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PHMSA-Supported GTI LNG Research Program

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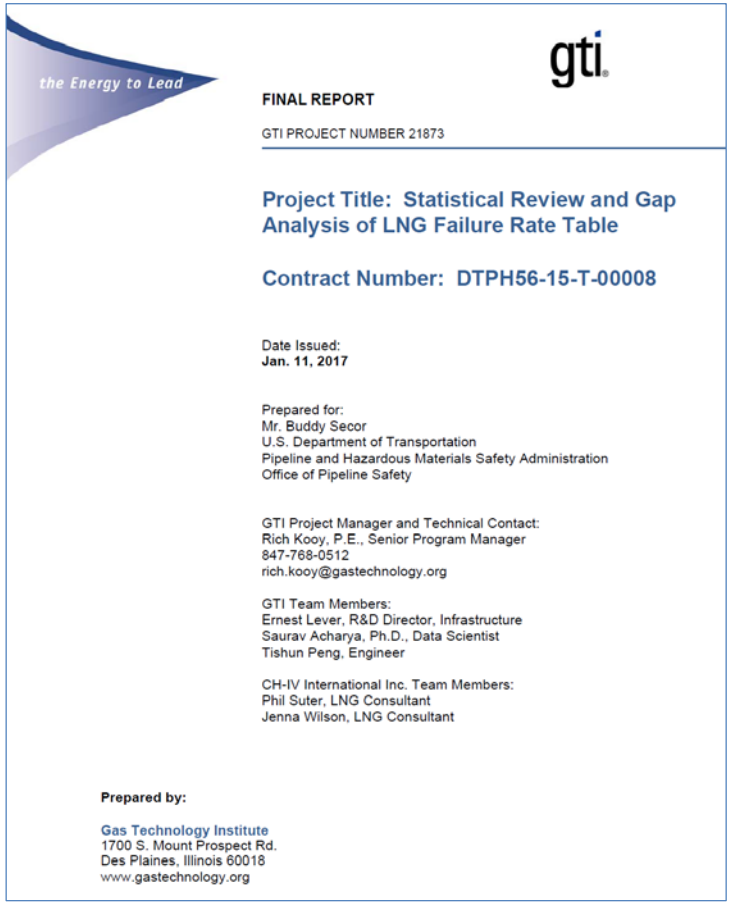
Statistical Review and Gap Analysis of LNG Failure Rate Table

- (PHMSA) contract #DTPH56-15-T-00008
- Review and consider recommendations for potential refinements of the LNG Failure Rate Table ("FRT")
- Update established criteria for Design Spills into impounding areas at LNG facilities.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FINAL REPORT

GTI PROJECT NUMBER 21873

Project Title: Statistical Review and Gap Analysis of LNG Failure Rate Table

Contract Number: DTPH56-15-T-00008

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Prepared for:
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Performance of Process Safety Management Standards and Regulatory Requirements

Objective

- Support PHMSA's review and strategy to update regulatory requirements for Process Safety Management (PSM) systems for LNG facilities
- Improve safety best practices at LNG facilities and enhance consistency with other industry standards.

