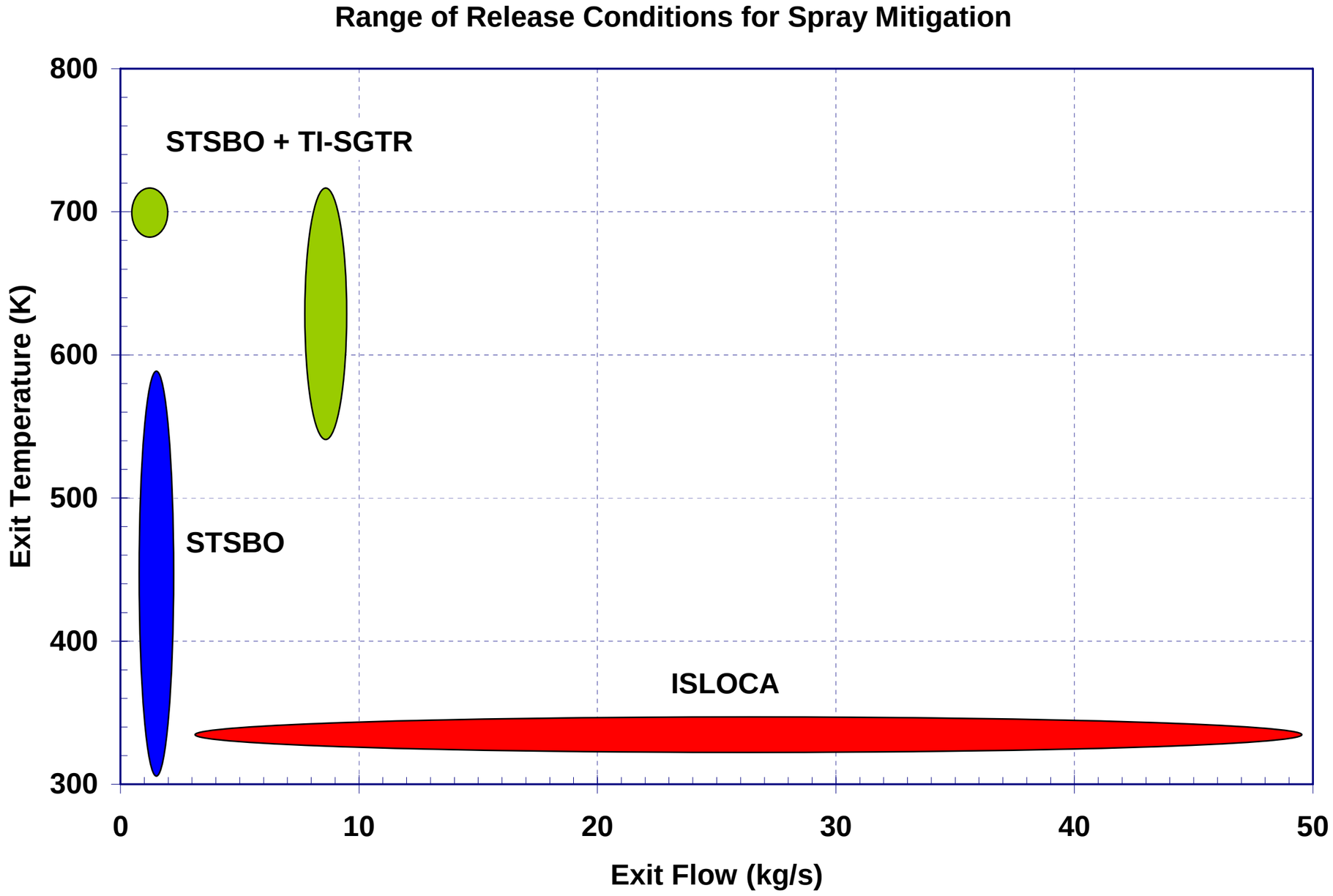
PWR Release Characteristics



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