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Tools and Strategies for Optimal Gas and Flame Detector Placement

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Tools and Strategies for Optimal Gas and Flame Detector Placement

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Agenda

- Basics of fire and gas detector mapping
- Shortcomings of the traditional approach
- Discussion of performance based detector mapping
- Importance of testing to validate results
- Comparison of fire and gas detection lifecycle and SIS lifecycle
- Summary

Understanding Basics – Flame Detector

- Flame Detector – sensor designed to detect and respond to the presence of flame or fire, allowing flame detection
- Types:
  - Ultraviolet
  - Infrared
  - UV/IR

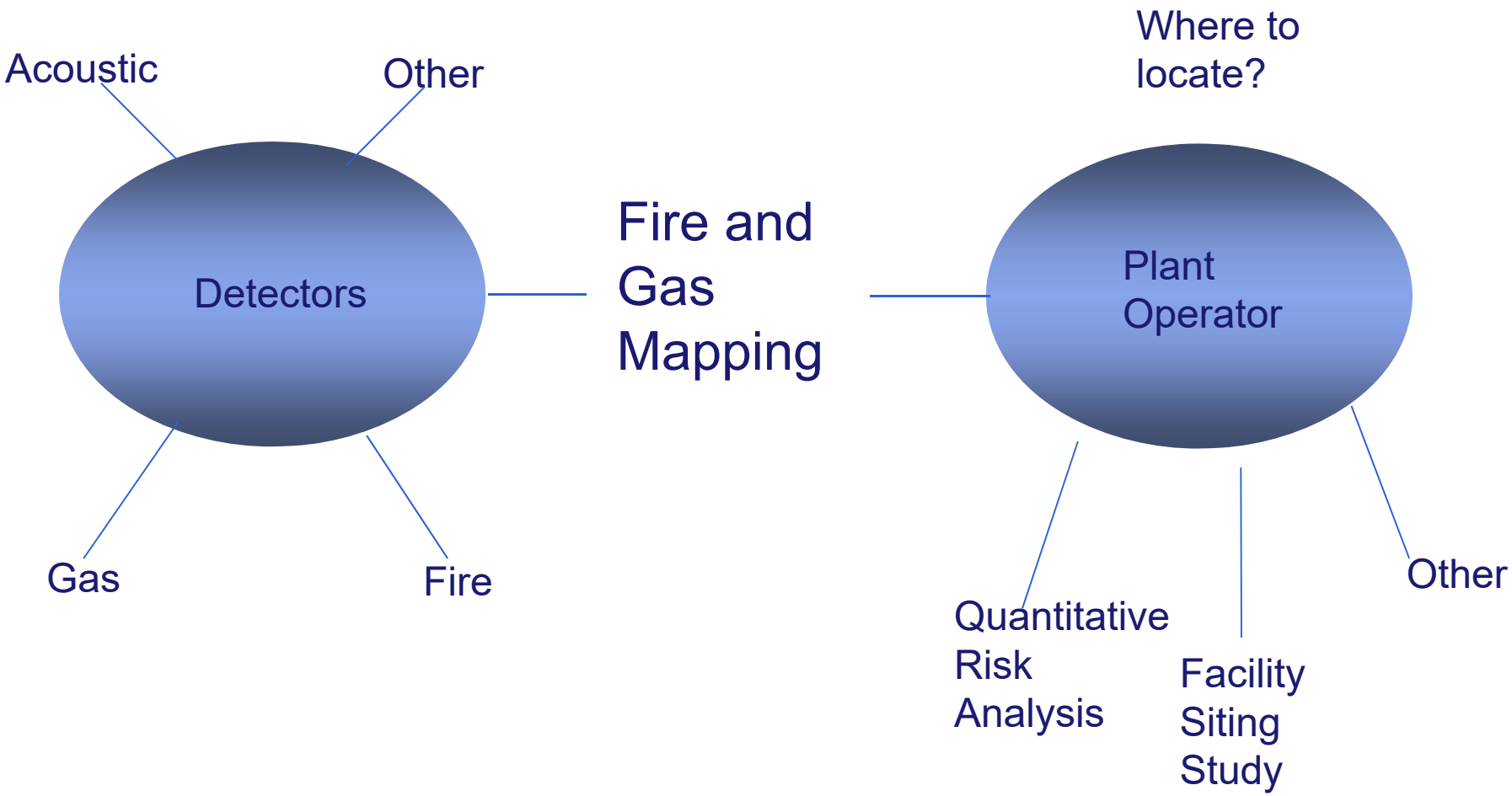
Understanding Basics – Gas Detector

- Gas Detector – Device that detects the presence of gases in an area, often as a part of the safety system
- Detectors can help early detection of different types of gases including flammable, toxic, oxygen, and others
- Types: Electrochemical, catalytic bead, IR, Photoionization and ultrasonic

Introduction

- What is F&G?
  - Fire and Gas Detection
    - Used to alert personnel of a potential fire or gas release
      - Outputs can include:
        - Visual and audible alarms
        - Operator intervention
        - Isolation of processes (manual/automatic)
        - Activation of deluge systems (manual/automatic)

How to Locate Fire and Gas Detectors

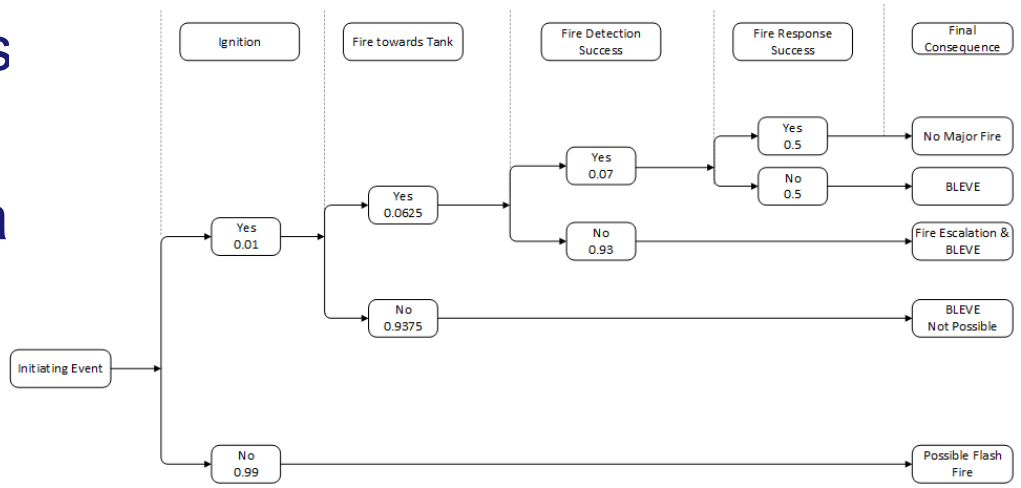


Introduction

- What makes F&G studies difficult?
  - HSE 8 years of offshore data – 60% of known releases were detected
  - No current technical industry standards
    - API Pub 2031 (1991)
    - Most users have internal standards
    - Best industry practice
  - Traditional studies
    - Experience based
    - CFD modeling involves high cost to place very few detectors

Performance Based Detector Mapping

- ISA84 TR7 provides guidance on the implementation of fire and gas detectors
- According to ISA84 TR7, performance of these systems depends on three main components:
  - Detector coverage
  - Fire and Gas System (FGS) safety availability
  - Mitigation effectiveness
- Two main approaches coverage
  - Geographic covera
  - Scenario coverage



Types of Coverage

- Simply defined,
  - Scenario coverage indicates the number of hazardous scenarios that can be successfully detected by FGS out of all the plausible scenarios
  - Geographic coverage indicates the area or a volume that can be covered with detectors if a release or fire occurs in the monitored area