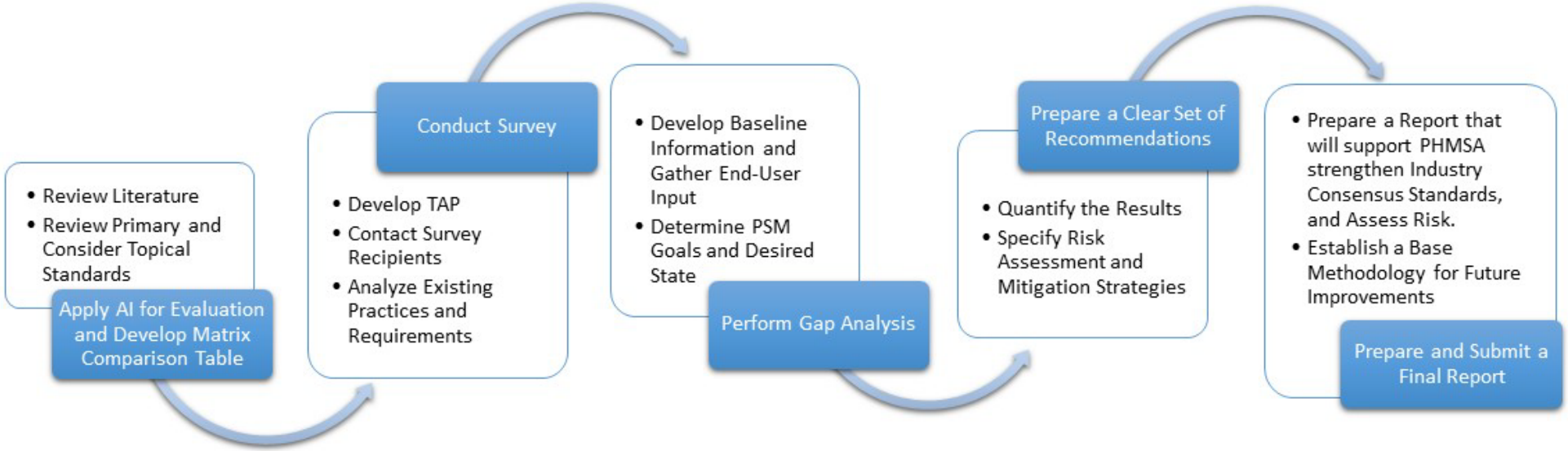
Research Team

- Gas Technology Institute
- Blue Consultants

Performance of Process Safety Management Standards and Regulatory Requirements

Approach

- Matrix comparison model to compare the primary applicable regulations and standards. Conduct a broad survey of industry best practices.
- Utilize an artificial intelligence (AI) approach supported by SME analysis to identify the interactions between the standards and best practices, gap analysis, and prioritization.
- Mitigation strategies and recommendations to address the high priority risks .



Performance of Process Safety Management Standards and Regulatory Requirements

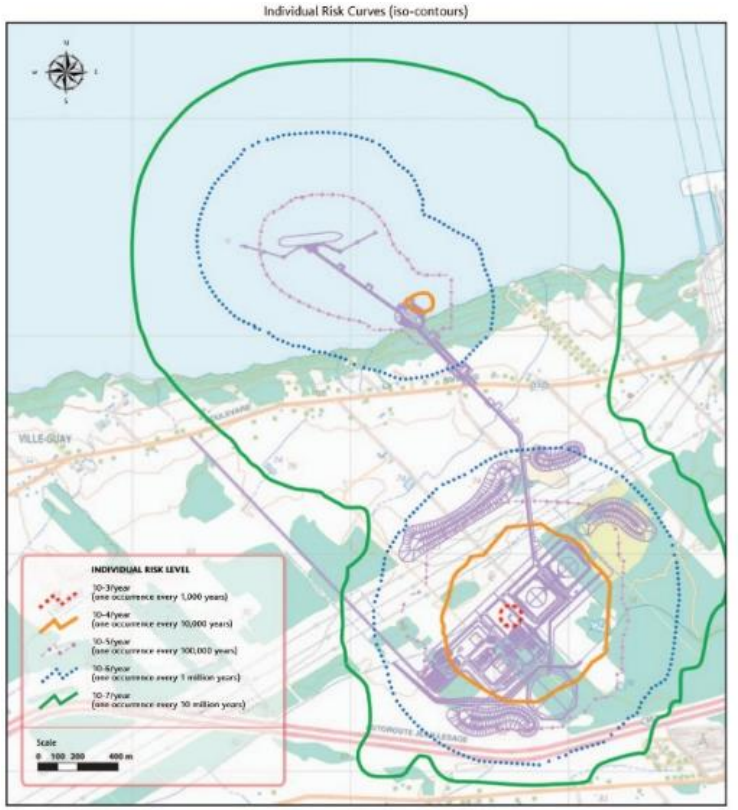
Deliverables

- Summary of PSM goals, industry standards, and desired state of PSM requirements for LNG facilities
- Gap Analysis between current requirements, regulations and practices (e.g., 49 CFR Part 193, API RP 1173, 29 CFR Part 1910.119) and desired state of PSM for LNG
- Recommendations to enhance PSM regulations for LNG.