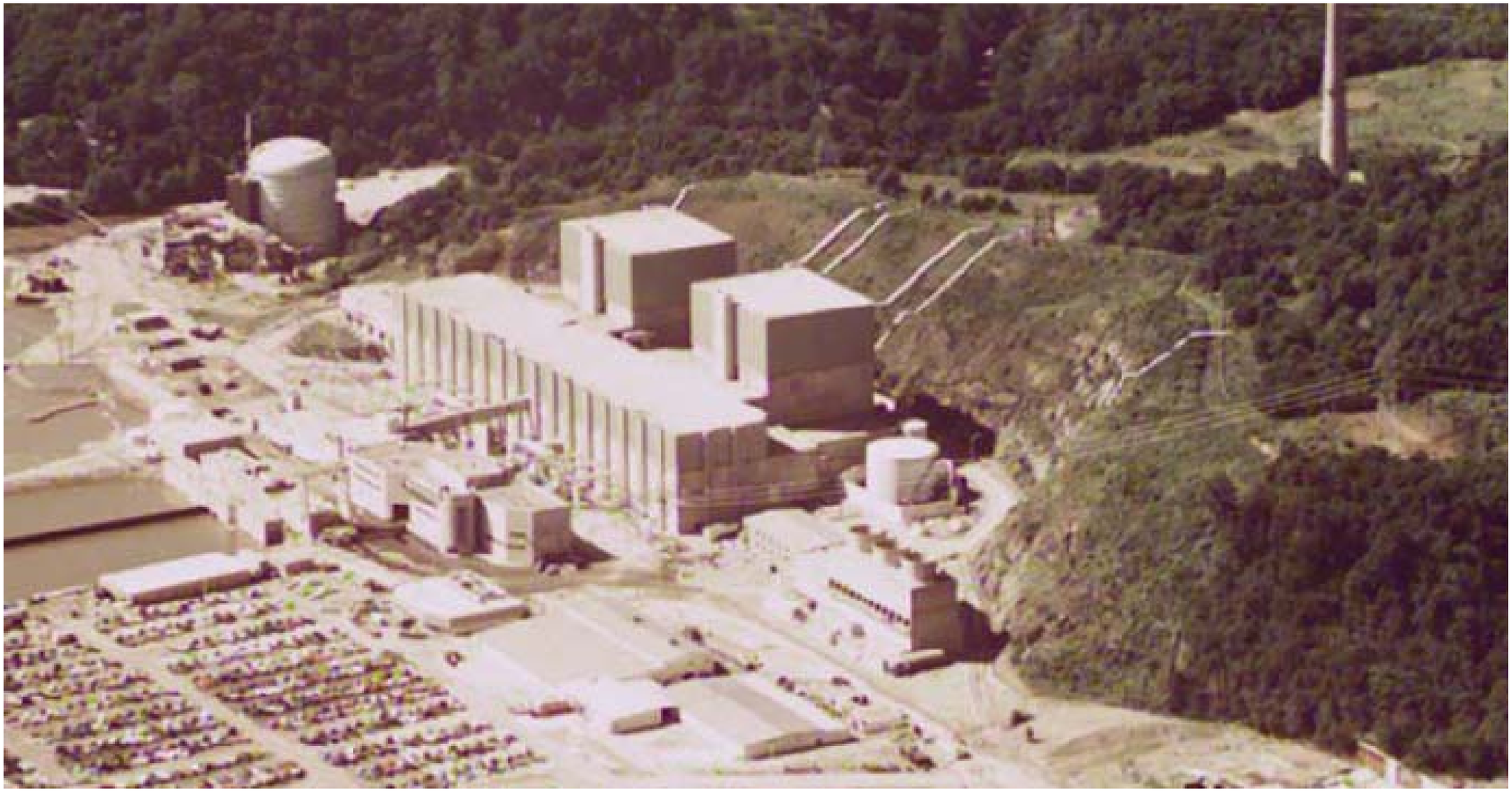
Peach Bottom Building Layout



