



# BakerRisk Testing and R&D



**Baker Engineering and Risk Consultants, Inc.**

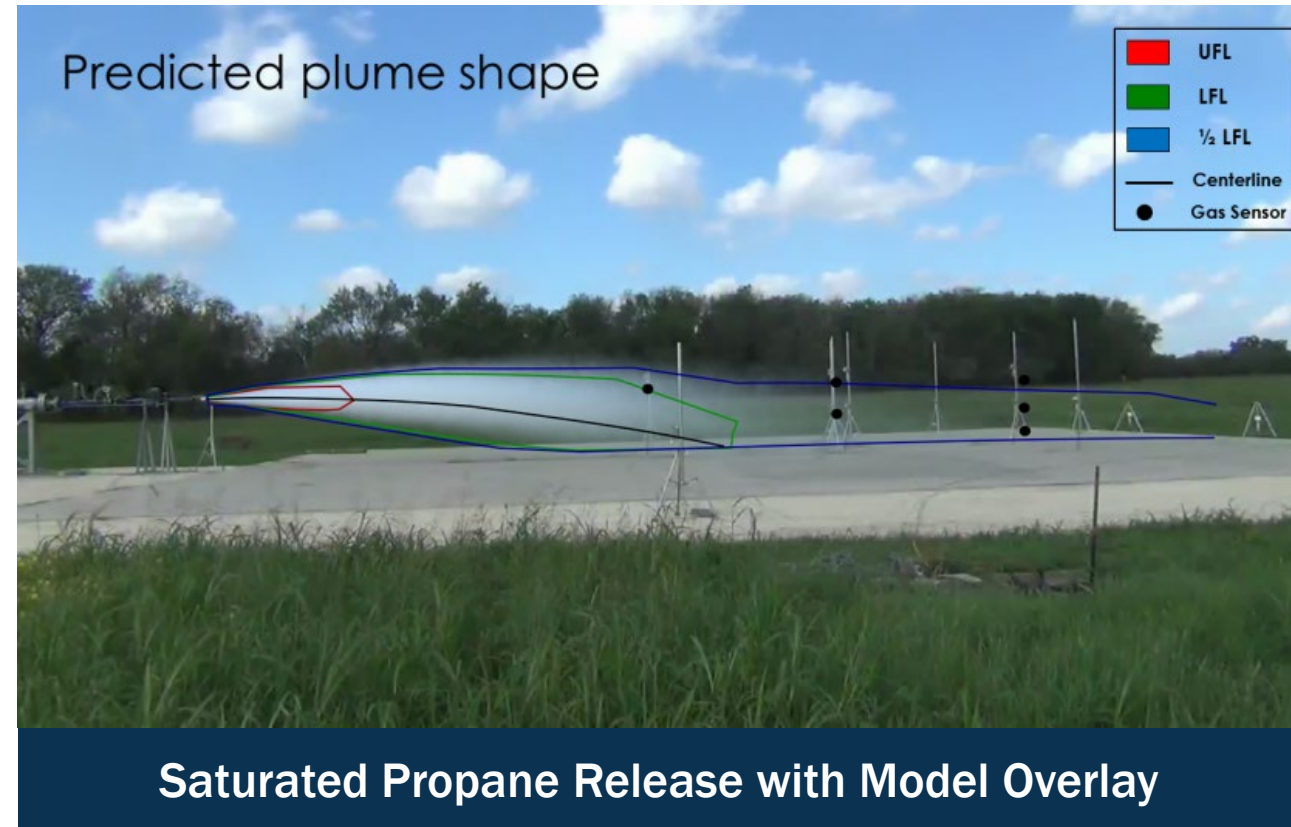
**PHMSA Conference 2023**

**Presenter: Nolan Gajeski**

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# Outline

- Introduction to BakerRisk
- Overview of Test Facilities
- BakerRisk Joint Industry Programs
- Review of Relevant Test Rigs and Test Programs
- Leak Detection



# BakerRisk – What we do!



# Introduction to BakerRisk

- Established in 1984
- 6 Offices, 200+ Employees, ESOP
- Conducted over 8,000 projects relating to explosion, fire, and toxic hazards
- Technical sections:
  - Process Safety and Risk Management
  - Structural Analysis and Design
  - Blast and Explosion Effects
  - Testing Services (integrated into other sections)
  - Accident Investigations (origin and cause; forensics)



# Overview of Testing Facilities

- **Wilfred E. Baker Test Facility (Scull Crossing):** 160 acres located southeast of San Antonio, Texas.