Review of Methodologies for Quantitative Risk Assessments for LNG Facilities

Objective

- Methodology and guideline to establish more consistency, guidance, and best practices for QRA on LNG facilities and interpret results
- Applicable to both grandfathered LNG facilities and new facilities
- Focused on LNG but also relevant to QRAs for Transmission & Distribution



Rabaska LNG Terminal (Quebec) Risk Assessment 2007
Image Credit: http://www.rabaska.net/safety#terminal

Review of Methodologies for Quantitative Risk Assessments for LNG Facilities

>Deliverables

- Guideline and methodology for performing QRA for LNG facilities
- Representative facility risk profiles Recommendations
- Demonstrate QRA methodology in two different generic LNG peak shaving and export facilities.

Research Team

- Gas Technology Institute
- C-FER Technologies (1999) Inc.
- Blue Consultants
- Idaho National Laboratory

Data Integration Approach in GTI's LNG Research Program

High Level Challenge:

"Data integration to support more informed identification, characterization and fitness for purpose of anomalies"

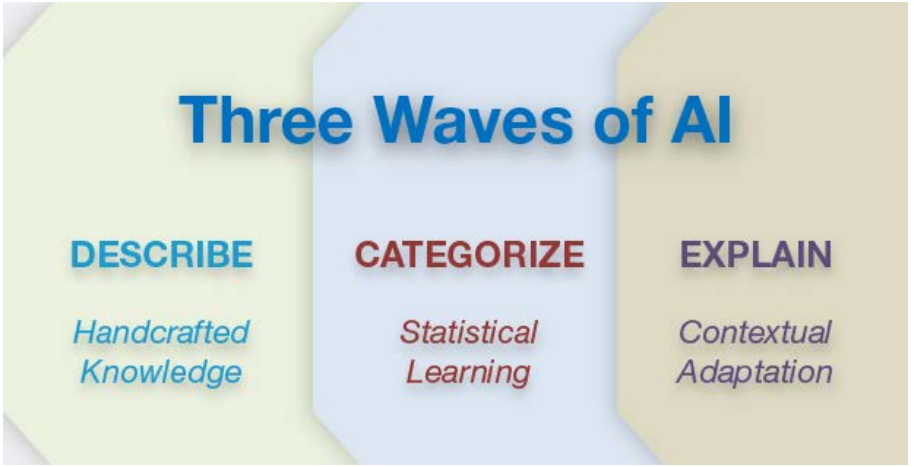
Sub-Challenges

- Uncertainty
- Disparate data sources
- Competing objectives
- How to support human decision makers in achieving their goals.

Explainable AI (XAI) Approach

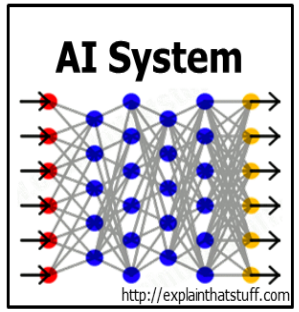
Explainable AI (XAI) program aims to create a suite of machine learning techniques that:

- Produce more explainable models, while maintaining a high level of learning performance (prediction accuracy)
- Enable human users to understand, trust, and effectively manage the emerging generation of artificially intelligent partners.