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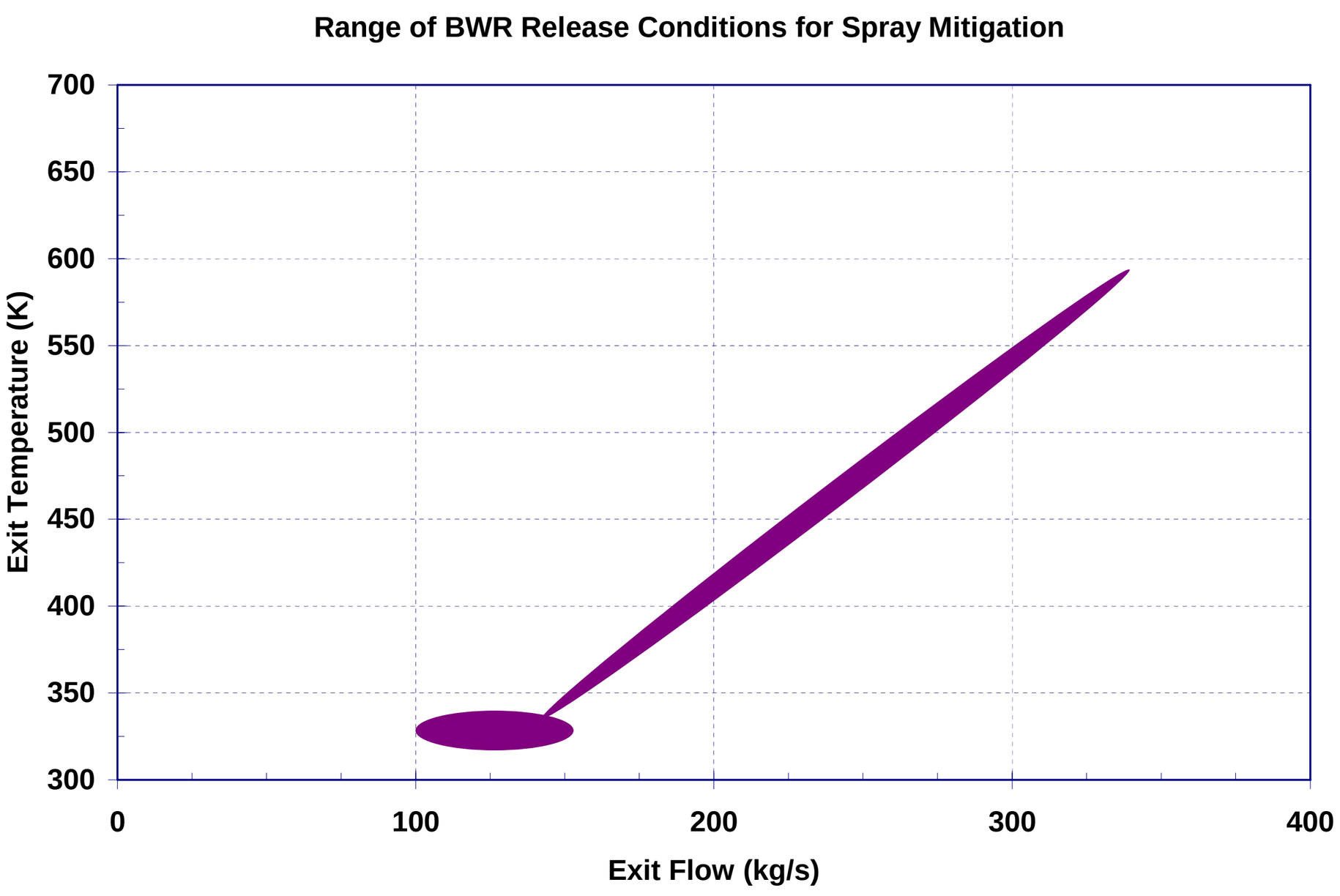
BWR Release Characteristics