Challenges with Calculating Detector Coverage

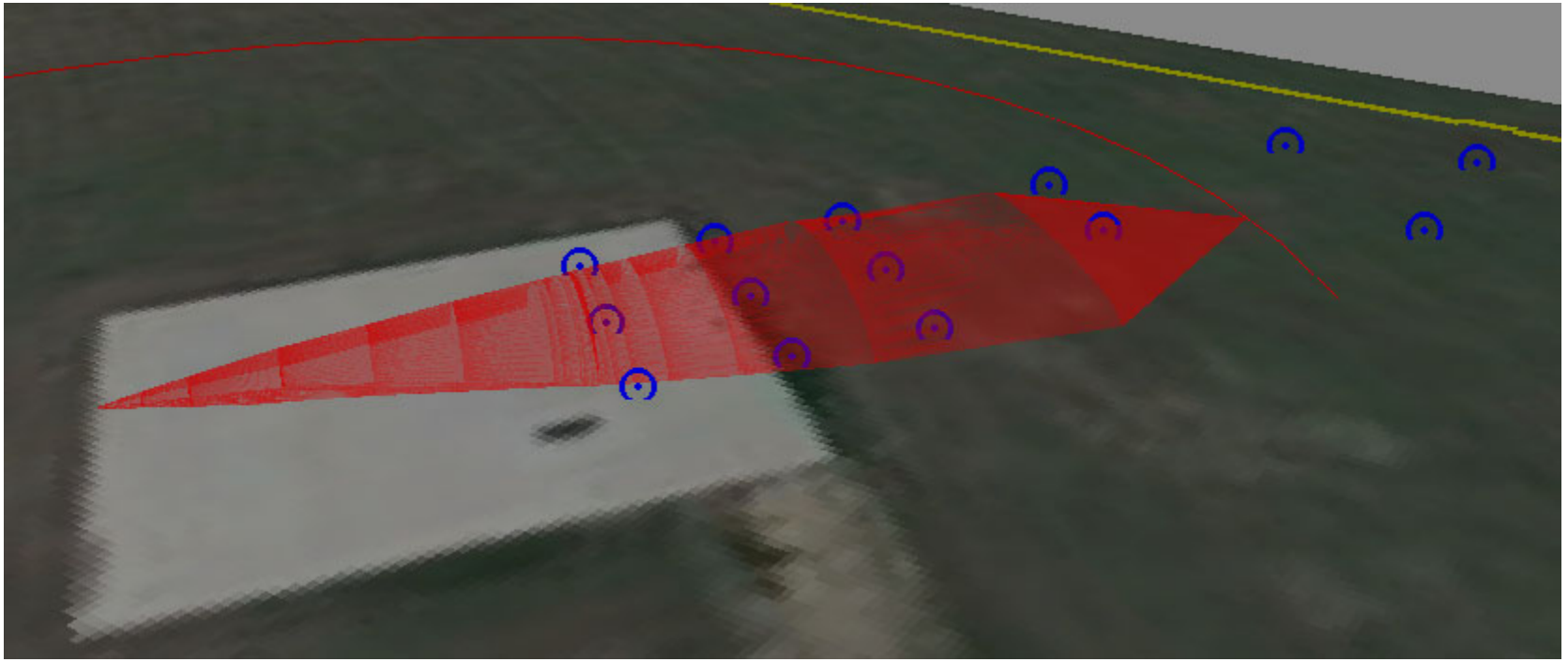
- Depends on the number of scenarios defined
  - What are the right number of scenarios?
- Depends on the fluctuations in the plume concentration
  - Is there enough time for the sensor to detect?
- How to model cross-wind and up-wind releases?
- Different detectors have different response times
  - Response characteristic impacts if detection is successful
  - Impacts the speed of the response

How Testing Helps to Validate Results

- To answer some of the questions, we performed a series of tests
- Tests were performed with saturated propane for ½", ¾" and 1" releases in 5 different orientations
- 74 tests were performed ranging from 1 to 1.5 minutes
- 14 detectors were placed 60ft up to 200ft from the release point (3 different manufacturers)

Case Study Results

- Horizontal release downwind



Case Study – Results (for 0.5inch tests)

- Scenario coverage for 1oo1 detector was observed to be <60%
- Scenario coverage for 2oo2 detector was observed to be <40%
- Most of the releases in the up or west direction were not detected
- Wide ranging fluctuations were observed in concentrations during the test duration
- Speed of rise and maximum concentrations varied significantly between detectors

Performing FGS Mapping with Scenario Coverage

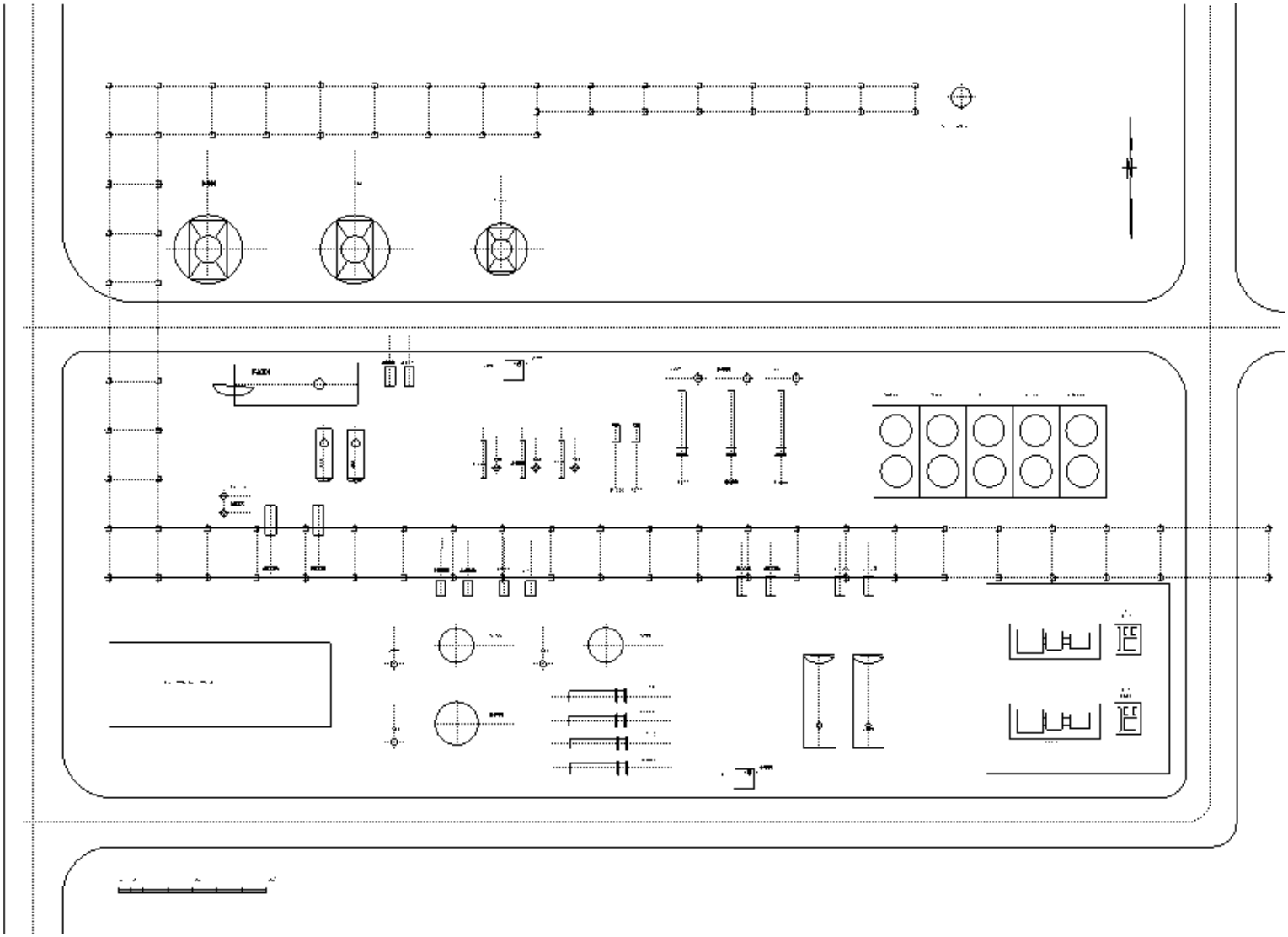
Methodology

- Model development
- Import consequence and risk contours to aid in fire and gas detector placement
  - Flammable Contours
  - Toxic Contours
  - Thermal Contours
  - Risk Contours
- Placement and orientation of fire and gas detectors within the site
- Analyze and review detector coverage