- Test Apparatus include:
  - Multiple Shock Tubes
  - Dispersion and Jet Fire Test Pad
  - High Speed / High Pressure Projectile and Terminal Ballistic Research Test Pad
  - Underwater High Pressure Release Test Pad
  - Drop-Test Apparatus
  - Severe-Load Static Test Apparatus
  - Vapor Cloud Explosion Test Pad

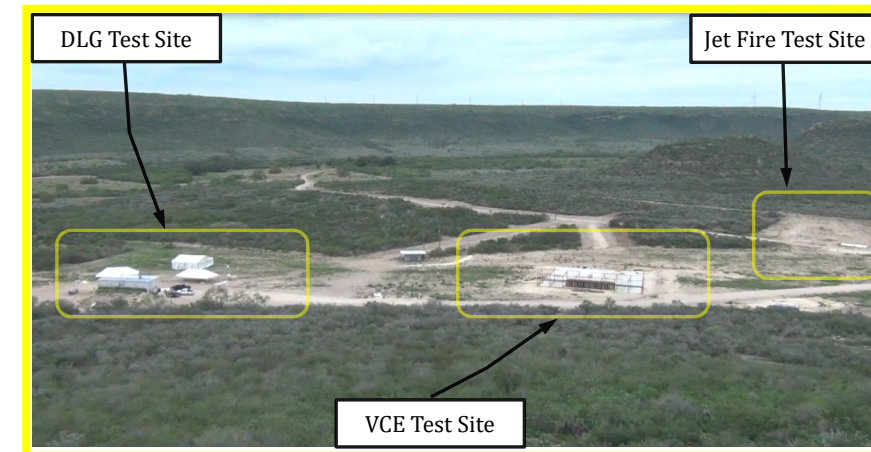


- **Box Canyon:** BakerRisk's largest test facility (2,300 acres) located west of San Antonio, Texas in Kinney County.

- Test Apparatus include:
  - Vapor Cloud Explosion (VCE)
  - Deflagration Load Generator (DLG)
  - Jet Fire/Misc.

- **Materials Testing Lab:** Located in San Antonio office building (not pictured)

- Types of testing include:
  - Materials Engineering and Metallurgical Analysis
  - Combustion Tests
  - Chemical and Special Tests



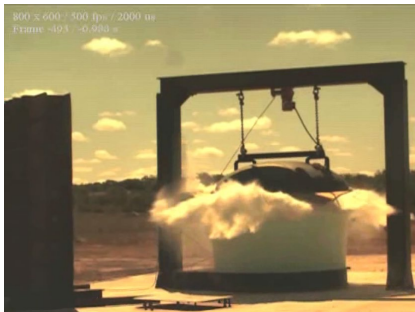
[Link to BakerRisk Website](#)

# Joint Industry Programs

## Past JIPs

- **Pressure Test Research Cooperative (PTRC)**

- 2006 - 2016
- Down hole tool industry group focused on high pressure (15-30,000 psi) hazards



- **Mud Plug JIP**

- Midstream industry group focused on hazards associated with pipeline isolation with mud plugs

## Current JIPs

- **Explosion Research Cooperative (ERC)**

- Started in 1993
- Currently 22 member companies
- Petrochemical/Refining industry group focused on vapor cloud explosion and structural response phenomena

- **Ammonia JIP**

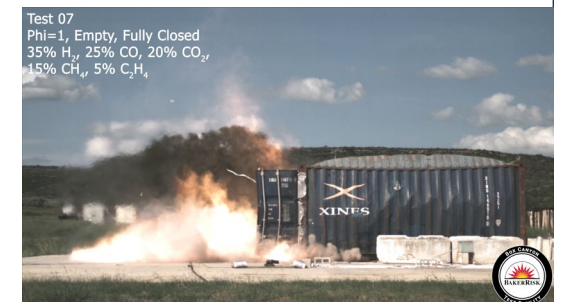
- Started in 2020
- Currently 14 member companies
- Ammonia and Fertilizer industry group focused on mechanical integrity related hazards