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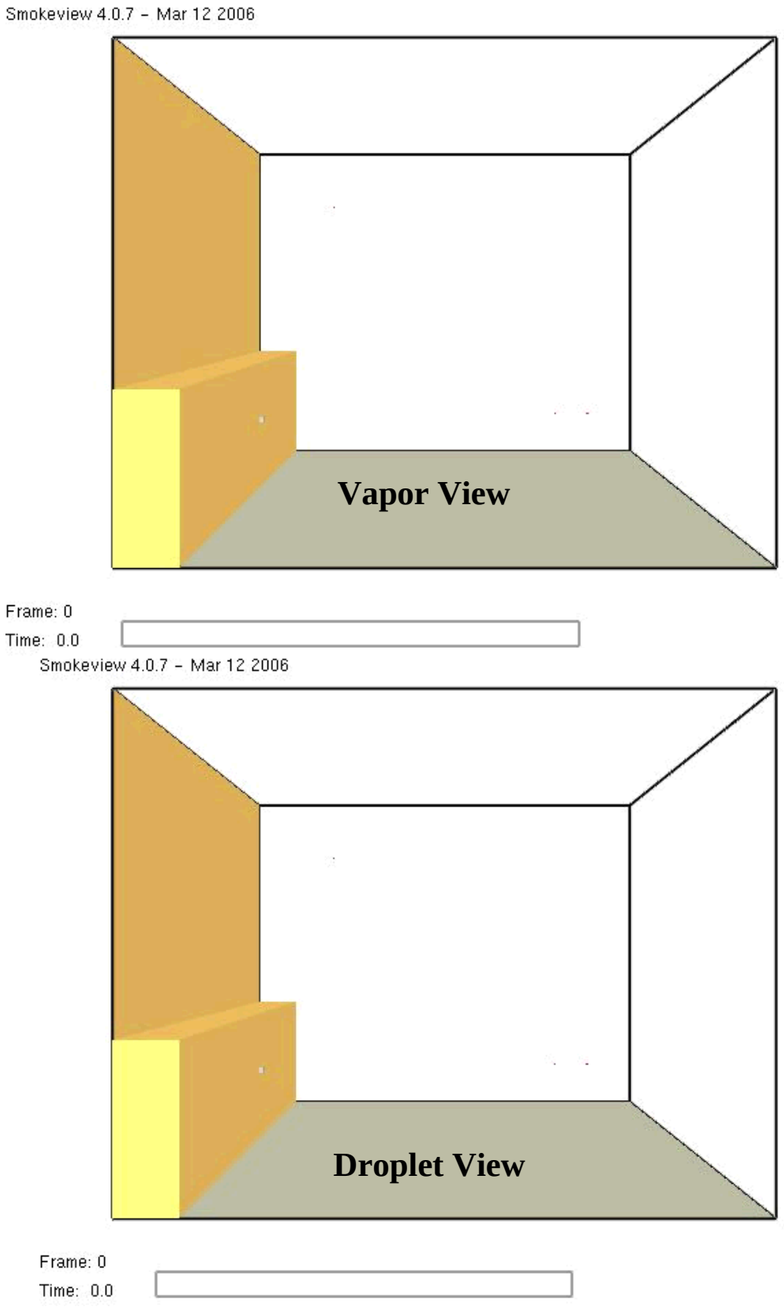
Initial Spray Modeling



- **Fire Dynamics Simulator (FDS)**
  - **CFD code developed by NIST**
- **Simulation of smoke plume and water spray interaction**
  - **Fire release = 1 MW**
  - **Water flow rate 2000 lpm**
  - **Cross wind = 1 m/s**
  - **Includes interfacial shear between falling water droplets and rising smoke plume**

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Prototypic Hardware

- **Blitzfire oscillating**
  - **Up to 500 gpm (2000 lpm)**
  - **Horizontal oscillation at 20, 30, and 40º**
  - **Vertical travel from 10 to 50º above horizontal**
- **Currently deployed at Surry and Peach Bottom**