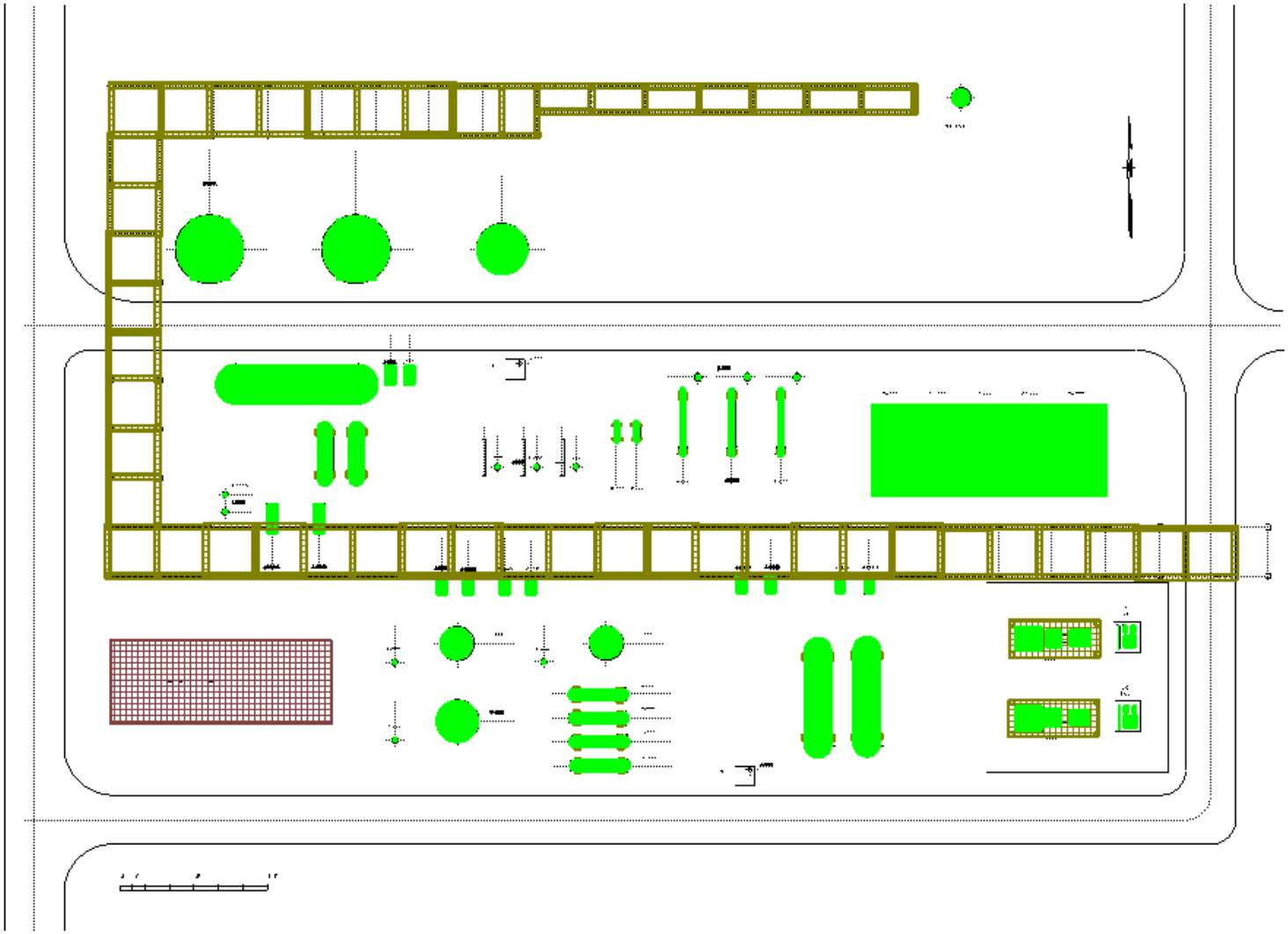
Model Development

- Start with a CAD plot plan of the unit
- A unit survey is conducted to determine the dimensions of major equipment and structures
- Major equipment and structures are added to the FGS software model in 3-dimensions