## Future JIPs

- **Hydrogen**



- **Battery Energy Storage Systems**



# Summary of BakerRisk Testing Experience

- ~40 years of experience
- >2,400 acres of land dedicated to testing operations
- Several Joint Industry Programs
- Works with >90% of operating companies in the United States and many governmental agencies



Flash Fire Hazards Demonstration



Full Scale PEMB test

# Saturated Propane Dispersion, 1/2"





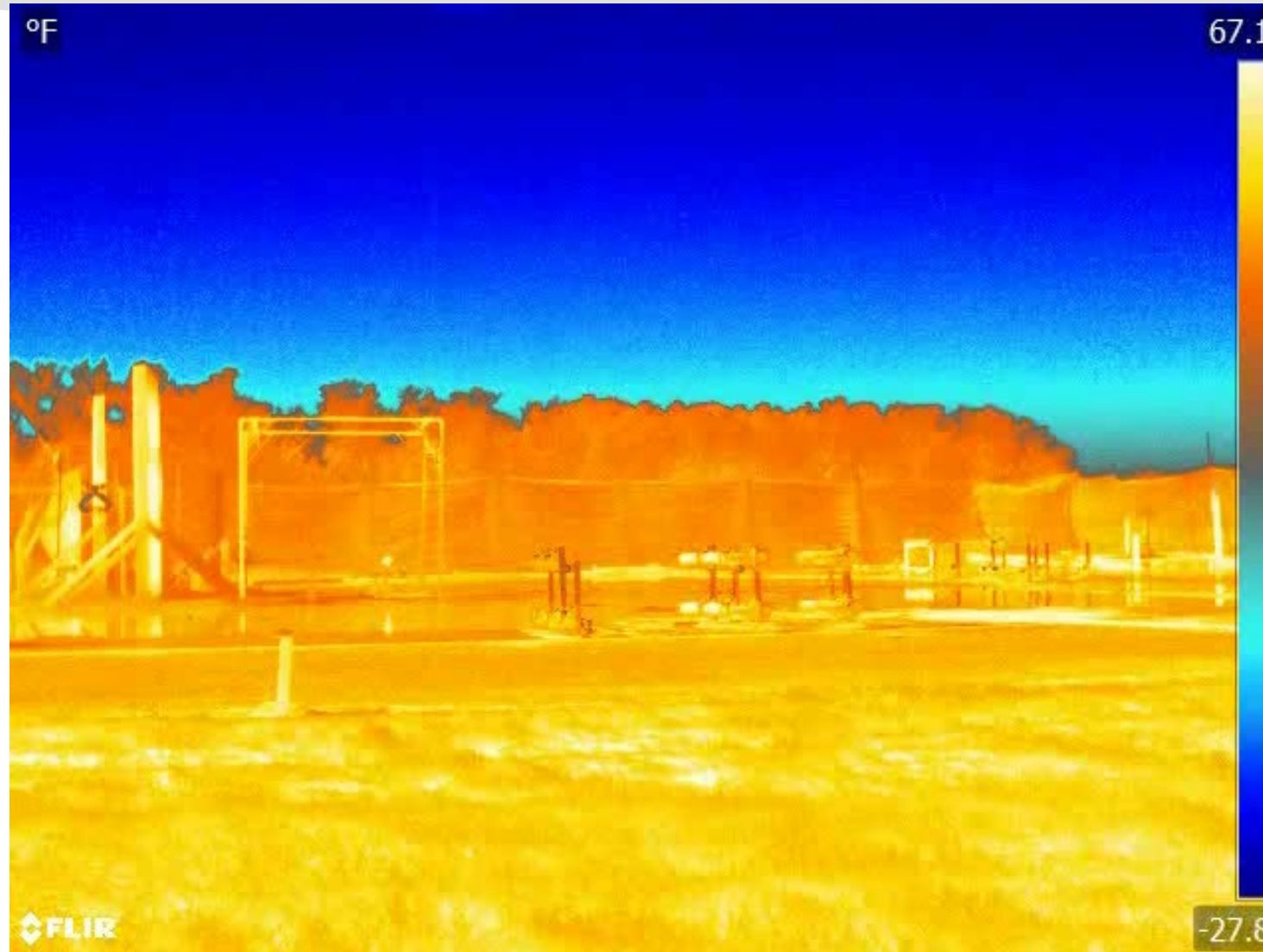
# Liquid Jet Fire



# Mitigated Gas Detection Testing



# Jet Fire Test with Deluge



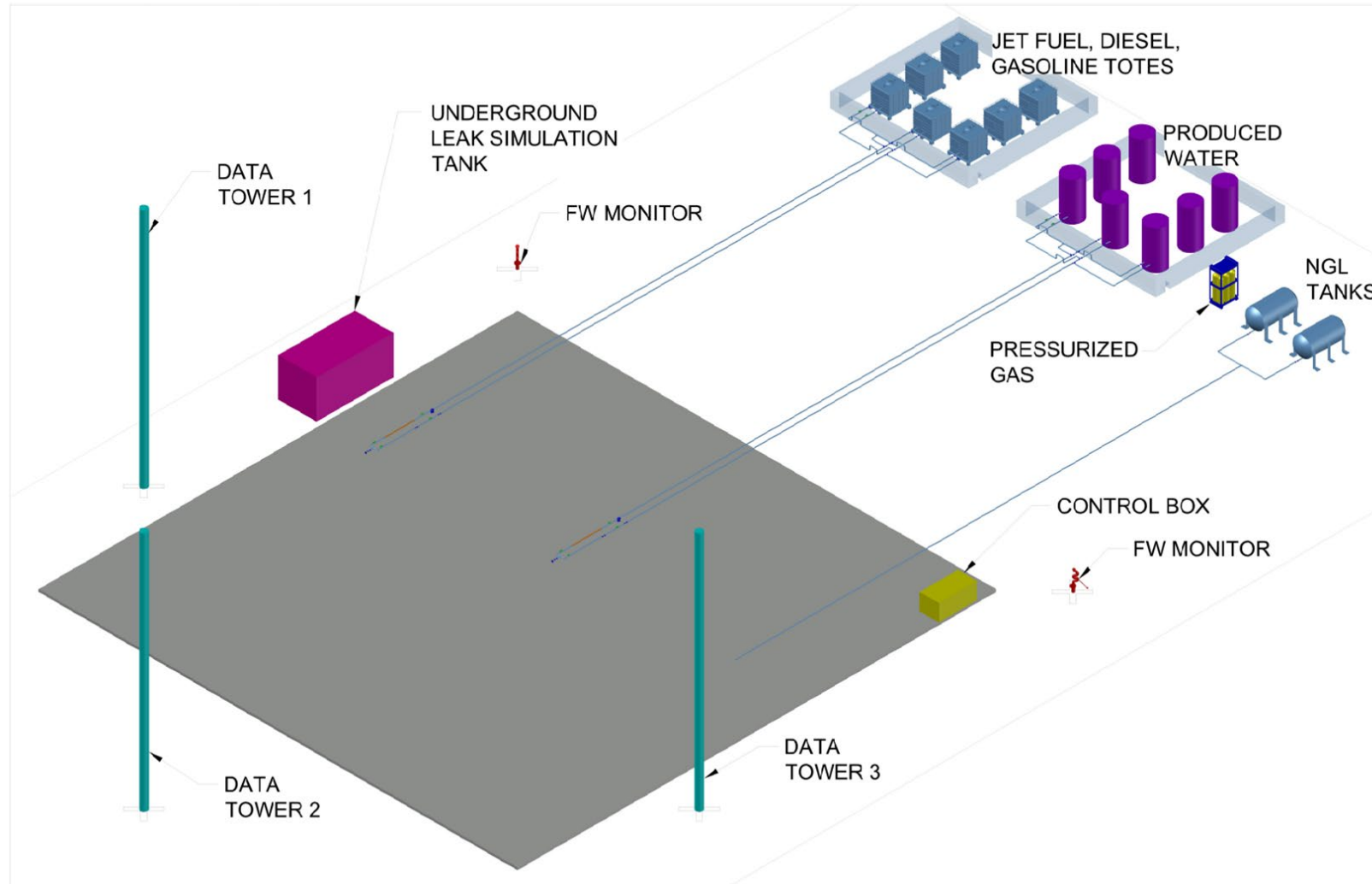
# Other (Process Safety) Test Programs Include

- **Jet fire impingement of building members studying:**
  - Effects on windows
  - Effects of different insulations
  - Effects of different building materials
- **Jet fire impacts to flexible piping**
- **Dispersion testing for IR gas detector validation**
- **Flame detector pool fire validation**
- **Foam Proportioner Testing**
- **Warehouse Pallet Storage Fire Testing**
- **Crude Storage Tank Rim Seal Fire Testing**
- **Biodiesel Mist Jet Fire Testing**
- **Leak detection testing of C1/C3/C3=/H2 w/ GCI IR cameras**