Source: DARPA, Advanced Research Project Agency

Explainable AI (XAI) Approach



- We are entering a new age of AI applications
- Machine learning is the core technology
- Machine learning models are opaque, non-intuitive, and difficult for people to understand

DoD and non-DoD Applications

Transportation

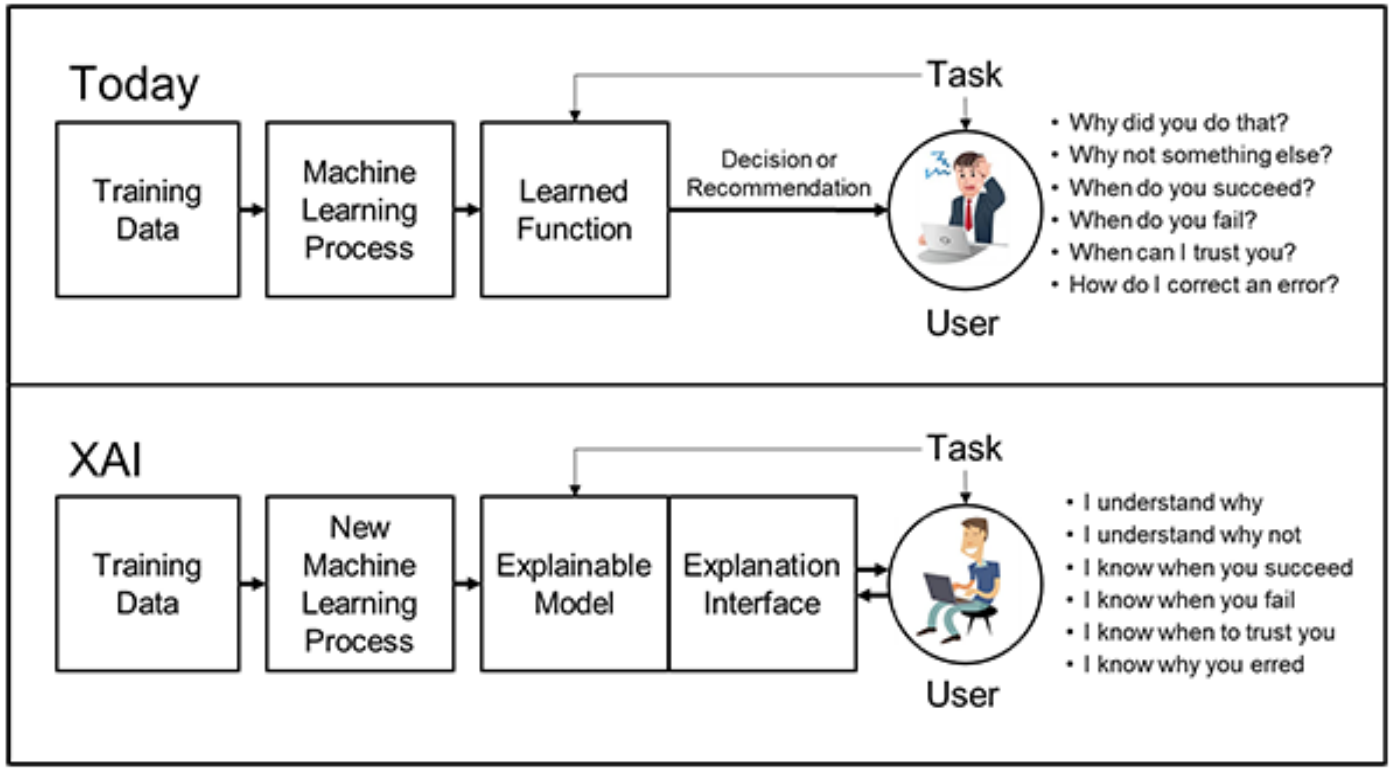
Security

Medicine

Finance

Legal

Military



Explainable AI (XAI) Approach

All Data Sources are Valid Inputs:

- Weight all available data sources correctly
- Provide coherent synthesis of all data sources
- Recognize subject matter expertise
- Emphasize the human interface
- Recommend multiple options for mitigation of problems to subject matter experts.

Explainable AI (XAI) Approach

Apply network methods that are ideally suited to:

- Addressing interactions
- Dealing with sparse data
- Incorporating big data
- Learning with each iteration
- Providing forensic reasoning to identify root causes
- Providing probabilistic prediction of future states.