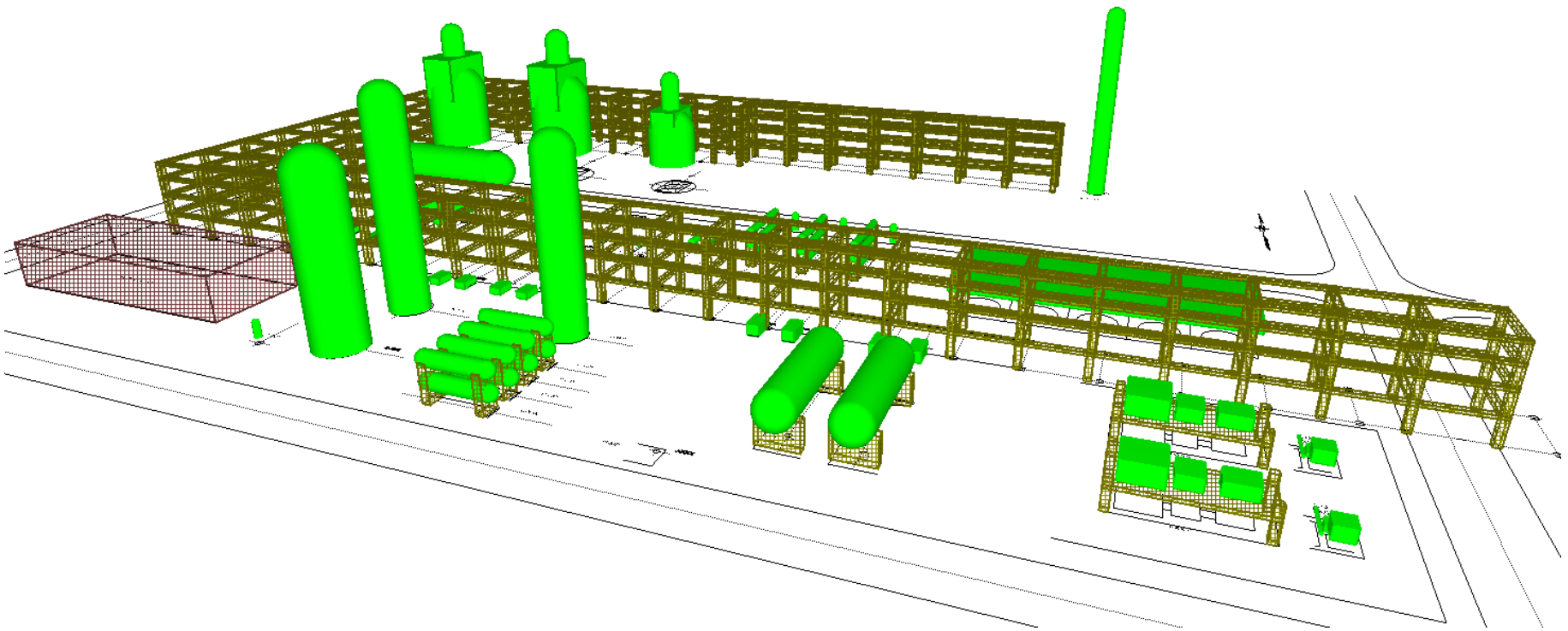
Plot Plan



Complete Model – 2D



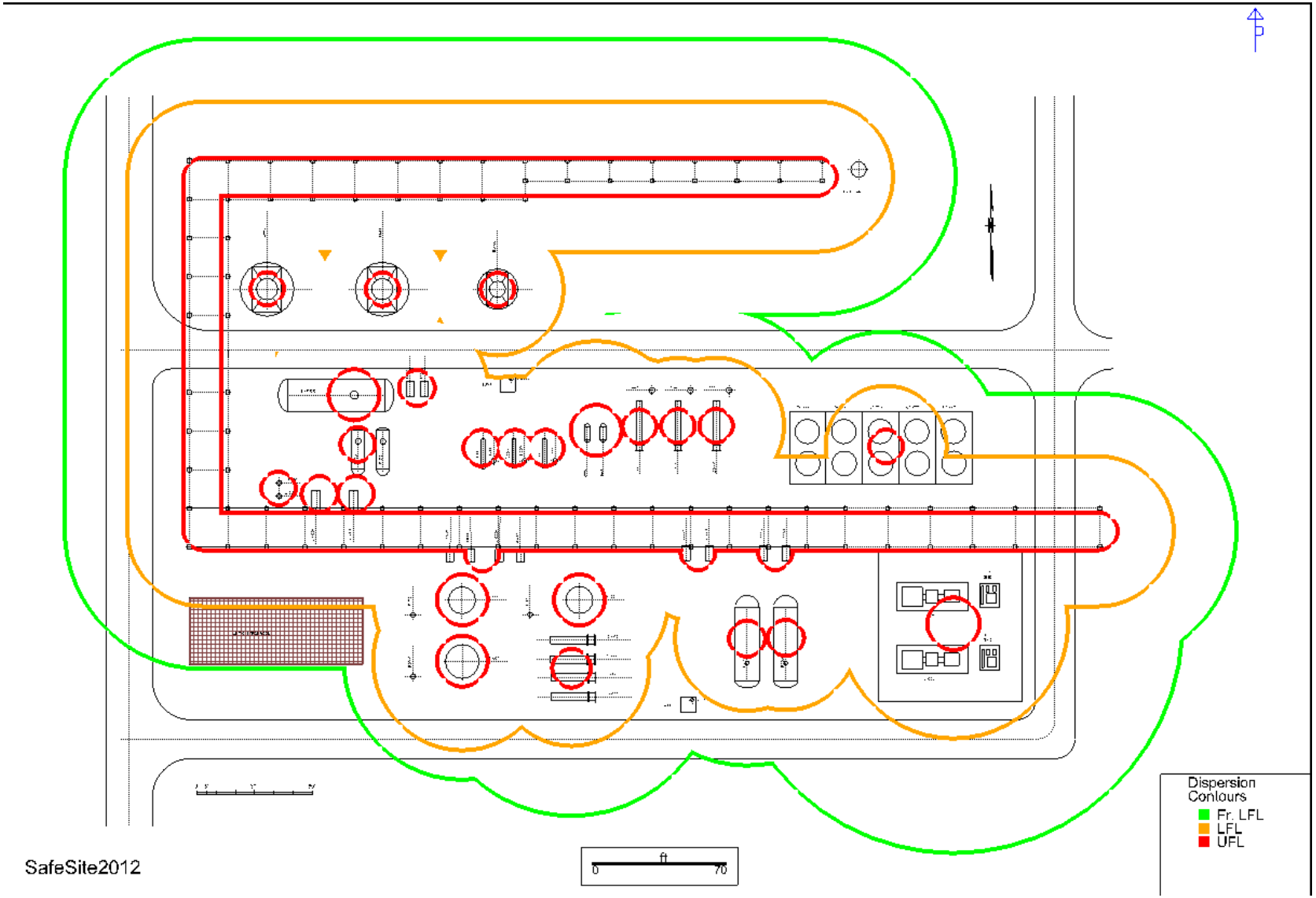
Complete Model – 3D



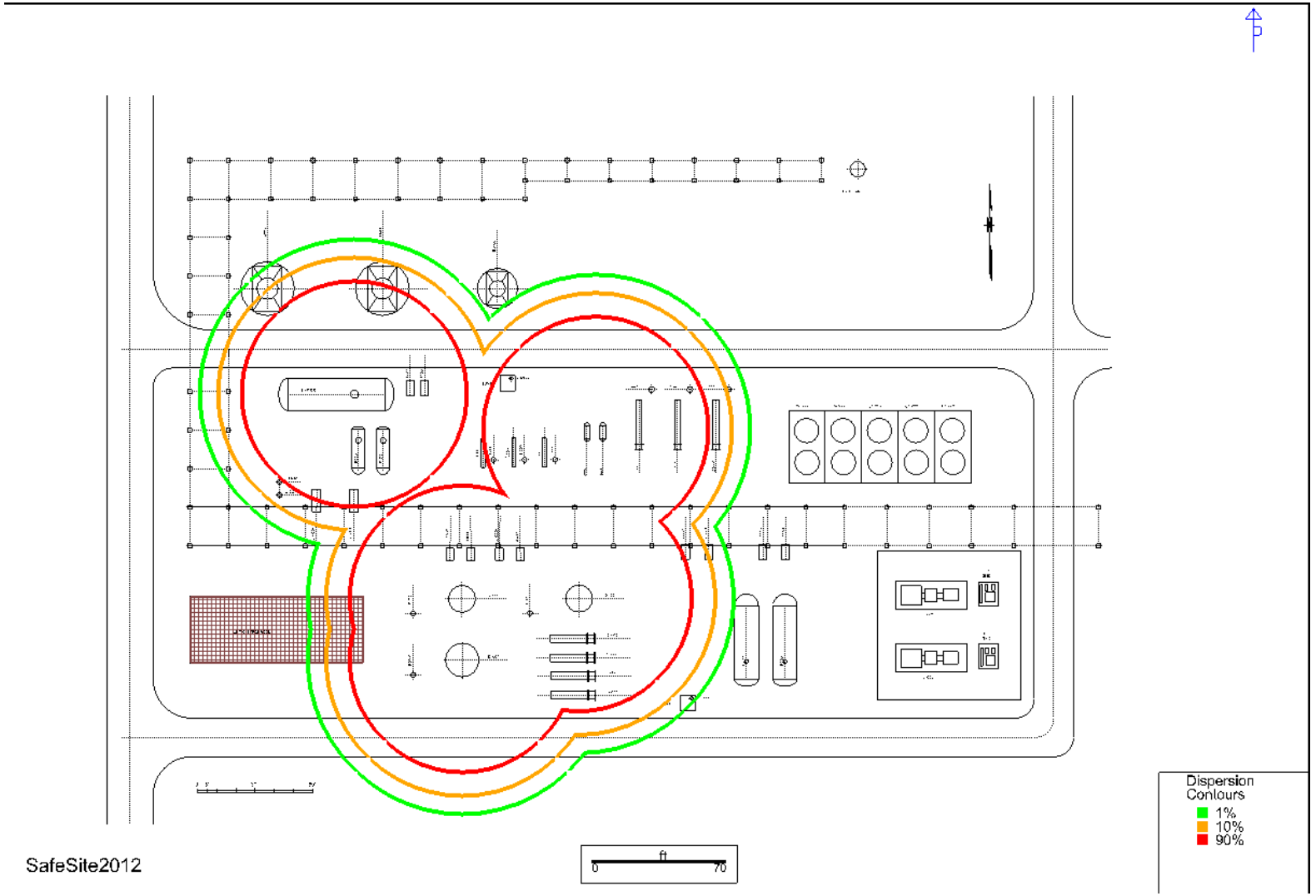
Consequence and Risk Contours

- Contours are imported into the model from the site consequence models
- Flammable contours are imported at values of UFL, LFL, ½ LFL
- Toxic contours are imported at values of appropriate probit concentrations
- Thermal contours are imported at values of 4 kW/m^2, 12.5 kW/m^2, and 37.5 kW/m^2
- Risk contours
  - Flammable, toxic, and thermal risk only