# Leak Detection Challenges

- **Low flow measurements in liquid leaks**
- **Inline Inspection of long-distance pipelines**
  - Axial measurements only
  - Limit to smaller sections
- **Legacy technologies**
- **Great camera technology but spurious alarms/fuel dependent**
- **FAA restrictions/lack of training (drones)**
- **Data analytics expertise**

# Leak Detection Rig - Example



# Leak Detection Feasibility Assessment

- **Contracted in October 2023**
- **Scope summary**
  - Evaluate leak detection capabilities of current industry test facilities
  - Identify gaps at current test sites to test existing technologies, including limitations of sites
  - Timelines to build/operator a test site, including practical options, maintenance, etc.
  - Types of testing including indoor/outdoor, above/below ground, on/offshore, multiple fluid types, etc.
  - Major maintenance activities & costs
  - Document major equipment, materials, hardware, software, maintenance, needs, etc., broken down by each leak detection type.
  - Include a cost analysis for facility(s), yearly operating costs, life expectancy, upgrade costs, support & maintenance, # tests per year for financial stability and depreciation rates.

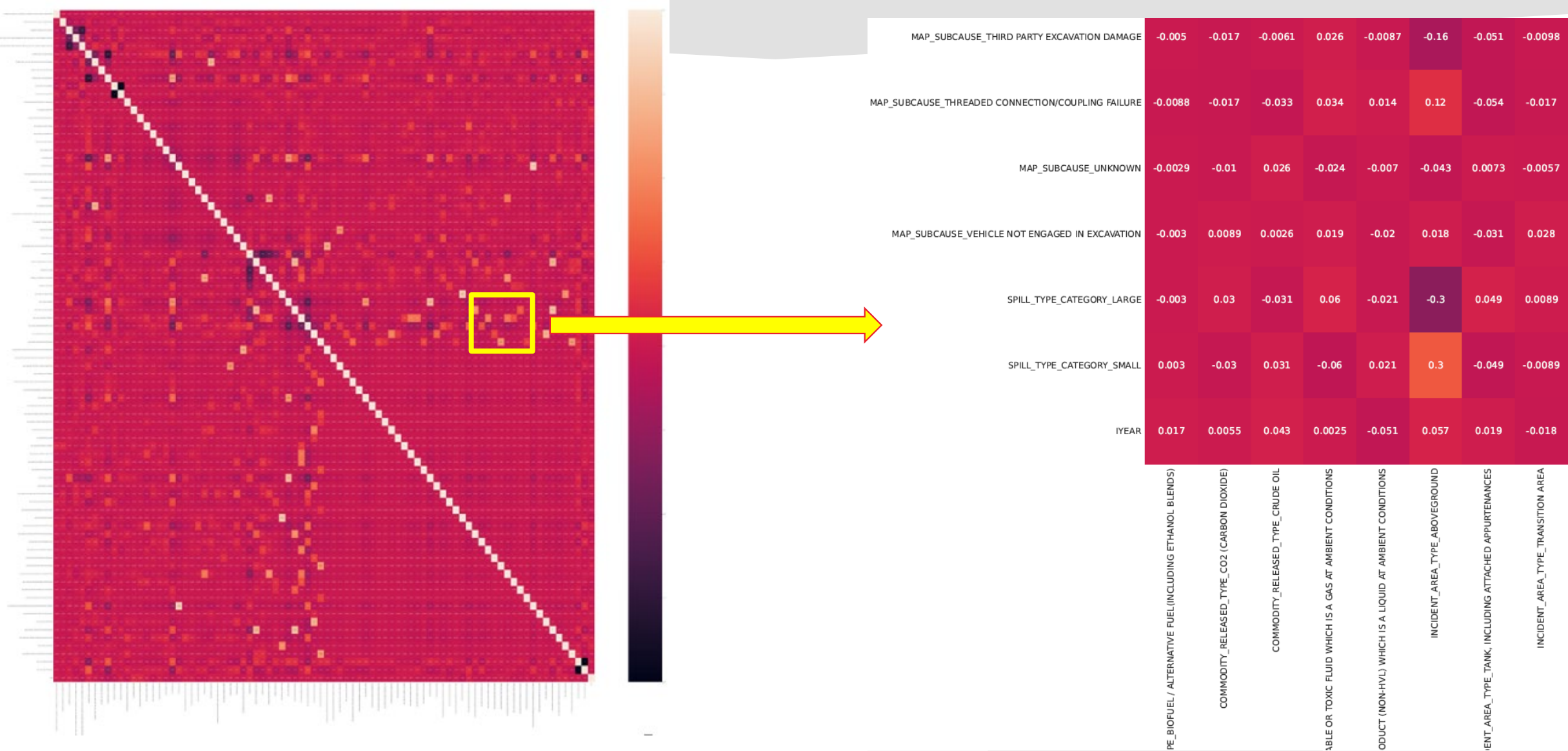
# Data Analytics/Machine Learning

Input factors		Input factors	
<b>Commodity Released Type:</b>	<ul style="list-style-type: none"> <li>Biofuel/Alternative Fuel, including Ethanol Fuel.</li> <li>CO2.</li> <li>Crude Oil.</li> <li>HVL (Highly Volatile Liquids) or Other Flammable or Toxic Fluids which are gases at ambient conditions.</li> <li>Refined and/or Petroleum Products (Non-HVL) which are liquids at ambient conditions.</li> </ul>	<b>Root Cause (MAP Cause):</b>	<ul style="list-style-type: none"> <li>Material.</li> <li>Weld.</li> <li>Equipment Failure.</li> <li>Corrosion.</li> <li>Incorrect Operation.</li> <li>Excavation Damage.</li> <li>Natural Force Damage.</li> <li>All Other Causes.</li> </ul>