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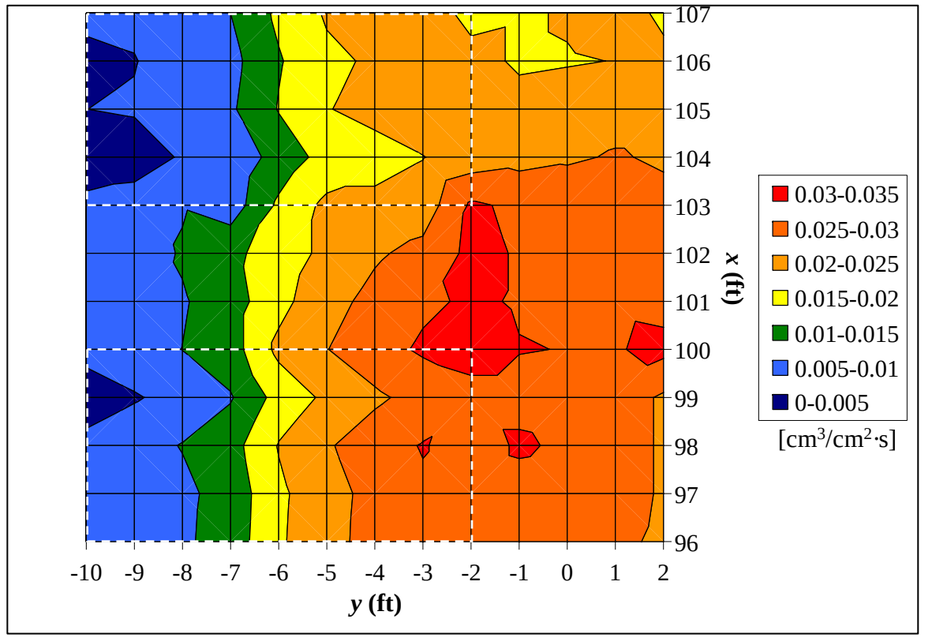
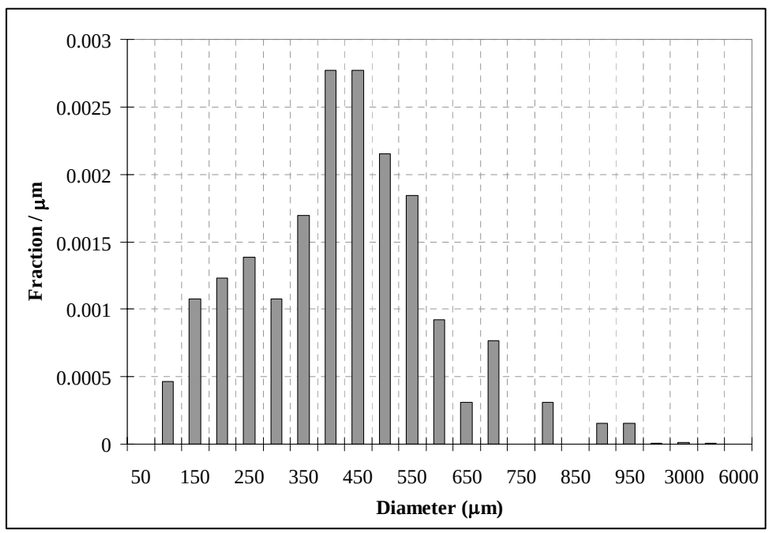
Initial Test Results



- **Water flux measurements**
  - **Measures the dispersion of water**
  - **Maximum measured = 0.032 $cm^3/cm^2 \cdot s$**
  - **NUREG/CR – 5966 (Powers and Burson) values of 0.001 to 0.25 $cm^3/cm^2 \cdot s$**

- **Droplet size distribution**
  - **Count mean diameter (CMD) = 468 μm**
  - **Sauter mean diameter (SMD) = 1.85 mm**
  - **Mass mean diameter (MMD) = 2.86 mm**



- **Secondary effects**
  - **Air entrainment by spray**
  - **Secondary breakup near surface from droplet**
- **Possible mechanisms for enhanced decontamination factor**