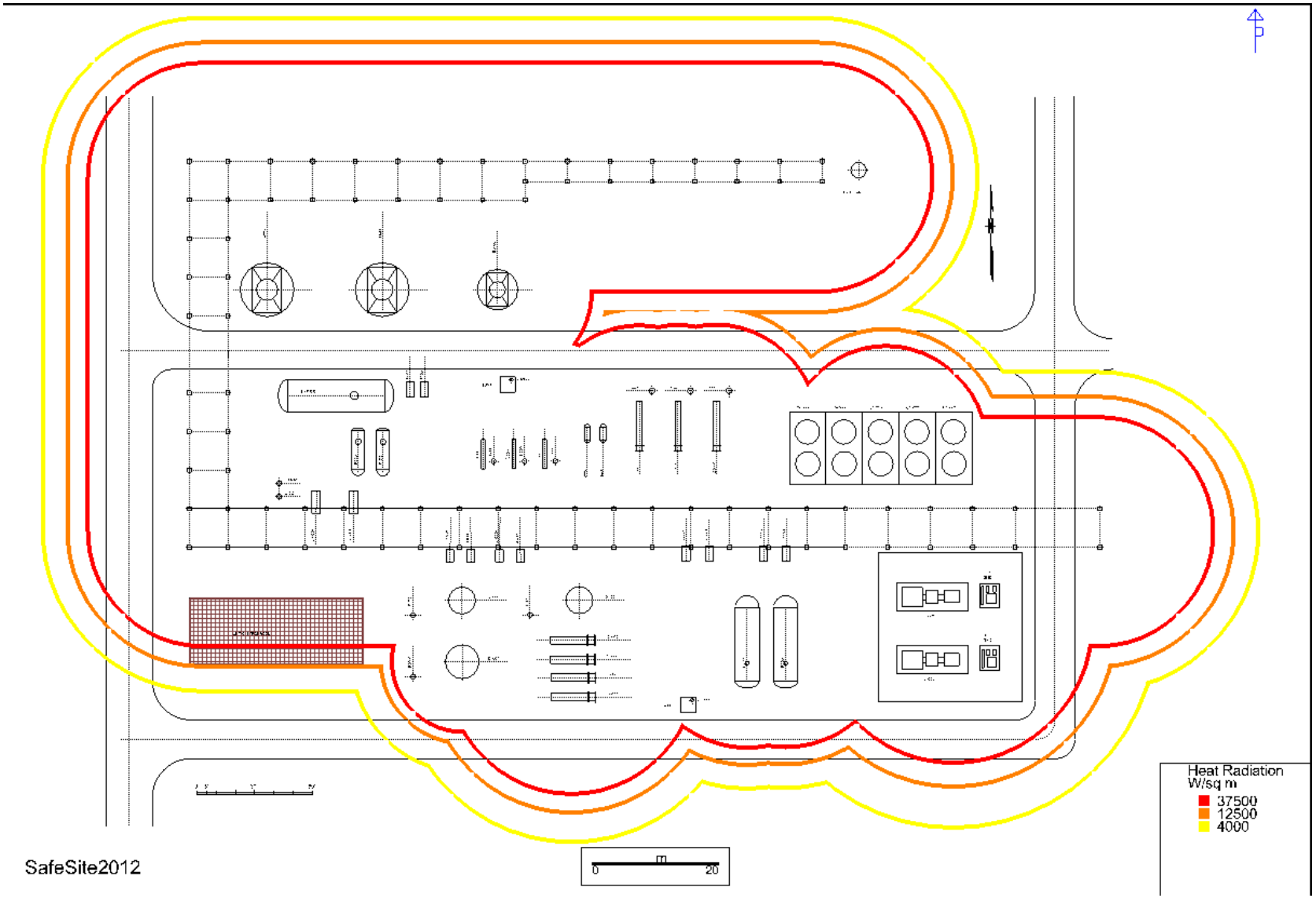
Flammable Contours



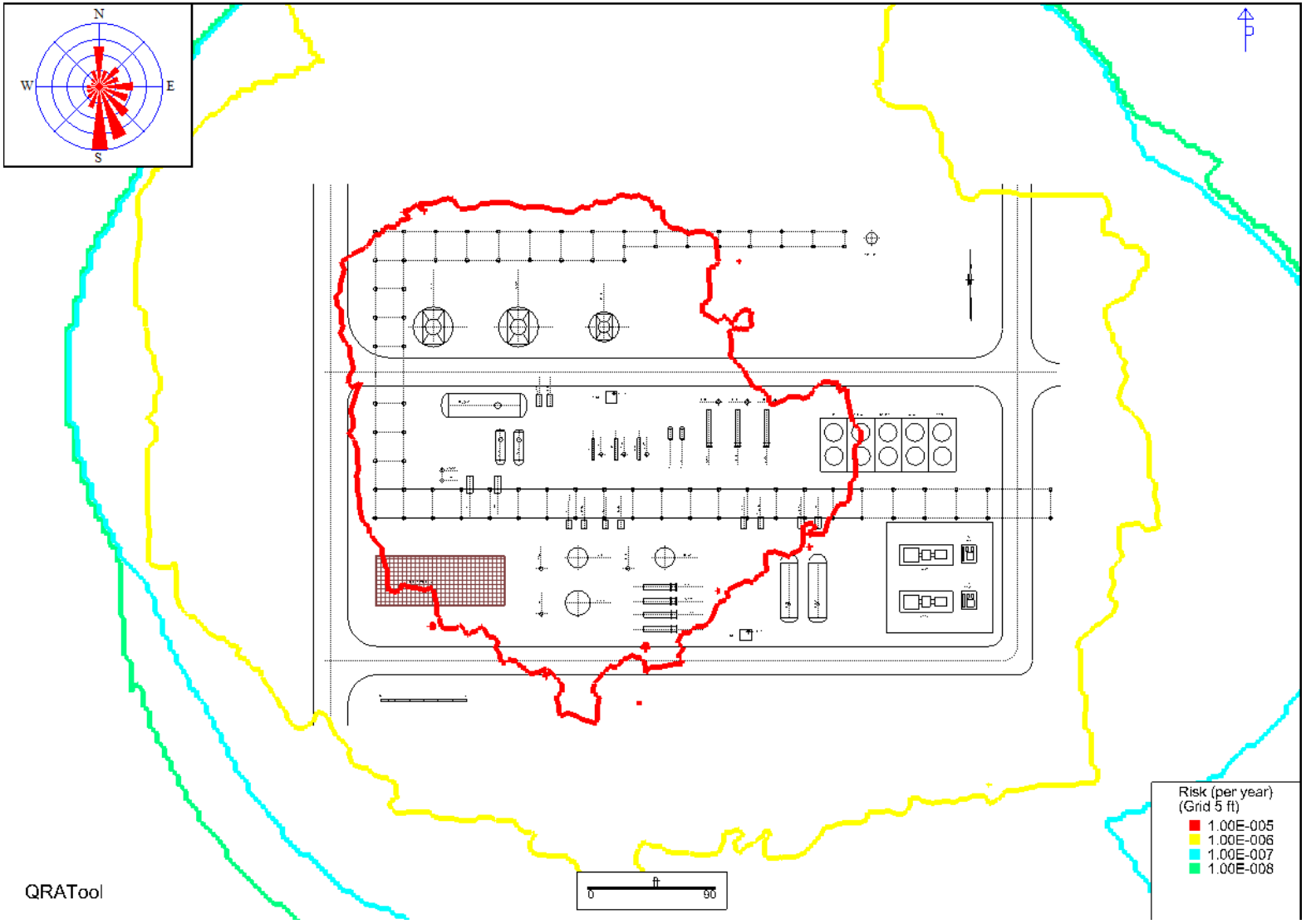
Toxic Contours



Thermal Contours



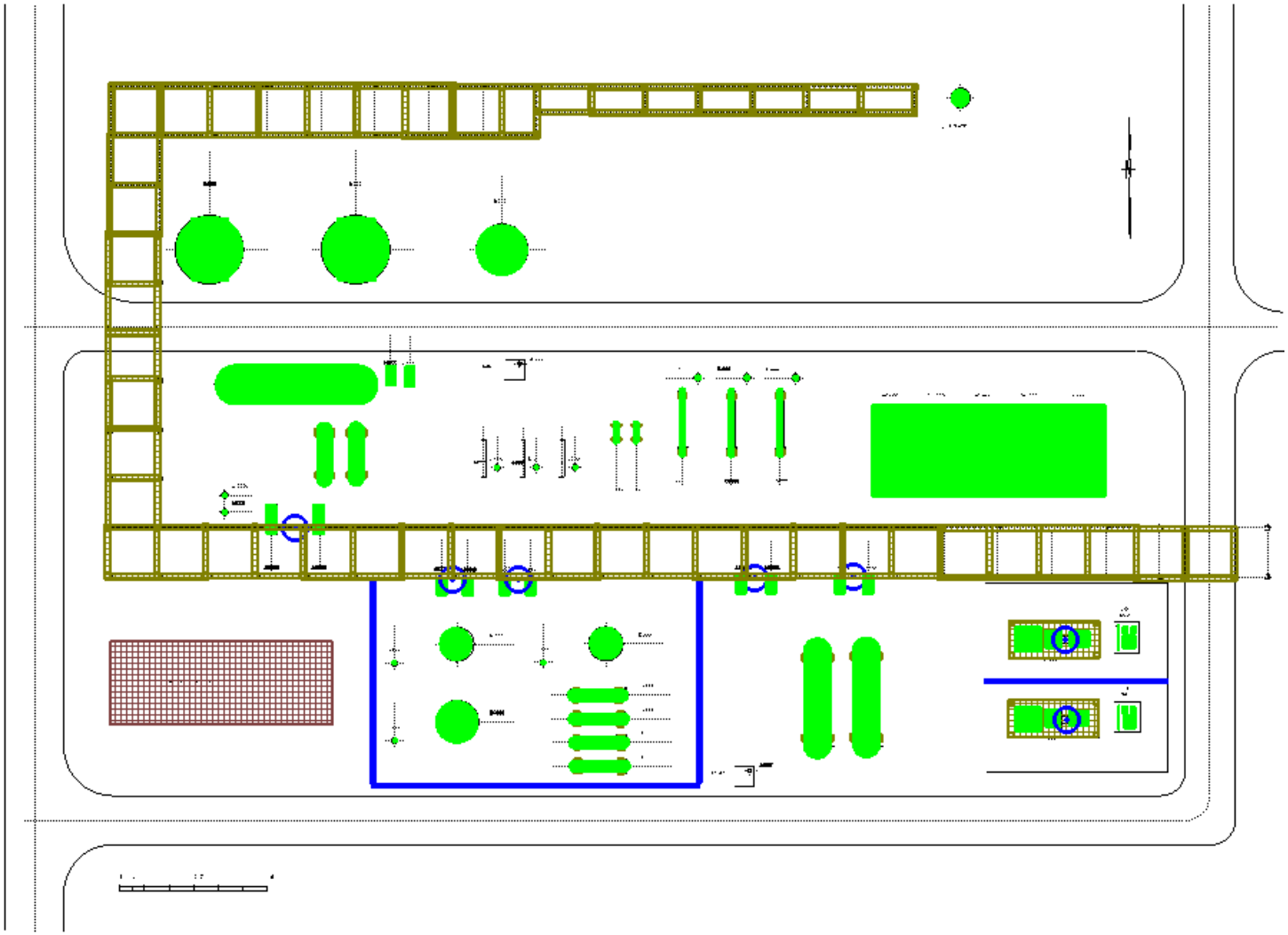
Risk Contours



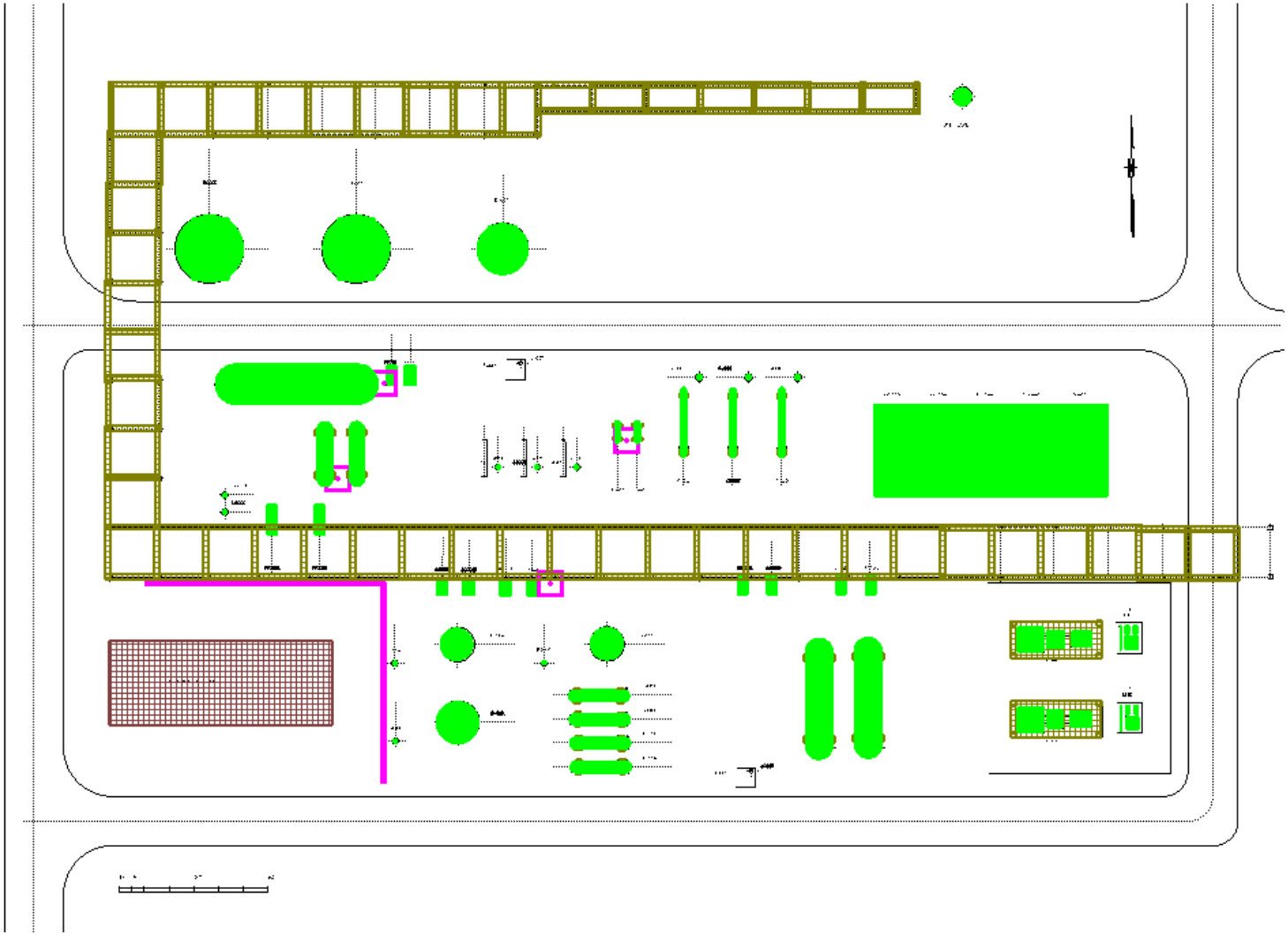
Fire and Gas Detection

- Fire and gas detectors are located based on consequence and risk contours, client guidelines, and industry practices
- Gas detectors
  - Point gas detectors are given coordinates and a height to show a physical location in 3D
  - Line detectors are given coordinates and a height to allow them to interact with the 3D model
  - Acoustic detectors are given coordinates and a height to allow them to interact with 3D model
- Fire detectors
  - Conical flame detectors