<b>Commodity Subtype:</b>	<ul style="list-style-type: none"> <li>Diesel</li> <li>Fuel Oil</li> <li>Kerosene</li> <li>Jet Fuel, etc.</li> </ul>	<b>Root Cause Subcause (MAP Subcause):</b>	<ul style="list-style-type: none"> <li>Internal.</li> <li>Incorrect Valve Position.</li> <li>Overfill.</li> <li>Overflow of Tank, Vessel, Sump.</li> <li>Manufacturing Related.</li> <li>Temperature, etc. (Note: Contains missing values, which should be considered in data preprocessing.)</li> </ul>
<b>Incident Area Type:</b>	<ul style="list-style-type: none"> <li>Interstate.</li> <li>Intrastate.</li> </ul>	<b>Materials Involved:</b>	<ul style="list-style-type: none"> <li>Carbon Steel.</li> <li>Materials other than Carbon Steel.</li> </ul>
<b>Item Involved:</b>	<ul style="list-style-type: none"> <li>Valve.</li> <li>Pipe.</li> <li>Sump.</li> <li>Tank.</li> <li>Vessel.</li> <li>Instrumentation, etc.</li> </ul>	<b>Equipment Failure Type:</b>	<ul style="list-style-type: none"> <li>Pump or Pump-Related Equipment.</li> <li>Threaded Connecting/Coupling Failure, etc. (Note: Contains missing values that should be addressed in data preprocessing.)</li> </ul>
<b>Pipe Type:</b>	missing values	<b>Internal/External:</b>	<ul style="list-style-type: none"> <li>Internal Corrosion.</li> <li>External Corrosion.</li> </ul>
<b>Pipe Diameter:</b>	missing values	<b>Spill Type Category:</b>	<ul style="list-style-type: none"> <li>Small.</li> <li>Large.</li> </ul>
<b>Item Involved Details:</b>	<ul style="list-style-type: none"> <li>Relief Valve and Support.</li> <li>Fitting on Pressure Regulator, etc. (missing values)</li> </ul>		

Output factor (response)	Output factor (response)
<b>Type of Release:</b>	<ul style="list-style-type: none"> <li>Leak</li> <li>Mechanical Rupture</li> <li>Rupture</li> <li>Overfill or Overflow</li> <li>Other</li> </ul>
<b>Type of Leak:</b>	<ul style="list-style-type: none"> <li>Connection Failure</li> <li>Crack</li> <li>Pinhole</li> <li>Seal or Packing</li> <li>Other</li> </ul>



# Data Analytics/Machine Learning



# For More Information



[www. BakerRisk.com](http://www.BakerRisk.com)



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Full Scale Modular Building Test