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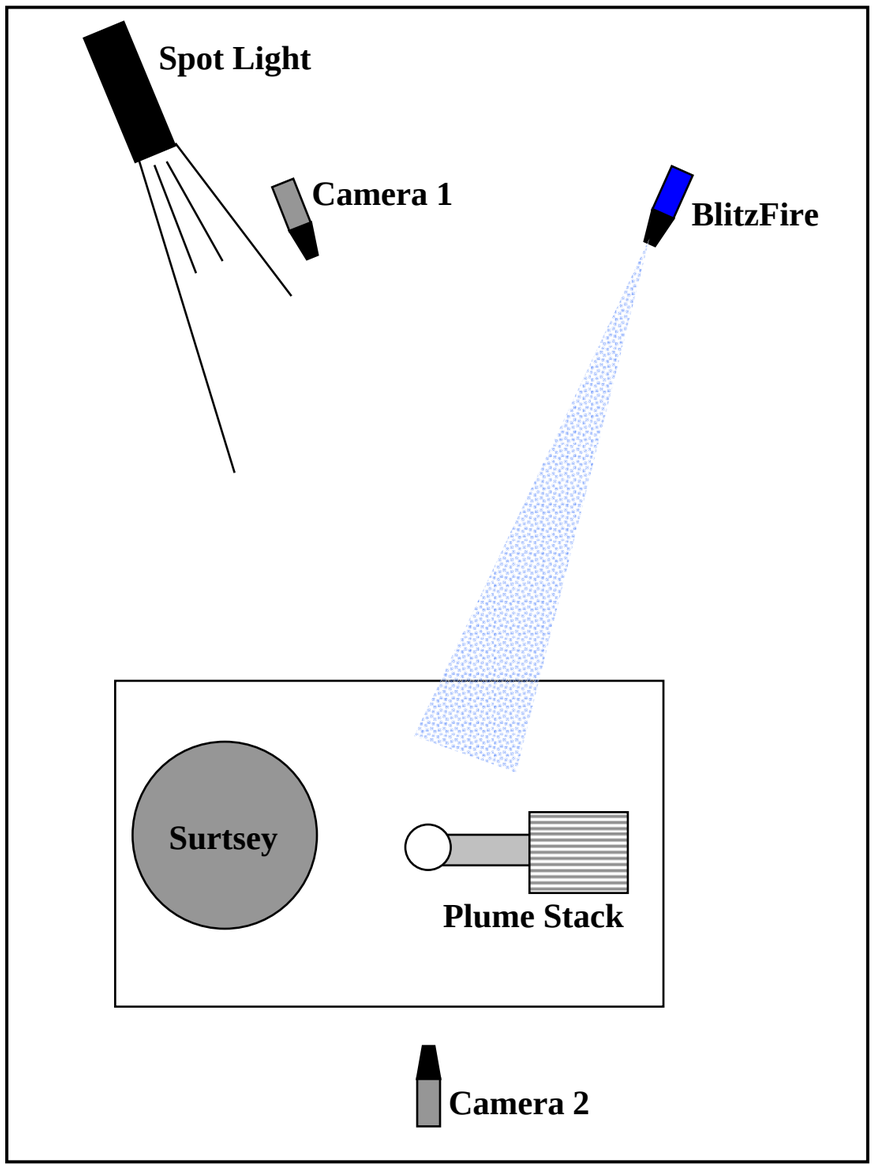
Interaction Visualizations



Overhead Layout

Camera 1

Camera 2

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Program Progress

Task	Purpose	Description	Result
1	Scoping analysis of conventional water sprays	Modeling	~150 MECLOR calcs. w/ 4 configurations analyzed
2	Experimental confirmation of system performance	Experiment	Water flux and droplet size dist. measured for prototypic fire nozzle
3	Optimization of water spray system	Modeling	Analyzing entrainment and secondary effects w/ CFD
4	Additional water spray testing	Experiment	Initial visualizations of buoyant plume / spray interaction complete Planning for simulant release and knockdown

= Completed = In Progress

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