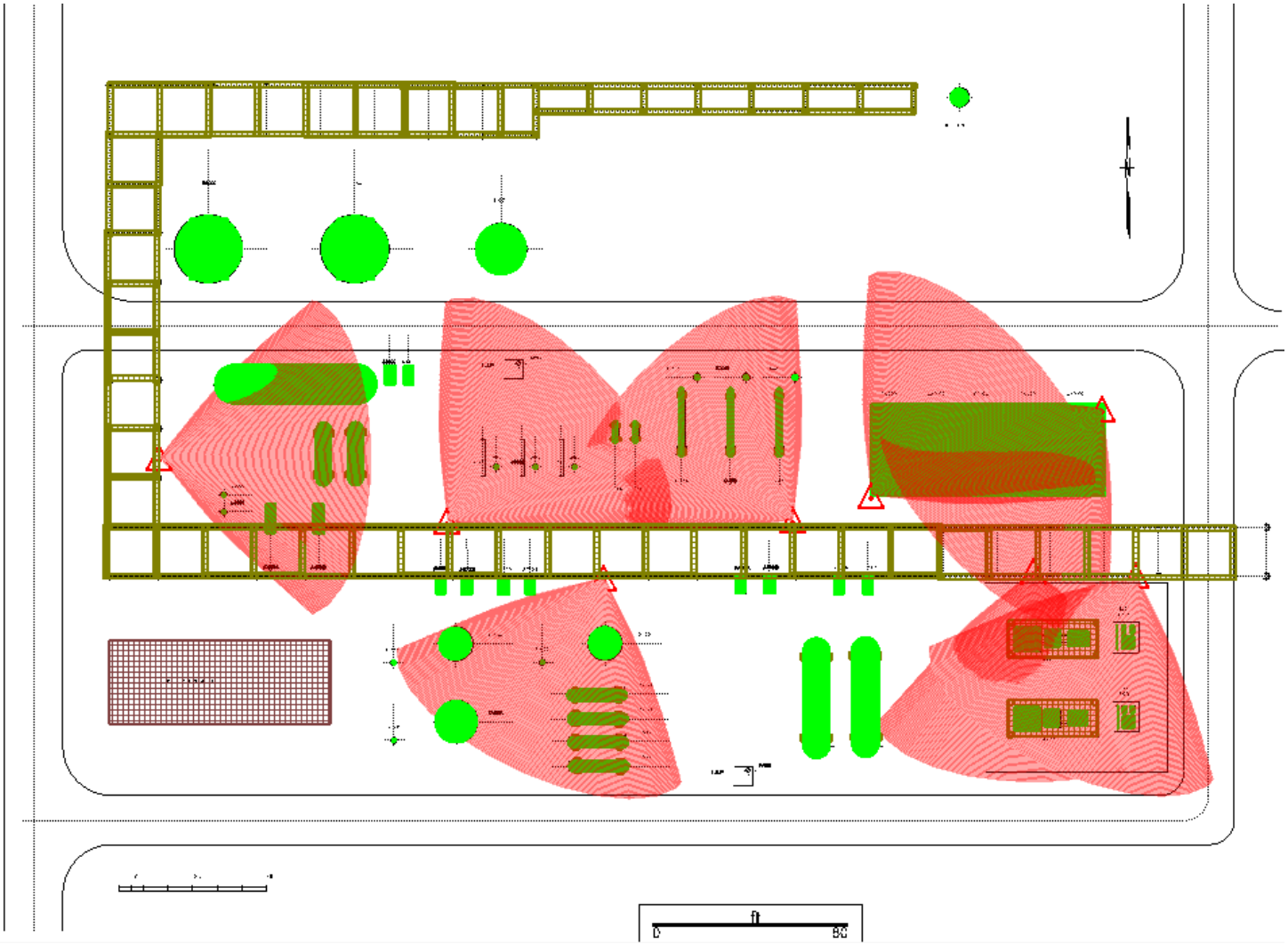
Example Flammable Gas Detection



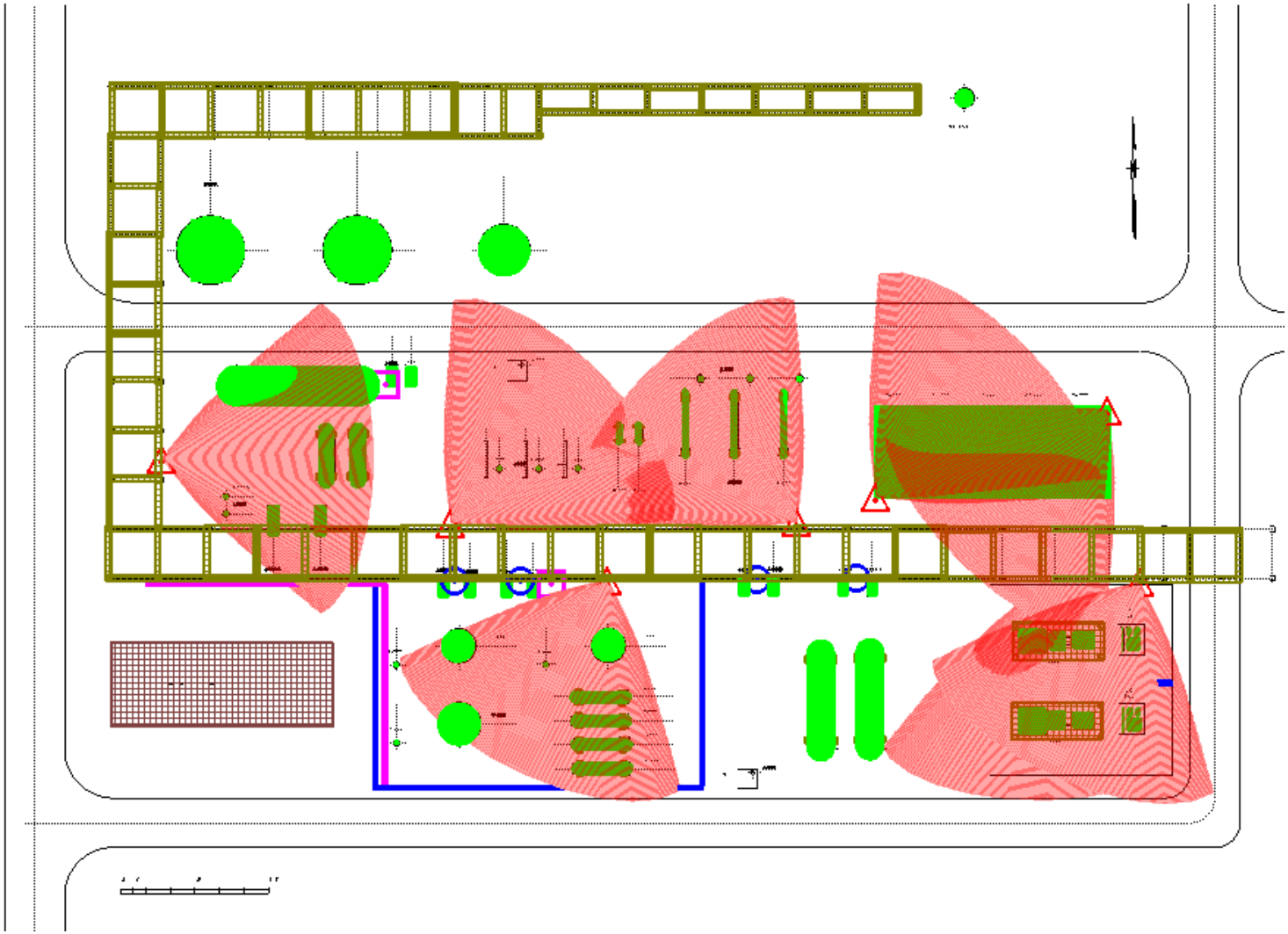
Example Toxic Gas Detection



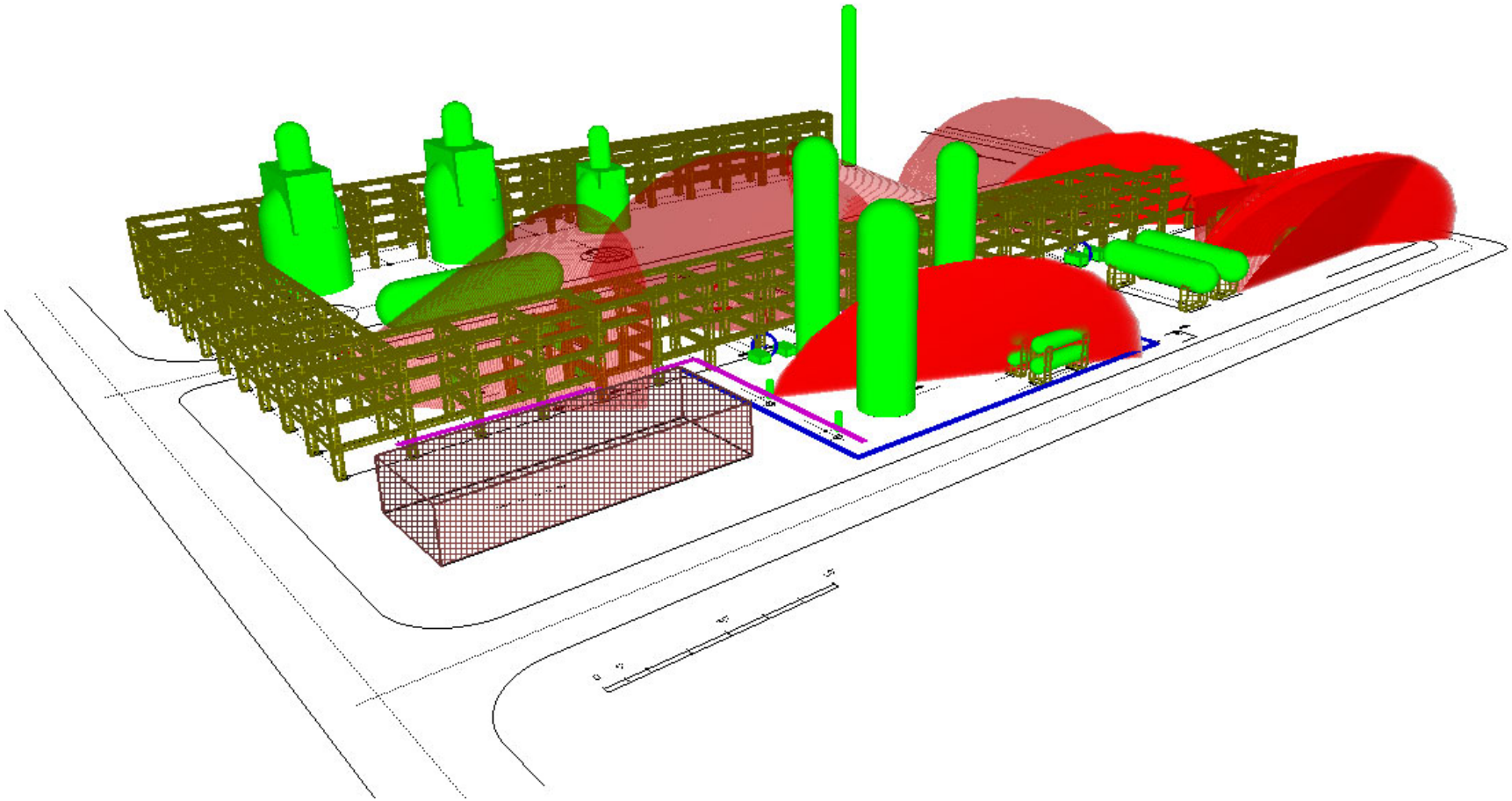
Example Fire Detection



Completed Model – 2D

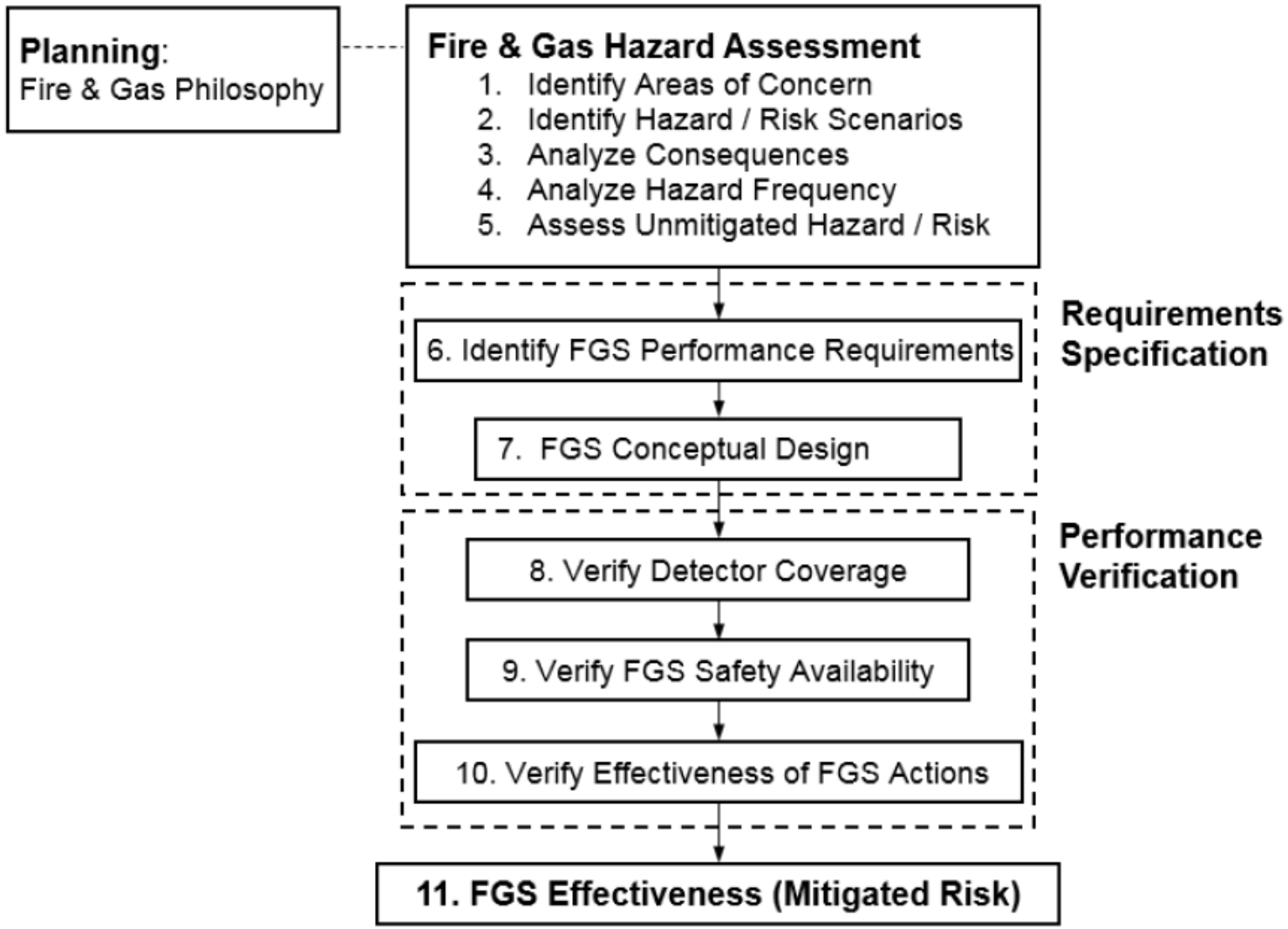


Completed Model – 3D

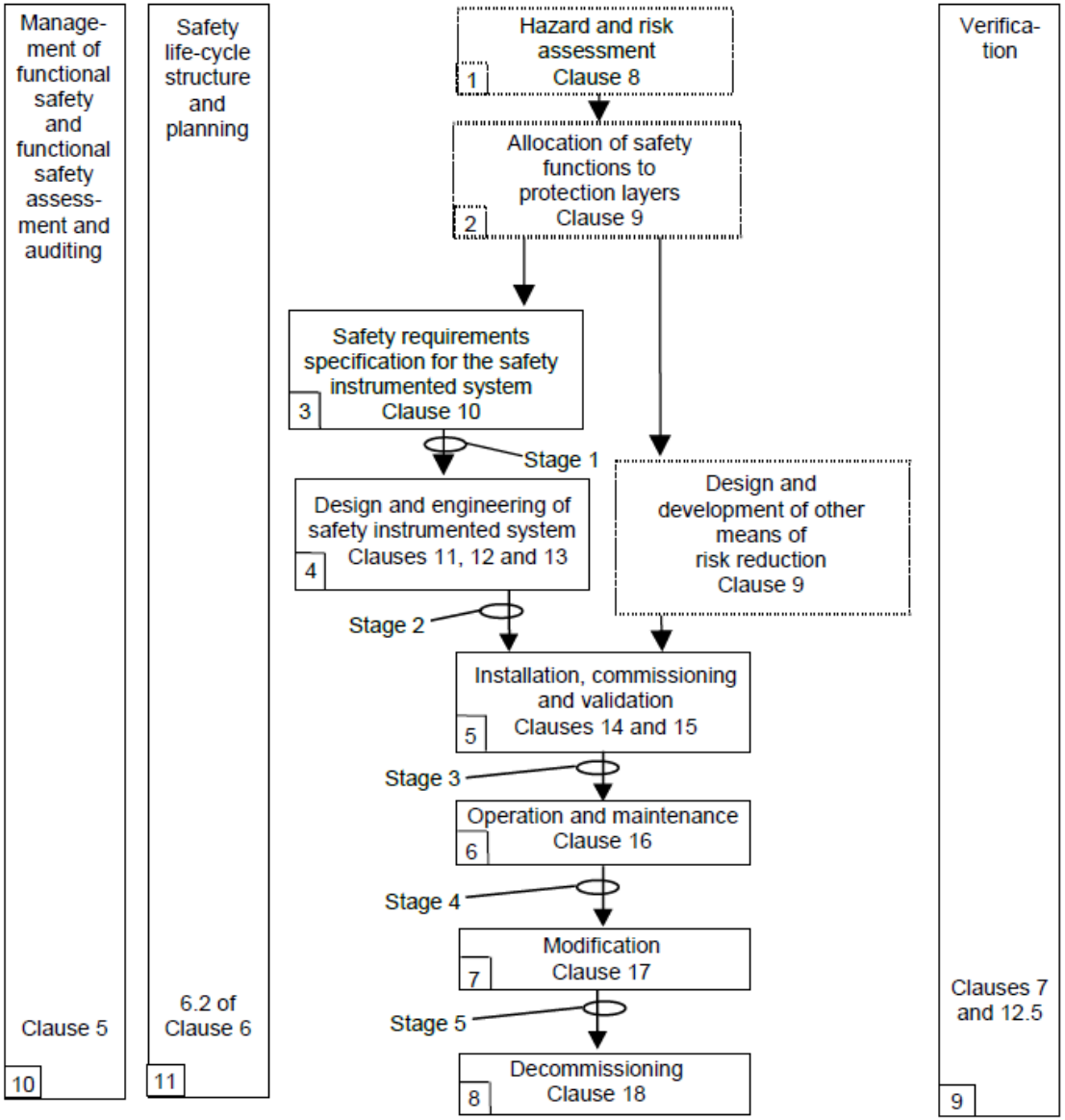


Comparison of FGS and SIS Life Cycles

FGS Life Cycle



SIS Life Cycle



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